

Contract No. FN5008

Metro Matters: Rail Yards Expansion (Greenbelt and Shady Grove Yards)

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00520 AGREEMENT FORM

This Section includes the Contract Form to be executed and submitted by the successful proposer and represents the legal instrument binding the two parties to the work once the document is signed by the Authority and the Design-Builder. PROPOSER'S INFORMATION NOTICE: The following form is included for the proposer's information and use in the event he is awarded the Contract. It is not required to be submitted with the proposal.

00521 DESIGN-BUILD CONTRACT FORM

DESIGN/BUILDER: Hensel-Phelps Construction Company, Inc. **CONTRACT NUMBER:** FN5008
4437 Brookfield Corporate Drive
Suite 207
Chantilly, VA 20151 **Date:** July 25, 2005

CONTRACT FOR: RAIL YARDS EXPANSION PROJECT AT GREENBELT & SHADY GROVE YARDS

CONTRACT TYPE: FIXED-PRICE CONSTRUCTION

CONTRACT PRICE: Ninety-Eight Million Three Hundred Thousand Twenty-One Dollars \$98,321,000.00

CONTRACT PERFORMANCE TIME: Shady Grove: NTP + 825 calendar days
Greenbelt: NTP + 660 calendar days

In consideration of the covenants contained herein, the Washington Metropolitan Area Transit Authority (hereinafter called the Authority), represented by the Contracting Officer executing this Contract, and the individual, partnership, joint venture or corporation named above (hereinafter, the Design-Builder), mutually agree to perform this Contract in strict accordance with its provisions. The Contract consists of: this RFP and its amendments, if any; all documents referenced or attached to the RFP including the following:

1. Project Manual as defined in the General Conditions including the Project Drawings and other attachments to the Project Manual.
2. Design-Builder's Proposals as finally accepted.
3. Other publications referenced in the Contract Documents.
4. Amendment Number(s): 001 thru 007

ALTERATIONS: The following alterations were made to this Contract before it was signed by the parties hereto:

In Witness Whereof, the parties hereto have executed this Contract as of the date entered above.

ATTEST: T. Wolf *By: [Signature]
HENSEL PHELPS CONSTRUCTION CO.
Design-Builder

ATTEST: T. Wolf *By: [Signature]
HENSEL PHELPS CONSTRUCTION CO.
Design-Builder

ATTEST: T. Wolf *By: [Signature]
HENSEL PHELPS CONSTRUCTION CO.
Design-Builder
**WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY**

By: [Signature]
Washington Metropolitan Area Transit Authority

***NOTE:** Execution for the Design-Builder that is an individual, corporation or partnership shall be accompanied by the Power of Execution that follows. A Joint Venture Design-Builder must complete the Power of Attorney that follows. All persons executing this Contract must complete the appropriate Certification of the person's authority to act on behalf of the Design-Builder.

00434 PRICE SCHEDULE - Submit with Price Proposal

A. DESCRIPTION OF WORK:

The Design-Builder shall Design and Build the Facilities satisfactorily completed for its intended use in the manner and at the locations set forth in the Requirements of the Project Manual and the Project Drawings of this solicitation, and in accordance with the Technical and Price Proposals as finally accepted by the Authority. The Design-Builder shall design the facility pursuant to the Authority's Design Criteria, and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities, and shall construct the facility in strict accordance with the Final Design Specifications and Final Design Drawings and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities.

Schedule A: GREENBELT YARD EXPANSION

Item	Description	Qty	Unit	Amount
1	Sitework			
1-A	Demolition	1	LS	\$ <u>150,422</u>
1-B	Earthwork	1	LS	\$ <u>182,700</u>
1-C	Paving and Surfacing	1	LS	\$ <u>307,938</u>
1-D	Piped Utilities	1	LS	\$ <u>543,211</u>
1-E	Site Improvements	1	LS	\$ <u>181,700</u>
1-F	Yard Electrical Work	1	LS	\$ <u>358,903</u>
2	New Shop and Existing Shop Reconfiguration			
2-A	Demolition and Earthworks	1	LS	\$ <u>1,478,323</u>
2-B	Concrete and Masonry	1	LS	\$ <u>4,500,816</u>
2-C	Metals	1	LS	\$ <u>2,464,733</u>
2-D	Thermal and Moisture Protection	1	LS	\$ <u>1,335,010</u>
2-E	Interior Construction and Finishes	1	LS	\$ <u>1,196,861</u>
2-F	Conveying Systems	1	LS	\$ <u>336,980</u>
2-G	Mechanical	1	LS	\$ <u>5,391,684</u>

Item	Description	Qty	Unit	Amount
2-H	Electrical	1	LS	\$ <u>4,715,244</u>
2-I	Building Communication and Electrical Specialties	1	LS	\$ <u>1,076,710</u>
3	Major Shop Equipment (Drwg. E11a-A-06, Sections 1003 - 1009, 1012 - 1021, 1024, 1044-1046, 1048)	1	LS	\$ <u>6,671,176</u>
4	Environmental Mitigation			
4-A	Petroleum Contaminated soil removal & disposal	120	CY	\$ <u>10,000</u>
4-B	Petroleum Contaminated Ground water removal & disposal	20	1000 GLS	\$ <u>5,000</u>
4-C	Other (Detergent, etc.) Contaminated soil removal & disposal	0	CY	\$ <u>0</u>
4-D	Other (Detergent, etc.) Contaminated ground water removal & disposal	200	1000 GLS	\$ <u>47,000</u>
5	Systems			
5-A	Track Work	1	LS	\$ <u>0</u>
5-B	Traction Power	1	LS	\$ <u>0</u>
5-C	Automatic Train Control	1	LS	\$ <u>0</u>
5-D	Train Control Communications	1	LS	\$ <u>0</u>
6	Design for Items 1 thru 5	1	LS	\$ <u>4,910,099</u>
7	Project General Conditions	1	LS	\$ <u>5,550,491</u>
SUBTOTAL Schedule A				\$41,415,000

Schedule B: SHADY GROVE YARD EXPANSION

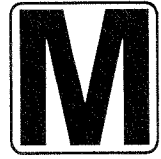
Item	Description	Qty	Unit	Amount
1	Sitework			
1-A	Demolition	1	LS	\$ <u>611,528</u>
1-B	Earthwork	1	LS	\$ <u>644,252</u>
1-C	Paving and Surfacing	1	LS	\$ <u>1,206,577</u>

Item	Description	Qty	Unit	Amount
1-D	Piped Utilities	1	LS	\$ <u>3,165,552</u>
1-E	Site Improvements	1	LS	\$ <u>760,225</u>
1-F	Yard Electrical Work	1	LS	\$ <u>1,606,616</u>
2	New Shop and Existing Shop Reconfiguration			
2-A	Demolition and Earthworks	1	LS	\$ <u>830,398</u>
2-B	Concrete and Masonry	1	LS	\$ <u>6,620,410</u>
2-C	Metals	1	LS	\$ <u>2,467,372</u>
2-D	Thermal and Moisture Protection	1	LS	\$ <u>644,004</u>
2-E	Interior Construction and Finishes	1	LS	\$ <u>722,541</u>
2-F	Conveying Systems	1	LS	\$ <u>58,641</u>
2-G	Mechanical	1	LS	\$ <u>4,857,777</u>
2-H	Electrical	1	LS	\$ <u>3,780,124</u>
2-I	Building Communication and Electrical Specialties	1	LS	\$ <u>1,032,825</u>
3	Shop Equipment Tools \$ Supplies	1	LS	\$ <u>5,060,926</u>
4	Environmental Mitigation			
4-A	Petroleum Contaminated soil removal & disposal	2500	CY	\$ <u>213,000</u>
4-B	Petroleum Contaminated Ground water removal & disposal	100	1000 GLS	\$ <u>52,000</u>
4-C	Other (Detergent, etc.) Contaminated soil removal & disposal	0	CY	\$ <u>0</u>
4-D	Other (Detergent, etc.) Contaminated ground water removal & disposal	0	1000 GLS	\$ <u>0</u>
5	Systems			
5-A	Track Work	1	LS	\$ <u>4,080,784</u>
5-B	Traction Power	1	LS	\$ <u>1,721,375</u>
5-C	Automatic Train Control	1	LS	\$ <u>6,205,159</u>
5-D	Train Control Communications	1	LS	\$ <u>w/ above</u>

Item	Description	Qty	Unit	Amount
6	Design for Items 1 thru 5	1	LS	\$ <u>4,354,093</u>
7	Project General Conditions	1	LS	\$ <u>4,103,822</u>
SUBTOTAL Schedule B				<u>\$54,800,000</u>

Schedule C: MISCELLANEOUS ALLOWANCES FOR GREENBELT/SHADY GROVE PROJECT

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ <u>20,000</u>
2	Disputes Review Board (Section 01260)	LS	\$ <u>86,000</u>
3	Minor Shop Equipment (Greenbelt Yard Only)	LS	\$ <u>1,500,000</u>
4	Spare Parts (Section 01780 1.07)	LS	\$ <u>500,000</u>
TOTAL Schedules A, B, C			<u>\$98,321,000</u>



metro[®]

washington
metropolitan
area transit
authority

Project Manual

**BOOK 1
(DIVISION 0-1)**

METRO MATTERS DESIGN/BUILD: RAIL YARDS EXPANSION PROJECT AT BRENTWOOD, GREENBELT, AND SHADY GROVE YARDS

Contract No. FN5008

**December 2004
(Reissued)**

**DIVISION 0
PROCUREMENT AND CONTRACTING REQUIREMENTS**

END OF SECTION



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INTRODUCTORY INFORMATION

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INTRODUCTORY INFORMATION

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PROJECT MANUAL

FOR

RFP-FN5008/FMP

DESIGN-BUILD

CONTRACT FN5008

METRO MATTERS: RAIL YARDS EXPANSION PROJECT
AT BRENTWOOD, GREENBELT, AND SHADY GROVE YARDS

December 3, 2004

END OF SECTION



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INTRODUCTORY INFORMATION

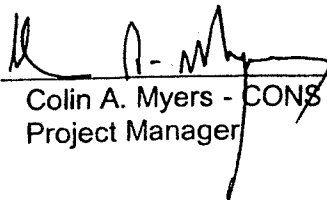
00005 SOLICITATION CERTIFICATIONS PAGE

METRO MATTERS: RAIL YARDS EXPANSION PROJECT
AT BRENTWOOD, GREENBELT, AND SHADY GROVE YARDS

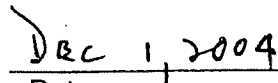
DESIGN-BUILD

CONTRACT No. FN5008

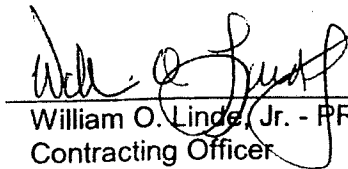
APPROVED FOR RELEASE



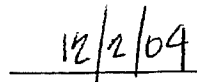
Colin A. Myers - CONS
Project Manager



Date



William O. Linde, Jr. - PRMT
Contracting Officer



Date

END OF SECTION



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INTRODUCTORY INFORMATION

00015 LIST OF PROJECT DRAWINGS

Book 1 of 3

<u>SHEET NO.</u>	<u>DRAWING NO.</u>	<u>TITLE OF DRAWING</u>
		BOOK 1
		COVER
M1210- 001	E11-G-00	INDEX OF DRAWINGS
M1210- 002	E11-G-01	INDEX OF DRAWINGS
M1210- 002A	E11-G-02	SYSTEM MAP
M1210- 003	E11-G-03	SUGGESTED STAGING NOTES
M1210- 004	E11-WS-03	STAGING PLAN - SHEET 1 OF 2
M1210- 005	E11-WS-01	STAGING PLAN - SHEET 2 OF 2
M1210- 006	E11-WS-02	AERIAL LAYOUT - 1
M1210- 007	E11-C-01	AERIAL LAYOUT - 2
M1210- 008	E11-C-02	HORIZONTAL AND VERTICAL CONTROL & DESCRIPTIONS
M1210- 009	E11-C-03	EXISTING SURVEY W/GEOTECH BORING LOCATION PLAN
M1210- 010	E11-SP-01	EXISTING SURVEY PLAN 1
M1210- 011	E11-SP-02	EXISTING SURVEY PLAN 2
M1210- 012	E11-SP-03	SITE OVERVIEW
M1210- 013	E11-G-04	SITE PLAN 1 - PARKING LOTS
M1210- 014	E11-G-05	SITE PLAN 2 - ANNEX
M1210- 015	E11-G-06	EXISTING UTILITY PLAN - 1
M1210- 016	E11-U-01	EXISTING UTILITY PLAN - 2
M1210- 017	E11-U-02	COMPOSITE UTILITY & GRADING PLAN - PARKING LOTS
M1210- 018	E11-U-03	COMPOSITE UTILITY & GRADING PLAN - ANNEX
M1210- 019	E11-U-04	STORMWATER MANAGEMENT PLAN - PARKING LOTS
M1210- 020	E11-SW-01	STORMWATER MANAGEMENT PLAN - ANNEX
M1210- 021	E11-SW-02	STORMWATER MANAGEMENT DETAILS
M1210- 022	E11-SW-03	STORMWATER MANAGEMENT PROFILES
M1210- 023	E11-SW-04	SOIL BORING LOGS B-1 TO B-2
M1210- 024	E11-SO-01	SOIL BORING LOGS B-3 TO B-4
M1210- 025	E11-SO-02	SOIL BORING LOGS B-5 TO B-6
M1210- 026	E11-SO-03	SOIL BORING LOGS B-7 TO B-8
M1210- 027	E11-SO-04	SOIL BORING LOGS B-9 TO B-10
M1210- 028	E11-SO-05	SOIL BORING LOGS B-11 TO B-12
M1210- 029	E11-SO-06	SOIL BORING LOGS B-13 TO B-14
M1210- 030	E11-SO-07	SOIL BORING LOGS B-15 TO B-16
M1210- 031	E11-SO-08	SOIL BORING LOGS B-17 TO B-18
M1210- 032	E11-SO-09	SOIL BORING LOGS B-19
M1210- 033	E11-SO-10	TRACK ALIGNMENT TRACK PLAN
M1210- 034	E11-TA-01	TRACK ALIGNMENT PROFILES
M1210- 035	E11-TA-02	TRACK ALIGNMENT DATA
M1210- 036	E11-TA-21	TRACK ALIGNMENT & TRACKWORK ABBREVIATIONS &
M1210- 037	E11-TW-04	

		SYMBOLS
M1210- 038	E11-TW-01	TRACKWORK TYPICAL SECTIONS, BALLASTED TRACK
M1210- 039	E11-TW-03	TRACK CONSTRUCTION PLAN & TURNOUT IDENTIFICATION MATRIX
M1210- 040	E11-TW-08	NO.6 GUARDED TURNOUT, BALLASTED TRACK
M1210- 041	E11-TW-09	NO.6 GUARDED TURNOUT, RAIL LAYOUT, BALLASTED TRACK
M1210- 042	E11-TW-10	NO.6 GUARDED TURNOUT, PLATED SWITCH, BALLASTED TRACK
M1210- 043	E11-TW-11	NO.6 GUARDED TURNOUT, PLATED FROG, BALLASTED TRACK
M1210- 044	E11-TW-12	NO.6 GUARDED TURNOUT, MANGANESE HOUSING PLATE DETAILS
M1210- 045	E11-TW-13	NO.6 GUARDED TURNOUT, DOUBLE RAIL INSULATED JOINT & SEPARATOR BLOCK DETAILS
M1210- 046	E11-TW-14	TIMBER GRADE CROSSING DETAILS
M1210- 047	E11-TW-15	MOW BUMPING POST
M1210- 048		NOT USED
M1210- 049		NOT USED
M1210- 050		NOT USED
M1210- 051		NOT USED
M1210- 052		NOT USED
M1210- 053	E11-A-01	CODE ANALYSIS, SYMBOLS & ABBREVIATIONS, ARCHITECTURAL
M1210- 054	E11-A-02	FIXED EQUIPMENT LIST
M1210- 055	E11-A-03	FIXED EQUIPMENT LIST
M1210- 056	E11-A-04	FIXED EQUIPMENT LIST
M1210- 057	E11-A-05	FIXED EQUIPMENT LIST
M1210- 058	E11-A-06	FIXED EQUIPMENT LIST
M1210- 059	E11-A-07	NOT USED
M1210- 060	E11-A-08	NOT USED
M1210- 061	E11-A-09	FIRST FLOOR OVERALL PLAN
M1210- 062	E11-A-10	SECOND FLOOR OVERALL PLAN
M1210- 063	E11-A-11	FIRST FLOOR PLAN AREA 5
M1210- 064	E11-A-12	FIRST FLOOR PLAN AREA 6
M1210- 065	E11-A-13	FIRST FLOOR PLAN AREA 8
M1210- 066	E11-A-14	FIRST FLOOR PLAN AREA 9
M1210- 067	E11-A-15	FIRST FLOOR PLAN AREA 10
M1210- 068	E11-A-16	FIRST FLOOR PLAN AREA 11
M1210- 069	E11-A-17	FIRST FLOOR PLAN AREA 12
M1210- 070	E11-A-18	SECOND FLOOR PLAN AREA 11
M1210- 071	E11-A-19	SECOND FLOOR PLAN AREA 12
M1210- 072	E11-A-20	ROOF PLAN
M1210- 073	E11-A-21	EXTERIOR ELEVATIONS
M1210- 074	E11-A-22	EXTERIOR ELEVATIONS
M1210- 075	E11-A-23	EXTERIOR ELEVATIONS
M1210- 076	E11-A-24	BUILDING SECTIONS
M1210- 077	E11-A-25	BUILDING SECTIONS
M1210- 078	E11-A-26	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR OVERALL PLAN
M1210- 079	E11-A-27	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR OVERALL PLAN

M1210- 080	E11-A-28	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN AREA 5
M1210- 081	E11-A-29	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN AREA 6
M1210- 082	E11-A-30	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN AREA 8
M1210- 083	E11-A-31	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN AREA 9
M1210- 084	E11-A-32	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN AREA 10
M1210- 085	E11-A-33	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 10
M1210- 086	E11-M-01	EXISTING CONDITIONS - REFERENCE ONLY - ABBREVIATIONS
M1210- 087	E11-M-02	EXISTING CONDITIONS - REFERENCE ONLY - SYMBOLS
M1210- 088	E11-M-03	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN AREA 5 - DUCTWORK
M1210- 089	E11-M-04	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 6 - DUCTWORK
M1210- 090	E11-M-05	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 7 - DUCTWORK
M1210- 091	E11-M-06	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 8 - DUCTWORK
M1210- 092	E11-M-07	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 9 - DUCTWORK
M1210- 093	E11-M-08	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 10 - DUCTWORK
M1210- 094	E11-M-09	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 6 - DUCTWORK
M1210- 095	E11-M-10	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 7 - DUCTWORK
M1210- 096	E11-M-11	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 9 - DUCTWORK
M1210- 097	E11-M-12	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 10 - DUCTWORK
M1210- 098	E11-M-13	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 5 - MECHANICAL
M1210- 099	E11-M-14	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 6 - MECHANICAL
M1210- 100	E11-M-15	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 7 - MECHANICAL
M1210- 101	E11-M-16	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 8 - MECHANICAL
M1210- 102	E11-M-17	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 9 - MECHANICAL
M1210- 103	E11-M-18	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 10 - MECHANICAL

M1210- 104	E11-M-19	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREAS 9 & 10 - HVAC PIPING
M1210- 105	E11-M-20	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 4 - FIRE PROT
M1210- 106	E11-M-21	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 5 - FIRE PROT
M1210- 107	E11-M-22	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 6 - FIRE PROT
M1210- 108	E11-M-23	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 7 - FIRE PROT
M1210- 109	E11-M-24	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 8 - FIRE PROT
M1210- 110	E11-M-25	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 9 - FIRE PROT
M1210- 111	E11-M-26	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 10 - FIRE PROT
M1210- 112	E11-M-27	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 6 - FIRE PROT
M1210- 113	E11-M-28	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 7 - FIRE PROT
M1210- 114	E11-M-29	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 9 - FIRE PROT
M1210- 115	E11-M-30	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 10 - FIRE PROT
M1210- 116	E11-M-31	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 5 - PLUMBING
M1210- 117	E11-M-32	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 6 - PLUMBING
M1210- 118	E11-M-33	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 7 - PLUMBING
M1210- 119	E11-M-34	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 8 - PLUMBING
M1210- 120	E11-M-35	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 9 - PLUMBING
M1210- 121	E11-M-36	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 10 - PLUMBING
M1210- 122	E11-M-37	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 6 - PLUMBING
M1210- 123	E11-M-38	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 7 - PLUMBING
M1210- 124	E11-M-39	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 9 - PLUMBING
M1210- 125	E11-M-40	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 10 - PLUMBING
M1210- 126	E11-M-41	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 5 - PROCESS

M1210- 127	E11-M-42	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 6 - PROCESS
M1210- 128	E11-M-43	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 7 - PROCESS
M1210- 129	E11-M-44	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 8 - PROCESS
M1210- 130	E11-M-45	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 9 - PROCESS
M1210- 131	E11-M-46	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 10 - PROCESS
M1210- 132	E11-M-47	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 6 - PROCESS
M1210- 133	E11-M-48	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 7 - PROCESS
M1210- 134	E11-E-01	EXISTING CONDITIONS - REFERENCE ONLY - SYMBOLS AND ABBREVIATIONS - ELECTRICAL
M1210- 135	E11-E-02	EXISTING CONDITIONS - REFERENCE ONLY - ONE-LINE DIAGRAM BLDG A - ELECTRICAL
M1210- 136	E11-E-03	EXISTING CONDITIONS - REFERENCE ONLY - ONE-LINE DIAGRAM BLDG A - ELECTRICAL
M1210- 137	E11-E-04	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 4 - ELECTRICAL
M1210- 138	E11-E-05	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 5 - ELECTRICAL
M1210- 139	E11-E-06	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 6 - ELECTRICAL
M1210- 140	E11-E-07	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 7 - ELECTRICAL
M1210- 141	E11-E-08	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 8 - ELECTRICAL
M1210- 142	E11-E-09	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 9 - ELECTRICAL
M1210- 143	E11-E-10	EXISTING CONDITIONS - REFERENCE ONLY - FIRST FLOOR PLAN - AREA 10 - ELECTRICAL
M1210- 144	E11-E-11	EXISTING CONDITIONS - REFERENCE ONLY - SECOND FLOOR PLAN - AREA 10 - ELECTRICAL
M1210- 145	E11-E-12	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 9 - ELECTRICAL
M1210- 146	E11-E-13	EXISTING CONDITIONS - REFERENCE ONLY - PANEL SCHEDULES - ELECTRICAL
M1210- 147	E11-E-14	EXISTING CONDITIONS - REFERENCE ONLY - PANEL SCHEDULES - ELECTRICAL
M1210- 148	E11-E-15	EXISTING CONDITIONS - REFERENCE ONLY - PANEL SCHEDULES - ELECTRICAL
M1210- 149	E11-E-16	EXISTING CONDITIONS - REFERENCE ONLY - PANEL SCHEDULES - ELECTRICAL



M1210- 150	E11-E-17	EXISTING CONDITIONS - REFERENCE ONLY - PANEL SCHEDULES - ELECTRICAL
M1210- 151	E11-E-18	EXISTING CONDITIONS - REFERENCE ONLY - PANEL SCHEDULES - ELECTRICAL
152		NOT USED

COMMUNICATIONS

NONE	COVER SHEET GREENBELT YARD GATEHOUSE DATA FILE
GBY-01	GATEHOUSE DATA FILE - FIRE ZONES
GBY-02	GATEHOUSE DATA FILE - INTRUSION ZONES
GBY-03	GATEHOUSE DATA FILE - TALKBACK SYSTEM
GBY-04	GATEHOUSE DATA FILE - S&I BLDG. PUBLIC ADDRESS
GBY-05	GATEHOUSE DATA FILE - S&I BLDG. PUBLIC ADDRESS
GBY-06	GATEHOUSE DATA FILE - S&I BLDG. PUBLIC ADDRESS
GBY-07	GATEHOUSE DATA FILE - FMNT/SMNT FIELD BASE BLDG. PA
GBY-08	GATEHOUSE DATA FILE - OPERATIONS BLDG. PUBLIC ADDRESS
GBY-09	GATEHOUSE DATA FILE - PAINT SHOP BLDG. PUBLIC ADDRESS
GBY-10	GATEHOUSE DATA FILE - GATEHOUSE CCTV SYSTEM
GBY-11	GATEHOUSE DATA FILE - YARD CONTROL CCTV SYSTEM
GBY-12	GATEHOUSE DATA FILE - S & I BLDG TEL LOCATIONS & NUMBERS
GBY-13	GATEHOUSE DATA FILE - S & I BLDG TEL LOCATIONS & NUMBERS
GBY-14	GATEHOUSE DATA FILE - S & I BLDG TEL LOCATIONS & NUMBERS
GBY-15	GATEHOUSE DATA FILE - FMNT/SMNT FIELD BASE TEL LOC & NO.
GBY-16	GATEHOUSE DATA FILE - OPERATIONS BLDG TEL LOC. & NO
GBY-17	GATEHOUSE DATA FILE - ANCILLARY BLDGS TEL LOC. & NO
GBY-18	GATEHOUSE DATA FILE - PAINT SHOP BLDG TEL LOC. & NO
CTS-G800	CARRIER TRANSMISSION SYSTEM BLOCK DIAGRAM
CTS-G801 SHT 1 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G801 SHT 2 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G801 SHT 3 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G801 SHT 4 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G801 SHT 5 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G801 SHT 6 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G801 SHT 7 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G801 SHT 8 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G801 SHT 9 OF 9	CARRIER TRANSMISSION SYSTEM SCHEMATIC DIAGRAM
CTS-G802	DATA SYSTEM BLOCK DIAGRAM
CTS-G803 SHT 1 OF 4	DATA SYSTEM SCHEMATIC DIAGRAM
CTS-G803 SHT 2 OF 4	DATA SYSTEM SCHEMATIC DIAGRAM
CTS-G803 SHT 3 OF 4	DATA SYSTEM SCHEMATIC DIAGRAM
CTS-G803 SHT 4 OF 4	DATA SYSTEM SCHEMATIC DIAGRAM
E-10-G800 SHT 1 OF 2	CARRIER TRANSMISSION SYSTEM INSTALLATION
E-10-G800 SHT 2 OF 2	CARRIER TRANSMISSION SYSTEM INSTALLATION
E99-G000	COMMUNICATIONS ROOM GROUNDING DETAILS
E99-G001 SHT 1 OF 3	COMMUNICATIONS ROOM INSTALLATION DETAILS
E99-G001 SHT 2 OF 3	COMMUNICATIONS ROOM INSTALLATION DETAILS
E99-G001 SHT 3 OF 3	COMMUNICATIONS ROOM INSTALLATION DETAILS
E99-G002	COMMUNICATIONS ROOM CABLE TRAY INSTALLATION DETAILS

E99-G003	YARD OPERATIONS BUILDING MAIN COMMUNICATIONS ROOM
E99-G004 SHT 1 OF 3	YARD OPERATIONS BUILDING MDF AND PROTECTORS
E99-G004 SHT 2 OF 3	YARD OPERATIONS BUILDING MDF AND PROTECTORS
E99-G004 SHT 3 OF 3	YARD OPERATIONS BUILDING MDF AND PROTECTORS
E99-G005	S & I SHOP BUILDING COMMUNICATIONS AND DATA ROOMS
E99-G006 SHT 1 OF 2	S & I SHOP COMMUNICATIONS ROOM MDF AND PROTECTORS
E99-G006 SHT 2 OF 2	S & I SHOP COMMUNICATIONS ROOM MDF AND PROTECTORS
E99-G007 SHT 1 OF 2	FMNT/SMNT BUILDING COMMUNICATIONS CLOSET
E99-G007 SHT 2 OF 2	FMNT/SMNT BUILDING COMMUNICATIONS CLOSET
E99-G008 SHT 1 OF 2	PAINT SHOP ELECTRIC AND COMMUNICATIONS ROOM
E99-G008 SHT 2 OF 2	PAINT SHOP ELECTRIC AND COMMUNICATIONS ROOM
E99-G009	S & I SHOP BUILDING SINGLE LINE DIAGRAM
E99-G010	YARD OPERATIONS BUILDING SINGLE LINE DIAGRAM
E99-G011	S & I SHOP BUILDING COMM ROOM POWER DISTRIBUTION
E99-G012	YARD OPERATIONS BUILDING POWER DISTRIBUTION
E99-G013	GATEHOUSE EMERGENCY POWER DISTRIBUTION
E99-G014	COMM EQUIP AND DATA ROOM TYPICAL AC POWER DETAILS
E99-G015	GATEHOUSE TYPICAL EMERGENCY AC POWER CIRCUIT DETAILS
E99-G016 SHT 1 OF 2	TYPICAL AC POWER DETAILS FOR COMM RACKS, CABS & CONSO
E99-G016 SHT 2 OF 2	TYPICAL AC POWER DETAILS FOR COMM RACKS, CABS & CONSO
E99-G0017	TYPICAL CCTV EQUIPMENT CABINET AC POWER DETAILS
E99-G018	YD OPS BLDG. COMM EQUIP -48VDC POWER SYSTEM RACKFACE
E99-G019	YD OPS BLDG. COMM EQUIP -48VDC POWER DISTRIBUTION
E99-G020	FMNT/SMNT FIELD BASE BLDG SINGLE LINE DIAGRAM
E99-G021	FMNT/SMNT FIELD BASE BLDG POWER DISTRIBUTION
E99-G023	TYPICAL SHIELD AND GROUND SCHEME FOR COMM CABLES
E99-G100	TELEPHONE SYSTEM BLOCK DIAGRAM
E99-G101 SHT 1 OF 6	TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G101 SHT 2 OF 6	TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G101 SHT 3 OF 6	TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G101 SHT 4 OF 6	TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G101 SHT 5 OF 6	TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G102	TELEPHONE SYSTEM CABINET ELEVATION
E99-G103 SHT 1 OF 4	TELEPHONE SYSTEM INSTALLATION DETAILS
E99-G103 SHT 2 OF 4	TELEPHONE SYSTEM INSTALLATION DETAILS
E99-G103 SHT 3 OF 4	TELEPHONE SYSTEM INSTALLATION DETAILS
E99-G103 SHT 4 OF 4	TELEPHONE SYSTEM INSTALLATION DETAILS
E99-G104 SHT 1 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G104 SHT 2 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G104 SHT 3 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G104 SHT 4 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G104 SHT 5 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G104 SHT 6 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G104 SHT 7 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G104 SHT 8 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G104 SHT 9 OF 9	S & I SHOP BLDG. TELEPHONE SYSTEM PLAN AND RISER
E99-G105 SHT 1 OF 2	FMNT/SMNT FIELD BASE BLDG TELEPHONE SYS PLAN AND RISER
E99-G105 SHT 2 OF 2	FMNT/SMNT FIELD BASE BLDG TELEPHONE SYS PLAN AND RISER
E99-G106 SHT 1 OF 2	YARD OPERATIONS BLDG. TEL SYSTEM PLAN AND RISER

E99-G106 SHT 2 OF 2 YARD OPERATIONS BLDG. TEL SYSTEM PLAN AND RISER
E99-G107 SHT 1 OF 3 ANCILLARY BUILDING TELEPHONE SYSTEM PLAN AND RISER
E99-G107 SHT 2 OF 3 ANCILLARY BUILDING TELEPHONE SYSTEM PLAN AND RISER
E99-G107 SHT 3 OF 3 ANCILLARY BUILDING TELEPHONE SYSTEM PLAN AND RISER
E99-G108 SHT 1 OF 2 S & I SHOP BLDG TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G108 SHT 2 OF 2 S & I SHOP BLDG TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G109 SHT 1 OF 2 YARD OPS BLDG TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G109 SHT 2 OF 2 YARD OPS BLDG TELEPHONE SYSTEM SCHEMATIC DIAGRAM
E99-G110 SHT 1 OF 2 FMNT/SMNT BASE BLDG. TELEPHONE SYS SCHEMATIC DIAGRAM
E99-G110 SHT 2 OF 2 FMNT/SMNT BASE BLDG. TELEPHONE SYS SCHEMATIC DIAGRAM
E99-G111 SHT 1 OF 2 ANCILLARY BUILDING TELEPHONE SYS SCHEMATIC DIAGRAM
E99-G111 SHT 2 OF 2 ANCILLARY BUILDING TELEPHONE SYS SCHEMATIC DIAGRAM
E99-G200 SHT 1 OF 2 FIRE AND INTRUSION BLOCK DIAGRAM
E99-G200 SHT 2 OF 2 FIRE AND INTRUSION BLOCK DIAGRAM
E99-G201 SHT 1 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 2 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 3 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 4 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 5 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 6 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 7 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 8 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 9 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 10 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 11 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G201 SHT 12 OF 12 FIRE AND INTRUSION SYSTEM SCHEMATIC
E99-G202 FIRE AND INTRUSION SYSTEM KDR-100 CABINET ELEVATION
E99-G203 SHT 1 OF 4 FIRE AND INTRUSION SYSTEM INSTALLATION DETAILS
E99-G203 SHT 2 OF 4 FIRE AND INTRUSION SYSTEM INSTALLATION DETAILS
E99-G203 SHT 3 OF 4 FIRE AND INTRUSION SYSTEM INSTALLATION DETAILS
E99-G203 SHT 4 OF 4 FIRE AND INTRUSION SYSTEM INSTALLATION DETAILS
E99-G205 SHT 1 OF 7 S & I SHOP BLDG. FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G205 SHT 2 OF 7 S & I SHOP BLDG. FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G205 SHT 3 OF 7 S & I SHOP BLDG. FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G205 SHT 4 OF 7 S & I SHOP BLDG. FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G205 SHT 5 OF 7 S & I SHOP BLDG. FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G205 SHT 6 OF 7 S & I SHOP BLDG. FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G205 SHT 7 OF 7 S & I SHOP BLDG. FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G206 SHT 1 OF 2 FMNT/SMNT FLD BASE FIRE AND INTRUSION SYS PLAN AND RISER
E99-G206 SHT 2 OF 2 FMNT/SMNT FLD BASE FIRE AND INTRUSION SYS PLAN AND RISER
E99-G207 SHT 1 OF 2 YD OPS BLDG FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G207 SHT 2 OF 2 YD OPS BLDG FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G208 SHT 1 OF 3 ANCILLARY BLDG FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G208 SHT 2 OF 3 ANCILLARY BLDG FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G208 SHT 3 OF 3 ANCILLARY BLDG FIRE AND INTRUSION SYSTEM PLAN AND RISER
E99-G209 FIRE AND INTRUSION SYSTEM FIA/DF AND PROTECTOR CABINETS
E99-G210 FIRE AND INTRUSION SYSTEM ANNUNCIATOR PANEL DISPLAY
E99-G300 SHT 1 OF 2 CLOSED CIRCUIT TELEVISION SYSTEM BLOCK DIAGRAM
E99-G300 SHT 2 OF 2 CLOSED CIRCUIT TELEVISION SYSTEM BLOCK DIAGRAM
E99-G301 SHT 1 OF 5 CLOSED CIRCUIT TELEVISION SYSTEM SCHEMATIC DIAGRAM
E99-G301 SHT 2 OF 5 CLOSED CIRCUIT TELEVISION SYSTEM SCHEMATIC DIAGRAM

E99-G301 SHT 3 OF 5	CLOSED CIRCUIT TELEVISION SYSTEM SCHEMATIC DIAGRAM
E99-G301 SHT 4 OF 5	CLOSED CIRCUIT TELEVISION SYSTEM SCHEMATIC DIAGRAM
E99-G301 SHT 5 OF 5	CLOSED CIRCUIT TELEVISION SYSTEM SCHEMATIC DIAGRAM
E99-G302	CLOSED CIRCUIT TELEVISION SYSTEM RACKFACE ELEVATION
E99-G303 SHT 1 OF 6	CLOSED CIRCUIT TELEVISION SYSTEM INSTALLATION DETAILS
E99-G303 SHT 2 OF 6	CLOSED CIRCUIT TELEVISION SYSTEM INSTALLATION DETAILS
E99-G303 SHT 3 OF 6	CLOSED CIRCUIT TELEVISION SYSTEM INSTALLATION DETAILS
E99-G303 SHT 4 OF 6	CLOSED CIRCUIT TELEVISION SYSTEM INSTALLATION DETAILS
E99-G303 SHT 5 OF 6	CLOSED CIRCUIT TELEVISION SYSTEM INSTALLATION DETAILS
E99-G303 SHT 6 OF 6	CLOSED CIRCUIT TELEVISION SYSTEM INSTALLATION DETAILS
E99-G304	GATEHOUSE CLOSED CIRCUIT TELEVISION PLAN AND RISER
E99-G305	YD CONTROL RM CLOSED CIRCUIT TELEVISION PLAN AND RISER
E99-G400	MOBILE RADIO SYSTEM BLOCK DIAGRAM
E99-G401 SHT 1 OF 2	MOBILE RADIO SYSTEM INSTALLATION DETAILS
E99-G401 SHT 2 OF 2	MOBILE RADIO SYSTEM INSTALLATION DETAILS
E99-G500	PUBLIC ADDRESS SYSTEM BLOCK DIAGRAM
E99-G501 SHT 1 OF 2	PUBLIC ADDRESS SYSTEM SCHEMATIC DIAGRAM
E99-G501 SHT 2 OF 2	PUBLIC ADDRESS SYSTEM SCHEMATIC DIAGRAM
E99-G502 SHT 1 OF 2	PUBLIC ADDRESS SYSTEM RACKFACE ELEVATION
E99-G502 SHT 2 OF 2	PUBLIC ADDRESS SYSTEM RACKFACE ELEVATION
E99-G503 SHT 1 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G503 SHT 2 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G503 SHT 3 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G503 SHT 4 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G503 SHT 5 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G503 SHT 6 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G503 SHT 7 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G503 SHT 8 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G503 SHT 9 OF 9	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
E99-G504 SHT 1 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G504 SHT 2 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G504 SHT 3 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G504 SHT 4 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G504 SHT 5 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G504 SHT 6 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G504 SHT 7 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G504 SHT 8 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G504 SHT 9 OF 9	S & I SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G505 SHT 1 OF 2	FMNT/SMNT FIELD BASE PUBLIC ADDRESS SYS PLAN AND RISER
E99-G505 SHT 2 OF 2	FMNT/SMNT FIELD BASE PUBLIC ADDRESS SYS PLAN AND RISER
E99-G506 SHT 1 OF 2	YARD OPS BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G506 SHT 2 OF 2	YARD OPS BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G507	PAINT SHOP BLDG. PUBLIC ADDRESS SYSTEM PLAN AND RISER
E99-G508	TALKBACK SYSTEM BLOCK DIAGRAM
E99-G509 SHT 1 OF 2	TALKBACK SYSTEM SCHEMATIC DIAGRAM
E99-G509 SHT 2 OF 2	TALKBACK SYSTEM SCHEMATIC DIAGRAM
E99-G510 SHT 1 OF 2	TALKBACK SYSTEM PLAN
E99-G510 SHT 2 OF 2	TALKBACK SYSTEM PLAN
E99-G511	TALKBACK SYSTEM STANDARD INSTALLATION DETAILS
E99-G512	TALKBACK SYSTEM DISTRIBUTION FRAME



E99-G513 SHT 1 OF 2 TALKBACK SYSTEM INSTALLATION DETAILS
E99-G513 SHT 2 OF 2 TALKBACK SYSTEM INSTALLATION DETAILS
E99-G600 SHT 1 OF 2 GATEHOUSE CONSOLE RACKFACE ELEVATION
E99-G600 SHT 2 OF 2 GATEHOUSE CONSOLE RACKFACE ELEVATION
E99-G601 GATEHOUSE FLOOR PLAN
E99-G602 GATEHOUSE TERMINATION FACILITY DETAILS
E99-G603 YARD COMMUNICATIONS CONSOLE RACKFACE ELEVATION

BOOK 2

M1210- 153 B5-G-00 COVER
M1210- 154 B5-G-01 INDEX OF DRAWINGS
M1210- 155 B5-G-02 INDEX OF DRAWINGS
M1210- 156 B5-G-03 SYSTEM MAP
M1210- 157 B5-WS-03 SUGGESTED STAGING NOTES
M1210- 158 B5-WS-01 STAGING PLAN - SHEET 1 OF 2
M1210- 159 B5-WS-02 STAGING PLAN - SHEET 2 OF 2
M1210- 160 B5-C-01 AERIAL LAYOUT - 1
M1210- 161 B5-C-02 AERIAL LAYOUT - 2
M1210- 162 B5-C-03 HORIZONTAL AND VERTICAL CONTROL
M1210- 163 B5-C-04 HORIZONTAL AND VERTICAL CONTROL DESCRIPTIONS
M1210- 164 B5-SP-01 EXISTING SURVEY W/GEOTECH BORING LOCATION PLAN
M1210- 165 B5-SP-02 EXISTING SURVEY PLAN 1
M1210- 166 B5-SP-03 EXISTING SURVEY PLAN 2
M1210- 167 B5-G-04 SITE PLAN - SHEET 1 OF 2
M1210- 168 B5-G-05 SITE PLAN - SHEET 2 OF 2
M1210- 169 B5-U-01 EXISTING UTILITY PLAN - 1
M1210- 170 B5-U-02 EXISTING UTILITY PLAN - 2
M1210- 171 B5-U-03 COMPOSITE UTILITY & GRADING PLAN - SHEET 1 OF 2
M1210- 172 B5-U-04 COMPOSITE UTILITY & GRADING PLAN - SHEET 2 OF 2
M1210- 173 B5-SO-01 SOIL BORING LOGS B-1 TO B-2
M1210- 174 B5-SO-02 SOIL BORING LOGS B-3 TO B-4
M1210- 175 B5-SO-03 SOIL BORING LOGS B-5 TO B-6
M1210- 176 B5-SO-04 SOIL BORING LOGS B-7 TO B-8
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M1210- 178 B5-SO-06 SOIL BORING LOGS B-11 TO B-12
M1210- 179 B5-TA-01 TRACK PLAN - 1 OF 2
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M1210- 181 B5-TA-03 TRACK ALIGNMENT PROFILES - TRACKS 9, 9A, AND 9B
M1210- 182 B5-TA-04 TRACK ALIGNMENT PROFILES - TRACK 9C AND 10
M1210- 183 B5-TA-21 TRACK ALIGNMENT DATA - 1 OF 2
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M1210- 185 B5-TW-06 TRACK ALIGNMENT & TRACKWORK ABBREVIATIONS, SYMBOLS
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M1210- 186 B5-TW-01 TRACKWORK TYPICAL SECTIONS, BALLASTED TRACK
M1210- 187 B5-TW-02 EMBEDDED SHOP TRACK CLEARANCE ENVELOPE
M1210- 188 B5-TW-03 TRACK CONSTRUCTION PLAN & TURNOUT IDENTIFICATION MATRIX
M1210- 189 B5-TW-04 SHOP APPROACH, TANGENT AND CURVE RADIUS > 450 FEET

M1210- 190	B5-TW-05	MISC RAIL JOINT AND GROUT PAD REINFORCING DETAILS
M1210- 191	B5-TW-08	NO.6 GUARDED TURNOUT, BALLASTED TRACK
M1210- 192	B5-TW-09	NO.6 GUARDED TURNOUT, RAIL LAYOUT, BALLASTED TRACK
M1210- 193	B5-TW-10	NO.6 GUARDED TURNOUT, PLATED SWITCH, BALLASTED TRACK
M1210- 194	B5-TW-11	NO.6 GUARDED TURNOUT, PLATED FROG, BALLASTED TRACK
M1210- 195	B5-TW-12	NO.6 GUARDED TURNOUT, MANGANESE HOUSING PLATE DETAILS
M1210- 196	B5-TW-13	NO.6 GUARDED TURNOUT, DOUBLE RAIL INSULATED JOINT & SEPARATOR BLOCK DETAILS
M1210- 197	B5-TW-14	TIMBER GRADE CROSSING DETAILS
M1210- 198	B5-TW-15	MOW BUMPING POST
M1210- 199	B5-TW-16	RESTRAINING RAIL LUBRICATOR LOCATION, BALLASTED TRACK
M1210- 200	B5-TW-17	RESTRAINING RAIL DETAILS, SEPARATOR & END BLOCKS, END FLARE & RESTRAINING RAIL PLATE
M1210- 201	B5-TW-18	RESTRAINING RAIL DETAILS, JOINT DETAILS, BALLASTED TRACK
M1210- 202	B5-TW-19	RESTRAINING RAIL/RUNNING RAIL INSULATED JOINT DETAILS, BALLASTED TRACK
M1210- 203	B5-TW-20	RESTRAINING RAIL LAYOUT, BALLASTED TRACK
M1210- 204	B5-TP-01	TRACTION POWER CONTACT RAIL PLAN - 1 OF 2
M1210- 205	B5-TP-02	TRACTION POWER CONTACT RAIL PLAN - 2 OF 2
M1210- 206	B5-TP-03	TRACTION POWER ELECTRIFICATION SINGLE LINE DIAGRAM
M1210- 207	B5-TP-04	TRACTION POWER DC SWITCHGEAR ROOM
M1210- 208	B5-TP-05	TRACTION POWER SHOP TRACK NEGATIVE RETURN CONNECTION
M1210- 209	B5-TC-01	YARD SIGNALS SYMBOLS, ABBREVIATIONS AND GENERAL NOTES
M1210- 210	B5-TC-02	YARD SIGNALS DOUBLE LINE TRACK - SCHEMATIC - SHEET 1 OF 2
M1210- 211	B5-TC-03	YARD SIGNALS DOUBLE LINE TRACK - SCHEMATIC - SHEET 2 OF 2
M1210- 212	B5-TC-04	YARD SIGNALS TRAIN CONTROL ROOM EQUIPMENT LAYOUT
M1210- 213	B5-TC-05	CONTROL MACHINE FACEPLATE TYPICAL LAYOUT - SHEET 1 OF 3
M1210- 214	B5-TC-06	CONTROL MACHINE FACEPLATE TYPICAL LAYOUT - SHEET 2 OF 3
M1210- 215	B5-TC-07	CONTROL MACHINE FACEPLATE TYPICAL LAYOUT - SHEET 3 OF 3
M1210- 216	B5-A-01	CODE ANALYSIS, SYMBOLS AND ABBREVIATIONS, ARCHITECTURAL
M1210- 217	B5-A-02	FIXED EQUIPMENT LIST
M1210- 218	B5-A-03	FIXED EQUIPMENT LIST
M1210- 219	B5-A-04	FIXED EQUIPMENT LIST
M1210- 220	B5-A-05	FIXED EQUIPMENT LIST
M1210- 221	B5-A-06	NOT USED
M1210- 222	B5-A-07	NOT USED
M1210- 223	B5-A-08	NOT USED
M1210- 224	B5-A-09	BASEMENT FLOOR PLAN
M1210- 225	B5-A-10	BASEMENT FLOOR PLAN - AREA 1
M1210- 226	B5-A-11	BASEMENT FLOOR PLAN - AREA 2
M1210- 227	B5-A-12	BASEMENT FLOOR PLAN - AREA 3
M1210- 228	B5-A-13	GROUND FLOOR PLAN
M1210- 229	B5-A-14	GROUND FLOOR PLAN - AREA 1
M1210- 230	B5-A-15	GROUND FLOOR PLAN - AREA 2
M1210- 231	B5-A-16	GROUND FLOOR PLAN - AREA 3
M1210- 232	B5-A-17	MEZZANINE FLOOR PLAN - AREA 1
M1210- 233	B5-A-18	ROOF PLAN



M1210- 234	B5-A-19	PARTIAL NORTH, SOUTH AND EAST ELEVATIONS
M1210- 235	B5-A-20	LONGITUDINAL BUILDING SECTION
M1210- 236	B5-A-21	CROSS BUILDING SECTIONS
M1210- 237	B5-A-22	EXISTING CONDITIONS - REFERENCE ONLY BASEMENT FLOOR PLAN
M1210- 238	B5-A-23	EXISTING CONDITIONS - REFERENCE ONLY BASEMENT FLOOR PLAN - AREA 1
M1210- 239	B5-A-24	EXISTING CONDITIONS - REFERENCE ONLY BASEMENT FLOOR PLAN - AREA 2
M1210- 240	B5-A-25	EXISTING CONDITIONS - REFERENCE ONLY BASEMENT FLOOR PLAN - AREA 3
M1210- 241	B5-A-26	EXISTING CONDITIONS - REFERENCE ONLY GROUND FLOOR PLAN
M1210- 242	B5-A-27	EXISTING CONDITIONS - REFERENCE ONLY GROUND FLOOR PLAN - AREA 1
M1210- 243	B5-A-28	EXISTING CONDITIONS - REFERENCE ONLY GROUND FLOOR PLAN - AREA 2
M1210- 244	B5-A-29	EXISTING CONDITIONS - REFERENCE ONLY GROUND FLOOR PLAN - AREA 3
M1210- 245	B5-A-30	EXISTING CONDITIONS - REFERENCE ONLY MEZZANINE FLOOR PLAN - AREA 1
M1210- 246	B5-A-31	EXISTING CONDITIONS - REFERENCE ONLY ROOF PLAN
M1210- 247	B5-A-32	EXISTING CONDITIONS - REFERENCE ONLY PARTIAL EAST, WEST & NORTH ELEVATIONS
M1210- 248	B5-A-33	EXISTING CONDITIONS - REFERENCE ONLY PARTIAL SOUTH ELEVATION
M1210- 249	B5-A-34	EXISTING CONDITIONS - REFERENCE ONLY LONGITUDINAL BUILDING SECTION
M1210- 250	B5-A-35	EXISTING CONDITIONS - REFERENCE ONLY CROSS BUILDING SECTION
M1210- 251	B5-M-01	ABBREVIATIONS, MECHANICAL
M1210- 252	B5-M-02	SYMBOLS, MECHANICAL
M1210- 253	B5-M-03	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 1 - DUCTWORK
M1210- 254	B5-M-04	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 2 - DUCTWORK
M1210- 255	B5-M-05	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 3 - DUCTWORK
M1210- 256	B5-M-06	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 1 - DUCTWORK
M1210- 257	B5-M-07	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 2 - DUCTWORK
M1210- 258	B5-M-08	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - DUCTWORK
M1210- 259	B5-M-09	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN AREA 1 - DUCTWORK
M1210- 260	B5-M-10	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN AREA 1 - MECHANICAL

M1210- 261	B5-M-11	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN AREA 2 - MECHANICAL
M1210- 262	B5-M-12	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN AREA 3 - MECHANICAL
M1210- 263	B5-M-13	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 1 - PIPING
M1210- 264	B5-M-14	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 2 - PIPING
M1210- 265	B5-M-15	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 3 - PIPING
M1210- 266	B5-M-16	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 1 - PIPING
M1210- 267	B5-M-17	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 2 - PIPING
M1210- 268	B5-M-18	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - PIPING
M1210- 269	B5-M-19	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN AREA 1 - PIPING
M1210- 270	B5-M-20	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 1 - FIRE PROT
M1210- 271	B5-M-21	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 2 - FIRE PROT
M1210- 272	B5-M-22	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 3 - FIRE PROT
M1210- 273	B5-M-23	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 1 - FIRE PROT
M1210- 274	B5-M-24	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 2 - FIRE PROT
M1210- 275	B5-M-25	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - FIRE PROT
M1210- 276	B5-M-26	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 1 - FIRE PROT
M1210- 277	B5-M-27	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 1 - UNDERGROUND PLUMBING
M1210- 278	B5-M-28	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 2 - UNDERGROUND PLUMBING
M1210- 279	B5-M-29	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 3 - UNDERGROUND PLUMBING
M1210- 280	B5-M-30	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 1 - PLUMBING
M1210- 281	B5-M-31	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 2 - PLUMBING
M1210- 282	B5-M-32	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 3 - PLUMBING
M1210- 283	B5-M-33	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 1 - PLUMBING

M1210- 284	B5-M-34	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 2 - PLUMBING
M1210- 285	B5-M-35	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - PLUMBING
M1210- 286	B5-M-36	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 1 - PLUMBING
M1210- 287	B5-M-37	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 1 - PROCESS
M1210- 288	B5-M-38	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 2 - PROCESS
M1210- 289	B5-M-39	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 3 - PROCESS
M1210- 290	B5-M-40	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 1 - PROCESS
M1210- 291	B5-M-41	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 2- PROCESS
M1210- 292	B5-M-42	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - PROCESS
M1210- 293	B5-M-43	EXISTING CONDITIONS - REFERENCE ONLY - DETAIL PHOTOGRAPHS - MECHANICAL
M1210- 294	B5-M-44	EXISTING CONDITIONS - REFERENCE ONLY - DETAIL PHOTOGRAPHS - MECHANICAL
M1210- 295	B5-E-01	EXISTING CONDITIONS - REFERENCE ONLY - SYMBOLS AND ABBREVIATIONS, ELECTRICAL
M1210- 296	B5-E-02	EXISTING CONDITIONS - REFERENCE ONLY - ONE LINE DIAGRAM, ELECTRICAL
M1210- 297	B5-E-03	EXISTING CONDITIONS - REFERENCE ONLY - ONE LINE DIAGRAM, ELECTRICAL
M1210- 298	B5-E-04	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 1 - ELECTRICAL
M1210- 299	B5-E-05	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 1 - ELECTRICAL
M1210- 300	B5-E-06	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 2 - ELECTRICAL
M1210- 301	B5-E-07	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 2 - ELECTRICAL
M1210- 302	B5-E-08	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 3 - ELECTRICAL
M1210- 303	B5-E-09	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 1 - ELECTRICAL
M1210- 304	B5-E-10	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 2 - ELECTRICAL
M1210- 305	B5-E-11	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - ELECTRICAL
M1210- 306	B5-E-12	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - ELECTRICAL
M1210- 307	B5-E-13	EXISTING CONDITIONS - REFERENCE ONLY - DETAIL

M1210- 308	B5-E-14	PHOTOGRAPHS, ELECTRICAL EXISTING CONDITIONS - REFERENCE ONLY - DETAIL
M1210- 309	B5-E-15	PHOTOGRAPHS, ELECTRICAL EXISTING CONDITIONS - REFERENCE ONLY - DETAIL PHOTOGRAPHS, ELECTRICAL
TRACTION POWER		
M20-261	B-5b-E-16	METRO MAJOR REPAIR YARD, TYPICAL DETAILS OF TRACTION POWER CONDUITS FOR YARD TRACKS (SHEET 1)
M20-262	B-5b-E-21	METRO MAJOR REPAIR YARD, TYPICAL DETAILS OF TRACITON POWER CONDUITS FOR YARD TRACKS (SHEET 2)
M20-263	B-5b-E-17	METRO MAJOR REPAIR YARD, TRACTION POWER CONDUITS, (SHEET 1)
M20-264	B-5b-E-18	METRO MAJOR REPAIR YARD, TRACTION POWER CONDUITS, (SHEET 2)
M20-265	B-5b-E-19	METRO MAJOR REPAIR YARD, TRACTION POWER CONDUITS, (SHEET 3)
M20-266	B-5b-E-20	METRO MAJOR REPAIR YARD, TRACTION POWER CONDUITS, (SHEET 4)
M20-267	B-5b-E-22	METRO MAJOR REPAIR YARD, CONDUIT SCHEDULE (SHEET 1)
M20-268	B-5b-E-23	METRO MAJOR REPAIR YARD, CONDUIT SCHEDULE (SHEET 2)
M23-81	TW1-CR-25	CONTACT RAIL, MAJOR REPAIR YARD, PLAN 2
M23-82	TW1-CR-26	CONTACT RAIL, MAJOR REPAIR YARD, PLAN 3
M23-83	TW1-CR-27	CONTACT RAIL, MAJOR REPAIR YARD, PLAN 4
M23-84	TW1-CR-28	CONTACT RAIL, MAJOR REPAIR YARD, ELECTRIFICATION SINGLE LINE DIAGRAM
M23-85	TW1-CR-29	CONTACT RAIL, MAJOR REPAIR YARD, SWITCH ENCLOSURE & SUPPORT
M35-192	B-5ai-E-21	MAJOR REPAIR SHOP, PARTIAL FIRST FLOOR PLAN - POWER
M35-193	B-5ai-E-22	MAJOR REPAIR SHOP, PARTIAL FIRST FLOOR PLAN - POWER
M35-194	B-5ai-E-23	MAJOR REPAIR SHOP, PARTIAL FIRST FLOOR PLAN - POWER
M35-197	B-5ai-E-26	MAJOR REPAIR SHOP, PARTIAL FIRST FLOOR PLAN - POWER
M35-198	B-5ai-E-27	MAJOR REPAIR SHOP, PARTIAL FIRST FLOOR PLAN - POWER
M95-70	SSI-70	ELECTRICAL, MAJOR REPAIR SHOP, D.C. SUBSTATION
M95-71	SSI-71	D.C. DISTRIBUTION & CONTROL WIRING, MAJOR REPAIR SHOP, FIRST FLOOR
M95-72	SSI-72	D.C. DISTRIBUTION, MAJOR REPAIR SHOP, BASEMENT
M95-74	SSI-74	SUBSTATION INSTALLATION - PHASE I, MAJOR REPAIR SHOP, MISCELLANEOUS DETAILS
M95-75	SSI-75	SUBSTATION INSTALLATION - PHASE I, MAJOR REPAIR SHOP, CABLE SCHEDULE
M95-77	SSI-77	WARNING SYSTEM & CONTROL CIRCUIT, SCHEMATIC, MAJOR REPAIR SHOP
M95-78	SSI-78	SINGLE LINE DIAGRAM, MAJOR REPAIR SHOP, D.C. SUBSTATION
M95-79	SSI-79	MAJOR REPAIR SHOP, D.C. SUBSTATION, STRUCTURAL DETAILS
M95-80	SSI-80	MAJOR REPAIR SHOP D.C. SUBSTATION, VENTILATION AND MECHANICAL PLAN, SECTION AND DETAILS
M95-81	SSI-81	MAJOR REPAIR SHOP, INTERIM D.C. POWER DETAILS



TRACKWORK

M1014- 923 TW19-RR-4

TRACKWORK-19 RAIL LUBRICATOR, ELECTRICAL DETAILS

YARD SIGNAL

INFO-TC-03	TYPICAL YARD CONTROLLED SIGNAL LAYOUT
INFO-TC-04	TYPICAL TRAILABLE SWITCH MACHINE LAYOUT
INFO-TC-05	TYPICAL SNOWMELTER INSTALLATION DETAILS
INFO-TC-06	TYPICAL SNOWMELTER HEATING ELEMENT MOUNTING DETAILS
INFO-TC-07	TYPICAL SWITCH ROD HEATER LAYOUT
INFO-TC-08	TYPICAL SNOWMELTER CONTROL CASE
INFO-TC-09	TYPICAL AC TRACK CIRCUIT CONNECTIONS
INFO-TC-10	TYPICAL SIGNAL RAIL BONDING
INFO-TC-11	TYPICAL NEGATIVE RETURN BONDING
INFO-TC-12	TYPICAL CABLE TRENCH HAND HOLE DETAILS
INFO-TC-13	TYPICAL CABLE TRENCH SCHEMATIC DETAILS
YB99-006A	TRK PLAN SYM & INST DET
YB99-007	TRK & LOC PLAN AUTO TRN CN
YB99-008	TRK & LOC PLAN AUTO TRN CN
YB99-009	TRK & LOC PLAN AUTO TRN CN
YB99-010	TRK & LOC PLAN AUTO TRN CN
YB99-010A	INSTL PLAN TRK EQU LOC
YB99-011	CABLE PLAN TRN CON & LN CB
YB99-012	CABLE PLAN INTERCON CB
YB99-013	CABLE PLAN CB TRN CON RM
YB99-014	CABLE PLAN LOCAL CABLES
YB99-020	CBL PLAN LIST OF WORK WRS
YB99-021	CBL PLAN LIST OF WORK WRS
YB99-026	ATP SPD COMM CON LINE DIA
YB99-027A	ROUTE CHART
YB99-028	AC TRK & REPEATERS CIR
YB99-030	SIGNAL CONTROL CIRCUITS
YB99-031	SW OPER CORRES & LOCK CIR
YB99-032	SW OPER & REPEATERS CIR
YB99-033	SW OPER & REPEATERS CIR
YB99-034	SNOW MEL & CASE LGHT CIR
YB99-035	ENER LOOPS & BLOWN FUSE
YB99-109	APP CIR INBOUND MAINLINE
YB99-111	LOOP CONTROL CIR
YB99-118	DISPATCH LOOP CIR IB-1A
YB99-121	LOOP SELECTION CIR
YB99-130	YARD LOOP TRANSM LOGIC CIR
YB99-134	SPD COM LOGIC CIR TRK #1
YB99-155	DAILY SAFETY TEST CIR
YB99-159	HGR (SIG CONTROL CIR)
YB99-167	ASR (APP LOCKING CIR)
YB99-173	ROUTE STICK CIR

YB99-176	LOCK CIRCUITS
YB99-183	SIG OVERRUN RELAY CIR
YB99-184	TYPSR CIRCUITS
YB99-186	HGPR REPEATER CIR
YB99-187	NSPR REPEATER CIR
YB99-188	SSPR REPEATER CIR
YB99-189	NWCPAR REPEATER CIR
YB99-190	RWCAR REPEATER CIR
YB99-193	TYPSR REPEATER CIR
YB99-194	TRACK REPEATER CIR
YB99-196	TPK RELAY CIR 7A-141B
YB99-199	NWK RWK & LK RLY CIR 7-69
YB99-203	NWZ & RWZ RLY CIR 7-71
YB99-207	APP & DEST IND RELAYS
YB99-209	DEST STORAGE REG RTE B1
YB99-218	DEST STORAGE REG RTE B2
YB99-219	P/B REPEAT SIG 6, 8, 58, 62
YB99-221	AUTO RTE SEL STORAGE CIR 6
YB99-222	P/B STICK RLY SIG 6, 8, 58
YB99-223	INIT NETWORK SIG 6, 8, 10, 58
YB99-261	EXIT AVAIL NETWRK SIG 6, 8
YB99-268	ROUTE COMPL NETWRK SW 7&11
YB99-281	ROUTE CHECK NETWRK SIG 6, 8
YB99-292	AUX SW P/B CIR SW 7, 11, 17
YB99-298	CNT MACH PAN LIGHT CIR 6, 8
YB99-336	MAN SW LIGHT IND RELAYS
YB99-337	APP & TRACK LIGHTS
YB99-350	BX110-CX110 ENR & ALARM
YB99-360	NX RK A1 ENR DIST
YB99-373	B28G LOOPS LR & WZ CKT
YB99-374	RK C14 ENR LPS B28G
YB99-398	ENR DIST RK A1 & A2
YB99-407	ENR LP DIST 7A-B, 11A-B
YB99-410	ENR LP 91, 95-97, 111, 37A
YB99-418	MAINT TELE CIR
YB99-422	RELAY ARR SD A
YB99-423	APPARATUS ARR SD B FRONT
YB99-424	TERMINAL BRD SD B BACK
YB99-440	RELAY ROOM LAYOUT
YB99-440A	CONTROL MACHINE PANEL
YB99-441	NX RKS TAG LIST A1-A6
YB99-443	MODULAR NX RACK A1 ARRANGEMENT PLAN
YB99-468	RK C9 AC TRK-TRANSF ARR
YB99-469	AC TRACK RELAY ARRANGEMENT RACK C10
YB99-506	CNT MACH ARR SECT 1
YB99-509	INTERCONNECTING CABLE PLANS
YB99-522	TYPICAL ARR PLAN JCT BX TJ



YB99-524	TYP ARR PLAN SW JCT BOX WJ
YB99-536	TYP SW MACH WIRING DIAGRAM
YB99-539	ARR PLAN WAYSIDE RT P/B BX
YB99-540	ARR PLAN TYP SIG COMP FLD
YB99-542	ARR PLAN SNOW MEL CASE WR
YB99-551	SPEED COMMAND LOOPS
YB99-557	RTU IND CIR (S1A)
YB99-598	AC TRACK TERMINATION
YB99-599	SURFACE TROUGH & CONDUIT LAYOUT SH. 1
YB99-600	SURFACE TROUGH & CONDUIT LAYOUT SH. 2
YB99-601	SURFACE TROUGH & CONDUIT LAYOUT SH. 3
YB99-602	SURFACE TROUGH & CONDUIT LAYOUT SH. 4
YB99-603	SURFACE TROUGH & CONDUIT LAYOUT SH. 5
YB99-604	SURFACE TROUGH & CONDUIT LAYOUT SH. 6
YB99-605	SURFACE TROUGH & CONDUIT LAYOUT SH. 7
YB99-606	SURFACE TROUGH & CONDUIT LAYOUT SH. 8

COMMUNICATIONS

NONE	COVER SHEET BRENTWOOD YARD GATEHOUSE DATA FILE
BW-1	GATEHOUSE DATA FILE FIRE ZONES
BW-2	GATEHOUSE DATA FILE FIRE ZONES
BW-3	GATEHOUSE DATA FILE INTRUSION ZONES
BW-4	GATEHOUSE DATA FILE INTRUSION ZONES
BW-5	GATEHOUSE DATA FILE CCTV
BW-6	GATEHOUSE DATA FILE TALKBACK
BW-7	GATEHOUSE DATA FILE TELEPHONE LOCATIONS AND NUMBERS
BW-8	GATEHOUSE DATA FILE TELEPHONE LOCATIONS AND NUMBERS
0001	FIRE AND INTRUSION ALARM SYSTEM INSTALLATION DETAILS
0002	FIRE AND INTRUSION ALARM SYSTEM INSTALLATION DETAILS
0003	FIRE ALARM SYSTEM AND RISER DIAGRAM
0004	BASEMENT FIRE AND INTRUSION ALARM SYSTEM LAYOUT
0005	MAJOR REPAIR SHOP FIRE AND INTRUSION ALARM SYSTEM
0007 SHT 1 OF 2	TELEPHONE HANDSET PUBLIC ADDRESS
0007 SHT 2 OF 2	TELEPHONE HANDSET PUBLIC ADDRESS
0011 SHT 1 OF 5	PUBLIC ADDRESS LOUDSPEAKER LAYOUT & RISER DIAGRAM
0011 SHT 2 OF 5	PUBLIC ADDRESS LOUDSPEAKER LAYOUT & RISER DIAGRAM
0011 SHT 3 OF 5	PUBLIC ADDRESS LOUDSPEAKER LAYOUT & RISER DIAGRAM
0011 SHT 4 OF 5	PUBLIC ADDRESS LOUDSPEAKER LAYOUT & RISER DIAGRAM
0011 SHT 5 OF 5	PUBLIC ADDRESS LOUDSPEAKER LAYOUT & RISER DIAGRAM
0012	PUBLIC ADDRESS SYSTEM RISER DIAGRAM BASEMENT
0015	MAJOR REPAIR SHOP INTRUSION SYSTEM RISER DIAGRAM
0016	TRACTION POWER SUBSTATION F& I ALARM SYS & RISER DIAG.
0017	DC TIEBREAKER F& I ALARM SYS RISER DIAGRAM
0029 SHT 1 OF 2	COMM ROOM PA & PABX RACKFACE ELEVATION
0029 SHT 2 OF 2	COMM ROOM PA & PABX RACKFACE ELEVATION
0033 SHT 1 OF 2	FIRE ALARM SYSTEM FIRE ALARM PANEL DETAILS
0033 SHT 2 OF 2	FIRE ALARM SYSTEM FIRE ALARM PANEL DETAILS
0037	INTRUSION SYSTEM INTRUSION ALARM PANEL DETAIL
0039 SHT 1 OF 2	COMM RM. F&I ALARM CABINETS RACKFACE ELEVATIONS

0039 SHT 2 OF 2	RACK FACE ELEVATION F&I ALARM CABINETS
0040 SHT 1 OF 3	COMMUNICATIONS ROOM LAYOUT
0040 SHT 2 OF 3	COMMUNICATIONS ROOM LAYOUT
0040 SHT 3 OF 3	COMMUNICATIONS ROOM LAYOUT
0084	MOBILE RADIO ANTENNA INSTALLATION DETAILS
0244 SHT 1 OF 4	PABX MDF/PROTECTOR BOX LAYOUT
0244 SHT 2 OF 4	PABX MDF/PROTECTOR BOX LAYOUT
0244 SHT 3 OF 4	PABX MDF/PROTECTOR BOX LAYOUT
0244 SHT 4 OF 4	PABX MDF/PROTECTOR BOX LAYOUT
0270 SHT 1 OF 2	PABX TELEPHONE KEY SYSTEM FRAME LAYOUT
0270 SHT 2 OF 2	PABX TELEPHONE KEY SYSTEM FRAME LAYOUT
0272 SHT 1 OF 3	PABX TELEPHONE LAYOUT
0272 SHT 2 OF 3	PABX TELEPHONE LAYOUT
0272 SHT 3 OF 3	PABX TELEPHONE LAYOUT
0272-A	PABX TELEPHONE LAYOUT - TEMP PHONE SERVICE
B99-0273 SHT 1 OF 3	PABX CABLE RUNNING LIST
B99-0273 SHT 2 OF 3	PABX CABLE RUNNING LIST
B99-0273 SHT 3 OF 3	PABX CABLE RUNNING LIST
0338	PABX BILL OF MATERIALS
0352	PA SYSTEM RACK FACE ELEVATION DETAILS (RACK E)
0368	PA SYSTEM RACK WIRING LAYOUT
0369	TELEPHONE AMPLIFIER AND POWER SUPPLY
0377	PA TEL POWER SUPPLY AMPLIFIER AND PAGE CONTROL
0382	PUBLIC ADDRESS SYS HANDSET INSTALLATION DETAILS
0389 SHT 1 OF 2	PA TERMINAL PANEL INTERCONNECTION PANEL
0389 SHT 2 OF 2	PA TERMINAL PANEL INTERCONNECTION PANEL
0390	PUBLIC ADDRESS PAGING INTERCONNECTION DIAGRAM
0391	PUBLIC ADDRESS SYSTEM DESK INSTRUMENT
0411 SHT 1 OF 2	FIRE & INTRUSION SYSTEM BACK BOX ASSY
0411 SHT 2 OF 2	FIRE & INTRUSION SYSTEM BACK BOX ASSY
0412	F & I ANCILLARY CABLE RUNNING DIAGRAM & DETAILS
0413	F & I FIRE ALARM PANEL SCHEMATIC
0413	F & I FIRE ALARM PANEL SCHEMATIC
0415 SHT 1 OF 2	INTRUSION ANNUNCIATOR PANEL WIRING DIAGRAM
0415 SHT 2 OF 2	INTRUSION ANNUNCIATOR PANEL WIRING DIAGRAM
0428	F & I SYSTEM DRESS FRAME DETAIL
0429	F & I SYSTEM DOOR DETAIL
0433	ANCILLARY BLDG. F & I CABLE LAYOUT & DETAILS
0448	CONTROL PANEL EXTERNAL CONNECTIONS
0499	F & I ALARM SYSTEM BLOCK DIAGRAM
0534 SHT 1 OF 2	COMMUNICATIONS ROOM AC POWER DISTRIBUTION
0534 SHT 2 OF 2	COMMUNICATIONS ROOM AC POWER DISTRIBUTION
B99-0551	PABX CROSS-CONNECTS
B99-0564 SHT 1 OF 3	TCF SUBSYSTEM CABLE RUNNING LIST
B99-0564 SHT 2 OF 3	TCF SUBSYSTEM CABLE RUNNING LIST
B99-0564 SHT 3 OF 3	TCF SUBSYSTEM CABLE RUNNING LIST
B99-0565 SHT 1 OF 2	TCF SUBSYSTEM STANDARD CROSS-CONNECTS
B99-0565 SHT 2 OF 2	TCF SUBSYSTEM STANDARD CROSS-CONNECTS
0596	TELEPRINTER INSTALLATION DETAILS
0653	PABX POWER CABLE HARNESS & CABLE TERMINATIONS
0682 SHT 1 OF 2	ALL SYSTEMS JUNCTION/PULL BOX SCHEDULE

0682 SHT 2 OF 2	ALL SYSTEMS JUNCTION/PULL BOX SCHEDULE
B99-4750	TELEPRINTER MAINT. CONTROL. CENTER TERM. LAYOUT
NOT LEGIBLE	TECHNICAL CONTROL CENTER CONFIGURATION
B99-5050	COMMUNICATIONS EQUIPMENT ROOM PLAN
B99-5051	PAS/CCTV ROOF PLAN
B99-5052	COMM ROOM DISTRIBUTION FRAME AND PROTECTORS
B99-5055 SHT 1 OF 3	COMPOSITE CABLE DIAGRAM AND DUCTBANK SCHEDULE
B99-5055 SHT 2 OF 3	COMPOSITE CABLE DIAGRAM AND DUCTBANK SCHEDULE
B99-5055 SHT 3 OF 3	COMPOSITE CABLE DIAGRAM AND DUCTBANK SCHEDULE
CTV-5303 SHT 3 OF 6	YARD CLOSED CIRCUIT TELEVISION SCHEMATIC
CTV-5303 SHT 4 OF 6	YARD CLOSED CIRCUIT TELEVISION SCHEMATIC
CTV-5303 SHT 5 OF 6	YARD CLOSED CIRCUIT TELEVISION SCHEMATIC
CTV-5303 SHT 6 OF 6	YARD CLOSED CIRCUIT TELEVISION SCHEMATIC
B99-5350	YARD CLOSED CIRCUIT TELEVISION SITE PLAN
HER-0048	INSTALLATION WIRING STATION B99 BRENTWOOD YARD
HER-0049	INSTALLATION WIRING RR2 LOCATION: BRENTWOOD YARD
HER-0049	INSTALLATION WIRING STATION B99 BRENTWOOD YARD
HER-0050	INSTALLATION WIRING SPAN SHELF & ORDER WIRE UNIT
NOT LEGIBLE	PROTECTOR BOX WIRING STATION: BRENTWOOD YARD
5194-008	C.T.S. CABLE PROTECTOR BOXES CONNECTIONS B99
3194-035 SHT 1 OF 2	CABLE TRANS SYSTEM RACK LAYOUT & EQUIP. LIST
3194-035 SHT 2 OF 2	CABLE TRANS SYSTEM RACK LAYOUT & EQUIP. LIST
B99-7000	COMMUNICATION EQUIPMENT ROOM PLAN
0099 SHT 1 OF 2	RHODE ISLAND AVE. STATION COMM RM FLOOR PLAN
0099 SHT 2 OF 2	RHODE ISLAND AVE. STATION COMM RM FLOOR PLAN
GEN-B99-001	TRAIN CONTROL, COMMUNICATIONS AND TELEPHONE DUCTBANK
	BOOK 3
M1210- 310 A16-G-00	COVER
M1210- 311 A16-G-01	INDEX OF DRAWINGS
M1210- 312 A16-G-02	INDEX OF DRAWINGS
M1210- 313 A16-G-03	SYSTEM MAP
M1210- 314 A16-WS-03	SUGGESTED STAGING NOTES
M1210- 315 A16-WS-01	STAGING PLAN - SHEET 1 OF 2
M1210- 316 A16-WS-02	STAGING PLAN - SHEET 2 OF 2
M1210- 317 A16-C-01	AERIAL LAYOUT - 1
M1210- 318 A16-C-02	AERIAL LAYOUT - 2
M1210- 319 A16-C-03	HORIZONTAL AND VERTICAL CONTROL
M1210- 320 A16-C-04	HORIZONTAL AND VERTICAL CONTROL DESCRIPTIONS
M1210- 321 A16-SP-01	EXISTING SURVEY W/GEOTECH BORING LOCATION PLAN
M1210- 322 A16-SP-02	EXISTING SURVEY PLAN 1
M1210- 323 A16-SP-03	EXISTING SURVEY PLAN 2
M1210- 324 A16-G-04	SITE PLAN - SHEET 1 OF 2
M1210- 325 A16-G-05	SITE PLAN - SHEET 2 OF 2
M1210- 326 A16-U-01	EXISTING UTILITY PLAN - 1
M1210- 327 A16-U-02	EXISTING UTILITY PLAN - 2
M1210- 328 A16-U-03	COMPOSITE UTILITY PLAN - SHEET 1 OF 2
M1210- 329 A16-U-04	COMPOSITE UTILITY PLAN - SHEET 2 OF 2

M1210- 330	A16-SO-01	SOIL BORING LOGS B-1 TO B-2
M1210- 331	A16-SO-02	SOIL BORING LOGS B-3 TO B-4
M1210- 332	A16-SO-03	SOIL BORING LOGS B-5 TO B-6
M1210- 333	A16-SO-04	SOIL BORING LOGS B-7 TO B-8
M1210- 334	A16-SO-05	SOIL BORING LOGS B-9 TO B-10
M1210- 335	A16-SO-06	SOIL BORING LOGS B-11 TO B-12
M1210- 336	A16-SO-07	SOIL BORING LOGS B-13 TO B-14
M1210- 337	A16-SO-08	SOIL BORING LOGS B-15 TO B-16
M1210- 338	A16-SO-09	SOIL BORING LOGS B-17
M1210- 339	A16-TA-01	TRACK PLAN - 1 OF 2
M1210- 340	A16-TA-02	TRACK PLAN - 2 OF 2
M1210- 341	A16-TA-03	TRACK ALIGNMENT PROFILES - TRACK 6 AND 7
M1210- 342	A16-TA-04	TRACK ALIGNMENT PROFILES - TRACK 8 AND 9
M1210- 343	A16-TA-05	TRACK ALIGNMENT PROFILES - TRACK 10, BYPASS AND M/W-7
M1210- 344	A16-TA-06	TRACK ALIGNMENT PROFILES - TRACK 10-C, 10-D AND M/W-8
M1210- 345	A16-TA-21	TRACK ALIGNMENT DATA - 1 OF 3
M1210- 346	A16-TA-22	TRACK ALIGNMENT DATA - 2 OF 3
M1210- 347	A16-TA-23	TRACK ALIGNMENT DATA - 3 OF 3
M1210- 348	A16-TW-05	TRACK ALIGNMENT & TRACKWORK ABBREVIATIONS, SYMBOLS & GENERAL NOTES
M1210- 349	A16-TW-01	TRACKWORK TYPICAL SECTIONS, BALLASTED TRACK
M1210- 350	A16-TW-02	EMBEDDED SHOP TRACK CLEARANCE ENVELOPE
M1210- 351	A16-TW-03	TRACK CONSTRUCTION PLAN & TURNOUT IDENTIFICATION MATRIX - 1
M1210- 351A	A16-TW-08	TRACK CONSTRUCTION PLAN & TURNOUT IDENTIFICATION MATRIX - 2
M1210- 352	A16-TW-04	SHOP APPROACH, TANGENT AND CURVE RADIUS > 450 FEET
M1210- 353	A16-TW-07	SHOP APPROACH, CURVE RADIUS <= 450 FEET
M1210- 354	A16-TW-10	NO.8 GUARDED TURNOUT, BALLASTED TRACK
M1210- 355	A16-TW-11	NO.8 GUARDED TURNOUT, RAIL LAYOUT, BALLASTED TRACK
M1210- 356	A16-TW-12	NO.8 GUARDED TURNOUT, PLATED SWITCH, BALLASTED TRACK
M1210- 357	A16-TW-13	NO.8 GUARDED TURNOUT, PLATED FROG, BALLASTED TRACK
M1210- 358	A16-TW-14	NO.8 GUARDED TURNOUT GAUGE PLATE DETAILS, BALLASTED TRACK
M1210- 359	A16-TW-15	SPECIAL LAYOUT FOR TURNOUTS HT2 AND HT3, BALLASTED TRACK
M1210- 360	A16-TW-16	MISC RAIL JOINT AND GROUT PAD REINFORCING DETAILS
M1210- 361	A16-TW-17	NO.6 GUARDED TURNOUT, BALLASTED TRACK
M1210- 362	A16-TW-18	NO.6 GUARDED TURNOUT, RAIL LAYOUT, BALLASTED TRACK
M1210- 363	A16-TW-19	NO.6 GUARDED TURNOUT, PLATED SWITCH, BALLASTED TRACK
M1210- 364	A16-TW-20	NO.6 GUARDED TURNOUT, PLATED FROG, BALLASTED TRACK
M1210- 365	A16-TW-21	NO.6 GUARDED TURNOUT, MANGANESE HOUSING PLATE DETAIL, BALLASTED TRACK
M1210- 366	A16-TW-22	NO.6 GUARDED TURNOUT, DOUBLE RAIL INSULATED JOINT & SEPARATOR BLOCK DETAILS
M1210- 367	A16-TW-23	TIMBER GRADE CROSSING DETAILS
M1210- 368	A16-TW-24	MOW BUMPING POST

M1210- 369	A16-TW-25	RESTRAINING RAIL LUBRICATOR LOCATION, BALLASTED TRACK
M1210- 370	A16-TW-26	RESTRAINING RAIL DETAILS, SEPARATOR & END BLOCKS, END FLARE & RESTRAINING RAIL PLATE
M1210- 371	A16-TW-27	RESTRAINING RAIL DETAILS, JOINT DETAILS, BALLASTED TRACK
M1210- 372	A16-TW-28	RESTRAINING RAIL/RUNNING RAIL INSULATED JOINT DETAILS, BALLASTED TRACK
M1210- 373	A16-TW-29	RESTRAINING RAIL LAYOUT, BALLASTED TRACK
M1210- 374	A16-TP-01	TRACTION POWER CONTACT RAIL PLAN - 1 OF 2
M1210- 375	A16-TP-02	TRACTION POWER CONTACT RAIL PLAN - 2 OF 2
M1210- 376	A16-TP-03	TRACTION POWER ELECTRIFICATION SINGLE LINE DIAGRAM
M1210- 377	A16-TP-04	TRACTION POWER DC SWITCHGEAR ROOM
M1210- 378	A16-TC-01	YARD SIGNALS SYMBOLS, ABBREVIATIONS AND GENERAL NOTES
M1210- 379	A16-TC-02	YARD SIGNALS DOUBLE LINE TRACK - SCHEMATIC - SHEET 1 OF 3
M1210- 380	A16-TC-03	YARD SIGNALS DOUBLE LINE TRACK - SCHEMATIC - SHEET 2 OF 3
M1210- 381	A16-TC-04	YARD SIGNALS DOUBLE LINE TRACK - SCHEMATIC - SHEET 3 OF 3
M1210- 382	A16-TC-05	YARD SIGNALS TRAIN CONTROL ROOM EQUIPMENT LAYOUT
M1210- 383	A16-TC-06	CONTROL MACHINE FACEPLATE TYPICAL LAYOUT - SHEET 1 OF 3
M1210- 384	A16-TC-07	CONTROL MACHINE FACEPLATE TYPICAL LAYOUT - SHEET 2 OF 3
M1210- 385	A16-TC-08	CONTROL MACHINE FACEPLATE TYPICAL LAYOUT - SHEET 3 OF 3
M1210- 386	A16-A-01	CODE ANALYSIS, SYMBOLS AND ABBREVIATIONS, ARCHITECTURAL
M1210- 387	A16-A-02	FIXED EQUIPMENT LIST
M1210- 388	A16-A-03	NOT USED
M1210- 389	A16-A-04	NOT USED
M1210- 390	A16-A-05	NOT USED
M1210- 391	A16-A-06	NOT USED
M1210- 392	A16-A-07	NOT USED
M1210- 393	A16-A-08	NOT USED
M1210- 394	A16-A-09	GROUND FLOOR PLAN
M1210- 395	A16-A-10	MEZZANINE FLOOR PLAN
M1210- 396	A16-A-11	ROOF PLAN
M1210- 397	A16-A-12	EXTERIOR ELEVATIONS
M1210- 398	A16-A-13	BUILDING SECTIONS
M1210- 399	A16-A-14	BUILDING SECTIONS
M1210- 400	A16-A-15	EXISTING CONDITION - REFERENCE ONLY - BASEMENT FLOOR PLAN
M1210- 401	A16-A-16	EXISTING CONDITION - REFERENCE ONLY - GROUND FLOOR PLAN
M1210- 402	A16-A-17	EXISTING CONDITION - REFERENCE ONLY - MEZZANINE FLOOR PLAN
M1210- 403	A16-A-18	EXISTING CONDITION - REFERENCE ONLY - ROOF PLAN
M1210- 404	A16-M-01	ABBREVIATIONS - MECHANICAL
M1210- 405	A16-M-02	SYMBOLS - MECHANICAL
M1210- 406	A16-M-03	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 7 - DUCTWORK
M1210- 407	A16-M-04	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - DUCTWORK
M1210- 408	A16-M-05	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 7 - DUCTWORK
M1210- 409	A16-M-06	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 4 - DUCTWORK

M1210- 410	A16-M-07	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 5 - DUCTWORK
M1210- 411	A16-M-08	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 3 - MECHANICAL
M1210- 412	A16-M-09	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 7 - MECHANICAL
M1210- 413	A16-M-10	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 7 - PIPING
M1210- 414	A16-M-11	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - PIPING
M1210- 415	A16-M-12	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 7 - PIPING
M1210- 416	A16-M-13	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 4 - PIPING
M1210- 417	A16-M-14	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 5 - PIPING
M1210- 418	A16-M-15	EXISTING CONDITIONS - REFERENCE ONLY - SECTIONS - DUCTWORK
M1210- 419	A16-M-16	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 7 - FIRE PROT
M1210- 420	A16-M-17	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 6 - FIRE PROT
M1210- 421	A16-M-18	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - FIRE PROT
M1210- 422	A16-M-19	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 7 - FIRE PROT
M1210- 423	A16-M-20	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 6 - FIRE PROT
M1210- 424	A16-M-21	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 4 - FIRE PROT
M1210- 425	A16-M-22	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 5 - FIRE PROT
M1210- 426	A16-M-23	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 7 - PLUMBING
M1210- 427	A16-M-24	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN- AREA 6 - PLUMBING
M1210- 428	A16-M-25	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - PLUMBING
M1210- 429	A16-M-26	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 7 - PLUMBING
M1210- 430	A16-M-27	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 6 - PLUMBING
M1210- 431	A16-M-28	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 4 & 5 - PLUMBING
M1210- 432	A16-M-29	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - AREA 7 - PLUMBING
M1210- 433	A16-M-30	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 3 - PLUMBING



M1210- 434	A16-M-31	EXISTING CONDITIONS - REFERENCE ONLY - ROOF PLAN - AREA 7 - PLUMBING
M1210- 435	A16-M-32	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 7 - PROCESS
M1210- 436	A16-M-33	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - AREA 6 - PROCESS
M1210- 437	A16-M-34	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 3 - PROCESS
M1210- 438	A16-M-35	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 7 - PROCESS
M1210- 439	A16-M-36	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - AREA 6 - PROCESS
M1210- 440	A16-M-37	EXISTING CONDITIONS - REFERENCE ONLY - DETAIL PHOTOGRAPHS - MECHANICAL
M1210- 441	A16-M-38	EXISTING CONDITIONS - REFERENCE ONLY - DETAIL PHOTOGRAPHS - MECHANICAL
M1210- 442	A16-E-01	EXISTING CONDITIONS - REFERENCE ONLY - SYMBOLS AND ABBREVIATIONS - ELECTRICAL
M1210- 443	A16-E-02	EXISTING CONDITIONS - REFERENCE ONLY - ONE LINE DIAGRAM - ELECTRICAL
M1210- 444	A16-E-03	EXISTING CONDITIONS - REFERENCE ONLY - BASEMENT FLOOR PLAN - ELECTRICAL
M1210- 445	A16-E-04	EXISTING CONDITIONS - REFERENCE ONLY - GROUND FLOOR PLAN - ELECTRICAL
M1210- 446	A16-E-05	EXISTING CONDITIONS - REFERENCE ONLY - MEZZANINE FLOOR PLAN - ELECTRICAL
M1210- 447	A16-E-06	EXISTING CONDITIONS - REFERENCE ONLY - AC SUBSTATION ELEVATION - ELECTRICAL
M1210- 448	A16-E-07	EXISTING CONDITIONS - REFERENCE ONLY - PHOTOGRAPHS - ELECTRICAL
M1210- 449	A16-E-08	EXISTING CONDITIONS - REFERENCE ONLY - PHOTOGRAPHS - ELECTRICAL
TRACTION POWER		
M292-224	A16a-E-4	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, POWER CONDUIT - MANHOLES, PLAN NORTH
M292-225	A16a-E-3	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, POWER CONDUIT - MANHOLES, PLAN SOUTH
M292-226	A16a-E-5	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER CONDUIT LAYOUT DETAILS
M292-227	A16a-E-6	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER CONDUIT LAYOUT DETAILS
M292-228	A16a-E-7	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER CONDUIT LAYOUT DETAILS
M292-229	A16a-E-8	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER CONDUIT LAYOUT DETAILS

M292-229A	A16a-E-8A	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER CONDUIT LAYOUT DETAILS
M292-230	A16a-E-9	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER CONDUIT STUBOUT DETAILS
M292-231	A16a-E-10	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER NEGATIVE CONDUITS & NEGATIVE CROSS-BONDING CONDUITS STUBOUT DETAILS
M292-233	A16a-E-12	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER CONDUIT SCHEDULES JUMPERS
M292-234	A16a-E-13	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER CONDUIT SCHEDULES JUMPERS
M292-263	A16a-E-42	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, TRACTION POWER NEGATIVE RETURN & CROSSBONDING CONDUITS FOR S & I SHOP
M369-211	A16b-E-1	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP INTERFACE, KEY PLAN - ELECTRICAL
M369-213	A16b-E-3	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP, BASEMENT FLOOR PLAN - ELECTRICAL
M369-221	A16b-E-11	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN LIGHTING & STRINGERS
M369-222	A16b-E-12	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN LIGHTING & STRINGERS
M369-223	A16b-E-13	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN LIGHTING & STRINGERS
M369-224	A16b-E-14	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN LIGHTING & STRINGERS
M369-225	A16b-E-15	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN LIGHTING & STRINGERS
M369-226	A16b-E-16	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN LIGHTING & STRINGERS
M369-227	A16b-E-17	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN POWER
M369-228	A16b-E-18	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN POWER
M369-229	A16b-E-19	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN POWER
M369-229	A16b-E-28	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP D.C. RISER & CONTROL
M369-230	A16b-E-20	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN POWER
M369-230	A16b-E-29	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP D.C. FEEDER & PANEL SCHEDULE
M369-231	A16b-E-21	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN POWER
M369-232	A16b-E-22	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP FIRST FLOOR PLAN POWER



M369-235	A16b-E-25	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION SHOP BSMT 1ST & 2ND FLOOR PLAN: POWER
M369-253	A16b-E-32	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD PROFILES
M369-254	A16b-E-33	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD PROFILES
M369-255	A16b-E-34	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD MANHOLE ENVELOPES & SECTIONS
M369-256	A16b-E-35	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD MANHOLE ENVELOPES, SECTIONS AND DETAILS
M369-256A	A16b-E-35A	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD MANHOLE ENVELOPES, SECTIONS AND DETAILS
M369-257	A16b-E-37	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, YARD LIGHTING PLAN-NORTH
M369-258	A16b-E-36	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD, YARD LIGHTING PLAN-NORTH
M369-262	SK-E-139	SHADY GROVE SERVICE & INSPECTION YARD SHOP RUNNING RAIL ISOLATION REQUIREMENTS
M392-113	TW6-CR-1	CONTACT RAIL ASSEMBLY-TIMBER TIE FIXATION TANGENT TRACK
M392-114	TW6-CR-26	CONTACT RAIL ASSEMBLY-DIRECT FIXATION FOR TANGENT OR SUPERELEVATED TRACK
M392-118	TW6-CR-6	CONTACT RAIL END APPROACH & SPLICE BAR FOR 150 NMC STEEL RAIL
M392-119	TW6-CR-7	CONTACT RAIL EXPANSION JOINT FOR 150 NMC STEEL RAIL
M392-124	TW6-CR-12	CONTACT RAIL SPACING-EXPANSION JOINTS. ANCHORS & INSULATORS
M392-125	TW6-CR-13	CONTACT RAIL TYPICAL CONDUIT AND CABLE ARRANGEMENT
M392-135	TW6-CR-23	ROCKVILL ROUTE SHADY GROVE SERVICE & INSPECTION YARD CONTACT RAIL LAYOUT
M392-136	TW6-CR-24	ROCKVILL ROUTE SHADY GROVE SERVICE & INSPECTION YARD CONTACT RAIL LAYOUT
M392-138	TW6-CR-26	CONTACT RAIL DISCONNECT SWITCH PLAN
M427-134	SSI6-E-134	SUBSTATION INSTALLATION SSI-6, SHADY GROVE YARD S & I SHOP, CONDUIT & CABLE TRAY
M427-135	SSI6-E-135	SUBSTATION INSTALLATION SSI-6, SHADY GROVE YARD S & I SHOP, GROUNDING
M427-136	SSI6-E-136	SUBSTATION INSTALLATION SSI-6, SHADY GROVE YARD S & I SHOP, PART PLANS, SECTIONS & DETAILS
M427-137	SSI6-E-137	SUBSTATION INSTALLATION SSI-6, SHADY GROVE YARD S & I SHOP, CABLE SCHEDULE - SHEET 1
M427-143	SSI6-E-143	SUBSTATION INSTALLATION SSI-6, EMERGENCY TRIP SWITCH LAYOUT SHEET 5
M427-144	SSI6-E-144	SUBSTATION INSTALLATION SSI-6, EMERGENCY TRIP SWITCH LAYOUT SHEET 6, YARD TRACK WORK
NONE	2977D62	S & I SHOP SINGLE LINE (SHOP DRAWING)
NONE	CRS-E-1	ROCKVILLE ROUTE, SHADY GROVE SERVICE & INSPECTION YARD SINGLE LINE DIAGRAM



YARD SIGNAL

INFO-TC-03	TYPICAL YARD CONTROLLED SIGNAL LAYOUT
INFO-TC-04	TYPICAL TRAILABLE SWITCH MACHINE LAYOUT
INFO-TC-05	TYPICAL SNOWMELTER INSTALLATION DETAILS
INFO-TC-06	TYPICAL SNOWMELTER HEATING ELEMENT MOUNTING DETAILS
INFO-TC-07	TYPICAL SWITCH ROD HEATER LAYOUT
INFO-TC-08	TYPICAL SNOWMELTER CONTROL CASE
INFO-TC-09	TYPICAL AC TRACK CIRCUIT CONNECTIONS
INFO-TC-10	TYPICAL SIGNAL RAIL BONDING
INFO-TC-11	TYPICAL NEGATIVE RETURN BONDING
INFO-TC-12	TYPICAL CABLE TRENCH HAND HOLE DETAILS
INFO-TC-13	TYPICAL CABLE TRENCH SCHEMATIC DETAILS
A16a-TC-1	SHADY GROVE S&I YD TC & COMM DUCTBANK LAYOUT
A16a-TC-2	SHADY GROVE S&I YD TC & COMM DUCTBANK LAYOUT
A16a-TC-3	SHADY GROVE S&I YD TC & COMM DUCTBANK LAYOUT
A16a-TC-4	SHADY GROVE S&I YD TC & COMM DUCTBANK LAYOUT
A16a-TC-5	SHADY GROVE S&I YD TC & COMM DUCTBANK LAYOUT
A16a-TC-6	SHADY GROVE S&I YD TC & COMM DUCTBANK LAYOUT
A16a-TC-7	SHADY GROVE S&I YD TC & COMM DUCTBANK PROFILES
A16a-TC-8	SHADY GROVE S&I YD TC & COMM DUCTBANK PROFILES
A16a-TC-9	SHADY GROVE S&I YD TC & COMM DUCTBANK SECTIONS
A16b-E-1	SHADY GROVE S&I SHOP INTERFACE PLAN- ELECTRICAL
YA99-G-001	SHADY GROVE YARD COVER SHEET
YA99-G-006	TYP RLY NOM (VITAL)
YA99-G-007	TYP RLY NOM (NON-VITAL)
YA99-G-008	RK TO RK CABLE PG 10F2
YA99-G-010	INST SKETCH YD CONT RM
YA99-G-011	INST PLN TRK EQUIP 1 OF 4
YA99-G-012	INST PLN TRK EQUIP 2 OF 4
YA99-G-013	INST PLN TRK EQUIP 3 OF 4
YA99-G-014	INST PLN TRK EQUIP 4 OF 4
YA99-G-015	YA99-G-15 INST SKETCH TRN CONT RM
YA99-G-019	YA99-G-19 MATERIAL REFERENCE LIST
YA99-G-100	YA99-G-100 TC & WYSD CBL PLN RT A
YA99-G-101	YA99-G-101 TC & WYSD CBL PLN RT A
YA99-G-111	YA99-G-111 MT COM SYST TCR ENT RK
YA99-G-120	YA99-G-120 ROUTE CHART
YA99-G-122	YA99-G-122 MAINT COM SYST TC-5DJ
YA99-WCL-001	TC WYSD CBL K1-K36
YA99-S-06	SERIES TRK CKTS Y18
YA99-S-11	AC TRK RLY CKTS 21ATR
YA99-S-22	60HZ TRK TRANS 21A-23B
YA99-C-01	EVENT RECORDER CKTS
YA99-I-001	PB REP RLY CKTS 22, 24, 26
YA99-I-012	SW TST KEY CKTS 21 & 23
YA99-I-027	INIT CKTS 22, 24, 26 & 28

YA99-I-038	COMP CKTS 22, 24, 26 & 28
YA99-I-050	TIME LCKING CKTS 22-28
YA99-I-56	RTE STK CKTS 21, 23, 53, 61
YA99-I-59	LOCK CKTSR & RESERVE
YA99-I-60	SW OPER CKTS 21-77
YA99-I-64	SW CORRESP CKTS 21-81
YA99-I-67	RTE CK NETWORK 22-28, 60-68
YA99-I-73	SIG CONT NETWORK 22-28
YA99-I-79	SIG LGT SIGS 142, 144, 146
YA99-I-107	CONT MACH LGHTING CKTS
YA99-I-127	CONT MACH LGT CKTS SIG IND
YA99-I-132	NON-VITAL RLY REPTR CKTS
YA99-I-146	SW REP CKTS SW21A, 21B, 23A
YA99-I-158	SW CNT CKTS(SG) SW53, 65, 71
YA99-I-166	SNOWMELTER CNT CKTS
YA99-I-168	PWR-OFF STK CKTS
YA99-P-007	ENG DIST UBX120-1-2, 3 MTCR
YA99-P-008	ENG DIST UBX120-1,2, 3 T RK
YA99-P-016	ENG DIST UCX-120 FOR SW
YA99-P-027	PWR FAILURE ALM CKTS
YA99-P-031	ENG DIST J CAB D2A N28G
YA99-P-075	CONT MACH ENG LOOPS
YA99-P-077	LC ENG DISTRIBUTION
YA99-P-078	CONT MACH ENG LOOPS PLCX
YA99-AR-001	ARR PLN RK B1
YA99-AM-001	CONT MACH PNL
YA99-AM-009	ARR PLN CONT PNL CP1Z
YA99-AM-012	ARR PLN J CAB J1A (5 HIGH)
YA99-AM-039	EVENT RECORDER
YA99-AJ-001	ARR PLN CASE #TC-2-DJ
YA99-AJ-017	ARR PLN SIG JCT BX 22-26GJ
YA99-AJ-055	ARR PLN SW JCT BX WJ TYP
YA99-AJ-058	ARR PLN TYP PT DET JCT BX
YA99-AJ-060	ARR PLN SNOWMELTERS
YA99-AJ-067	ARR TYP SIG COMP FLD WRNG
YA99-AJ-069	ARR PLN SW PNT DETECTOR
YA99-AJ-070	ARR PLN SW MACH WRNG DIAG

TRACKWORK
M1014- 92

TW19-RR-4

TRACKWORK-19 RAIL LUBRICATOR, ELECTRICAL DETAILS

COMMUNICATIONS

NONE
SG-1
SG-2
SG-3

COVER SHEET SHADY GROVE YARD GATEHOUSE DATA FILE
GATEHOUSE DATA FILE FIRE ZONES
GATEHOUSE DATA FILE FIRE ZONES
GATEHOUSE DATA FILE INTRUSION ZONES

SG-4	GATEHOUSE DATA FILE INTRUSION ZONES
SG-5	GATEHOUSE DATA FILE TALKBACK
SG-6	GATEHOUSE DATA FILE CCTV
SG-7	GATEHOUSE DATA FILE TELEPHONE LOCATIONS AND NUMBERS
SG-8	GATEHOUSE DATA FILE TELEPHONE LOCATIONS AND NUMBERS
A99-5050	COMM EQUIPMENT ROOM PLAN
A99-5051	AC POWER DISTRIBUTION
A99-5052 SHT 1 OF 2	COMM ROOM RACKFACE ELEVATION
A99-5052 SHT 2 OF 2	COMM ROOM RACKFACE ELEVATION
A99-5053 SHT 1 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5053 SHT 2 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5053 SHT 3 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5053 SHT 4 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5053 SHT 5 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5053 SHT 6 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5053 SHT 7 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5053 SHT 8 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5053 SHT 9 OF 9	COMM ROOM DIST. FRAME AND PROTECTORS
A99-5055 SHT 1 OF 3	COMPOSITE COMM CABLE DIAGRAM AND DUCTBANK SCHEDULE
A99-5055 SHT 2 OF 3	COMPOSITE COMM CABLE DIAGRAM AND DUCTBANK SCHEDULE
A99-5055 SHT 3 OF 3	COMPOSITE COMM CABLE DIAGRAM AND DUCTBANK SCHEDULE
A99-5056 SHT 1 OF 6	CONTROL ROOM INSTALLATION
A99-5056 SHT 2 OF 6	CONTROL ROOM INSTALLATION
A99-5056 SHT 3 OF 6	CONTROL ROOM INSTALLATION
A99-5056 SHT 4 OF 6	CONTROL ROOM INSTALLATION
A99-5056 SHT 5 OF 6	CONTROL ROOM INSTALLATION
A99-5056 SHT 6 OF 6	CONTROL ROOM INSTALLATION
A99-5058 SHT 1 OF 7	GATEHOUSE CONSOLE AND CABLE TERM. FAC. WIRING DIAG.
A99-5058 SHT 2 OF 7	GATEHOUSE CONSOLE AND CABLE TERM. FAC. WIRING DIAG.
A99-5058 SHT 3 OF 7	GATEHOUSE CONSOLE AND CABLE TERM. FAC. WIRING DIAG.
A99-5058 SHT 4 OF 7	GATEHOUSE CONSOLE AND CABLE TERM. FAC. WIRING DIAG.
A99-5058 SHT 5 OF 7	GATEHOUSE CONSOLE AND CABLE TERM. FAC. WIRING DIAG.
A99-5058 SHT 6 OF 7	GATEHOUSE CONSOLE AND CABLE TERM. FAC. WIRING DIAG.
A99-5058 SHT 7 OF 7	GATEHOUSE CONSOLE AND CABLE TERM. FAC. WIRING DIAG.
A99-5150 SHT 1 OF 8	TELEPHONE SYSTEM PLAN AND RISER
A99-5150 SHT 2 OF 8	TELEPHONE SYSTEM PLAN AND RISER
A99-5150 SHT 3 OF 8	TELEPHONE SYSTEM PLAN AND RISER
A99-5150 SHT 4 OF 8	TELEPHONE SYSTEM PLAN AND RISER
A99-5150 SHT 5 OF 8	TELEPHONE SYSTEM PLAN AND RISER
A99-5150 SHT 6 OF 8	TELEPHONE SYSTEM PLAN AND RISER
A99-5150 SHT 7 OF 8	TELEPHONE SYSTEM PLAN AND RISER
A99-5150 SHT 8 OF 8	TELEPHONE SYSTEM PLAN AND RISER
A99-5250 SHT 1 OF 7	FIRE AND INTRUSION SYSTEM PLAN AND RISER
A99-5250 SHT 2 OF 7	FIRE AND INTRUSION SYSTEM PLAN AND RISER
A99-5250 SHT 3 OF 7	FIRE AND INTRUSION SYSTEM PLAN AND RISER
A99-5250 SHT 4 OF 7	FIRE AND INTRUSION SYSTEM PLAN AND RISER
A99-5250 SHT 5 OF 7	FIRE AND INTRUSION SYSTEM PLAN AND RISER
A99-5250 SHT 6 OF 7	FIRE AND INTRUSION SYSTEM PLAN AND RISER



A99-5250 SHT 7 OF 7	FIRE AND INTRUSION SYSTEM PLAN AND RISER
A99-5350	CLOSED CIRCUIT TELEVISION INSTALLATION DETAILS
A99-5351	CLOSED CIRCUIT TELEVISION PLAN AND RISER
A99-5550	PUBLIC ADDRESS SYSTEM BLOCK AND LEVEL DIAGRAM
A99-5551	PUBLIC ADDRESS SYSTEM INSTALLATION DETAILS
A99-5552 SHT 1 OF 3	PUBLIC ADDRESS SYSTEM SCHEMATIC
A99-5552 SHT 2 OF 3	PUBLIC ADDRESS SYSTEM SCHEMATIC
A99-5552 SHT 3 OF 3	PUBLIC ADDRESS SYSTEM SCHEMATIC
A99-5553 SHT 1 OF 6	PUBLIC ADDRESS SYSTEM PLAN AND RISER
A99-5553 SHT 2 OF 6	PUBLIC ADDRESS SYSTEM PLAN AND RISER
A99-5553 SHT 3 OF 6	PUBLIC ADDRESS SYSTEM PLAN AND RISER
A99-5553 SHT 4 OF 6	PUBLIC ADDRESS SYSTEM PLAN AND RISER
A99-5553 SHT 5 OF 6	PUBLIC ADDRESS SYSTEM PLAN AND RISER
A99-5553 SHT 6 OF 6	PUBLIC ADDRESS SYSTEM PLAN AND RISER
A99-5557 SHT 1 OF 2	TALKBACK SYSTEM PLAN
A99-5557 SHT 2 OF 2	TALKBACK SYSTEM PLAN
A99-001	TRAIN CONTROL, COMMUNICATONS & TELEPHONE DUCTBANK

BOOK 4

M1210- 450	ST-C-002	METRO HORIZONTAL CURVES
M1210- 451	ST-C-002	METRO HORIZONTAL CURVES
M1210- 452	ST-C-002	METRO HORIZONTAL CURVES
M1210- 453	ST-C-003	SURVEY MONUMENTS - 1
M1210- 454	ST-C-019	SURVEY MONUMENTS - 2
M1210- 455	ST-C-004	WMATA CAR CLEARANCE ENVELOPE
M1210- 456	ST-C-013	TEMPORARY BARRICADES AND FENCES
M1210- 457	ST-C-016	TEMPORARY TREE GUARDS
M1210- 458	ST-C-017	METRO PAVEMENT SECTIONS AND DETAILS
M1210- 459	ST-C-067	PROJECT IDENTIFICATION SIGN FTA PROJECT IDENTIFICATION SIGN
M1210- 460	ST-C-072	JOINT DETAILS FOR CONCRETE PAVEMENT
M1210- 461	ST-C-073	SLOPE PROTECTION DETAILS
M1210- 462	ST-C-ADA-001	ADA PARKING DETAILS
M1210- 463	ST-U-014	UTILITY STANDARD ABBREVIATIONS AND GENERAL NOTES
M1210- 464	ST-U-064	WMATA UTILITY IDENTIFICATION
M1210- 465	ST-U-066	WMATA UTILITY MARKERS
M1210- 466	DD-TW-CR-001	COMPOSITE RAIL ASSEMBLY - DIRECT FIXATION
M1210- 467	DD-TW-CR-002	COMPOSITE RAIL ASSEMBLY, BALLASTED TRACK
M1210- 468	DD-TW-CR-003	COMPOSITE RAIL CLEARANCE ENVELOPE AND SPLICE JOINT ASSEMBLY
M1210- 469	DD-TW-CR-004	COMPOSITE RAIL END APPROACHES
M1210- 470	DD-TW-CR-005	COMPOSITE RAIL EXPANSION JOINT ASSEMBLY AND DETAILS
M1210- 471	DD-TW-CR-007	PORCELAIN INSULATOR ASSEMBLY AND DETAILS, SHEET 1 OF 2
M1210- 472	DD-TW-CR-008	PORCELAIN INSULATOR ASSEMBLY AND DETAILS, SHEET 2 OF 2
M1210- 473	DD-TW-CR-009	ANCHOR ASSEMBLY DETAILS AND SECTION 1 OF 2
M1210- 474	DD-TW-CR-010	ANCHOR ASSEMBLY DETAILS AND SECTION 2 OF 2

M1210- 475	DD-TW-CR-011	SPACING - EXPANSION JOINTS, ANCHORS AND INSULATORS
M1210- 476	DD-TW-CR-012	EXPANSION JOINT JUMPER CABLE SUPPORT DETAILS IN BALLASTED TRACK
M1210- 477	DD-TW-CR-015	COMPOSITE RAIL WITH TYPE B PROTECTION COVER
M1210- 478	DD-TW-CR-016	TYPE B PROTECTION COVER ASSEMBLY DETAILS AND SECTIONS
M1210- 479	DD-TW-CR-017	COMPOSITE RAIL TYPICAL CONDUIT AND CABLE ARRANGEMENT
M1210- 480	DD-TW-CR-018	CONTACT RAIL ARRANGEMENT NO.6, NO.8, NO.10, NO.15 TURNOUTS
M1210- 481	DD-TP-SSI-001	TYPICAL DETAILS SHEET 1
M1210- 482	DD-TP-SSI-002	TYPICAL DETAILS SHEET 2
M1210- 483	DD-TP-SSI-003	TYPICAL DETAILS SHEET 3
M1210- 484	DD-TP-SSI-004	TYPICAL DETAILS SHEET 4
M1210- 485	DD-TP-SSI-013	CONTACT RAIL TYPICAL CABLE CONNECTION DETAILS
M1210- 486	DD-TP-SSI-015	CONTACT RAIL HEATING TYPICAL DETAILS - SHEET 1
M1210- 487	DD-TP-SSI-016	CONTACT RAIL HEATING TYPICAL DETAILS - SHEET 2
M1210- 488	DD-TP-SSI-017	CONTACT RAIL HEATING TYPICAL DETAILS - SHEET 3
M1210- 489	DD-TP-SSI-018	CONTACT RAIL HEATING TYPICAL DETAILS - SHEET 4
M1210- 490	DD-TP-SSI-019	CONTACT RAIL HEATING TYPICAL DETAILS - SHEET 5
M1210- 491	DD-TP-SSI-020	CONTACT RAIL HEATING TRACKSIDE HEATER CONTROL PANEL MOUNTING REQUIREMENTS
M1210- 492	DD-TP-SSI-021	CONTACT RAIL HEATING MAINLINE ZONE & TRACKSIDE HEATER CONTROL-CONTROL PANEL SCHEMATIC
M1210- 493	DD-TP-SSI-022	CONTACT RAIL HEATING MAINLINE ZONE & TRACKSIDE HEATER CONTROL PANEL LAYOUT
M1210- 494	DD-TP-SSI-023	CONTACT RAIL HEATING ENCLOSURE DETAILS FOR ZONE CONTROL PANEL
M1210- 495	DD-TP-SSI-024	CONTACT RAIL HEATING ENCLOSURE DETAILS FOR TRACKSIDE HEATER CONTROL PANELS
M1210- 496	DD-TP-SSI-025	CONTACT RAIL HEATING TRACKSIDE HEATER POWER SCHEMATIC
M1210- 497	ST-E-301	CATHODIC PROTECTION DETAILS, SHEETS 1 OF 2
M1210- 498	ST-E-302	CATHODIC PROTECTION DETAILS, SHEETS 2 OF 2
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END OF SECTION



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PROCUREMENT REQUIREMENTS

00100 SOLICITATION - REQUEST FOR PROPOSALS

This Section includes project information for proposers.

NOTICE TO OFFERORS

RFP-FN5008/FMP includes Project Manuals and Project Drawing Sets for:

PROJECT DESCRIPTION: RAIL YARDS EXPANSION PROJECT
BRENTWOOD, GREENBELT, AND SHADY GROVE YARDS

PROPOSALS for the work described herein shall be submitted by the Proposers so as to be received at the Office of Procurement, Washington Metropolitan Area Transit Authority, Office of Procurement, **PRMT File Room 3C-02**, 600 Fifth Street, N.W., Washington, D.C. 20001 before the time and date listed in Section 00412 and 00413. Questions may be directed to the Contract Administrator.

DIRECTIONS FOR SUBMITTING OFFER: Read and comply with Section 00200, INSTRUCTIONS TO PROPOSERS. Proposal volumes shall be submitted in accordance with Section 00204. Proposal documents are contained in Section 00500, PROPOSAL FORMS AND SUPPLEMENTS.

The separate, sealed Proposal Volumes must be marked with offer under solicitation RFP NO. FN5008/FMP, Volume Number and Description. All amendments must be acknowledged on the Proposal Forms.

PROPOSALS MUST SET FORTH FULL, ACCURATE AND COMPLETE INFORMATION AS REQUIRED BY THIS REQUEST FOR PROPOSAL INCLUDING ANY AMENDMENTS.

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00101 GENERAL STATEMENT OF WORK:

- A. This solicitation is for a Design-Build Project that includes furnishing both design and construction services. The Design-Builder, through itself or others, shall provide professional design engineering and architectural services as well as technical, subprofessional, clerical and other services necessary for the complete design and preparation of the Final Design Drawings and Specifications, as well as the schedules, cost estimates, quality assurance/quality control and other Contract requirements. The Design-Builder shall also furnish all labor, equipment, materials, quality assurance/quality control and testing, construction and environmental/security/safety superintendence, and field engineering services required for the construction of the Project. The Design-Builder is responsible for program and project management; providing submittals, field engineering support, quality assurance and quality control during both design and construction; coordinating with jurisdictional agencies and utilities through the Authority Representative; obtaining all necessary permits, approvals and easements; fully constructing the Project ready for its intended use including as applicable, but not limited to: performing sitework; providing structural work and architectural finishes; electrical and mechanical items; installing and testing systems equipment, as well as integrating and testing these systems into existing systems; providing operation and maintenance training and manuals for the systems and equipment installed; commissioning the facilities and Project as applicable; furnishing all requisite deliverables including, but not limited to, spare equipment, record drawings and specifications, and warranties; all in accordance with the Contract requirements. No attempt has been made to separate the work by trades or types of construction, and the Design-Builder shall make its own decision as to who does what to accomplish the work.
- B. It is the responsibility of the Design-Builder to gather all data necessary for the performance of the Work under this Contract and to develop a complete and final design. The Authority will furnish the Design-Builder its Project Manual and Attachments to the Project Manual, which include Design Criteria (the WMATA-provided Program Criteria in Section 01112, applicable WMATA Standard and Technical Specifications Divisions 2 through 16; Project Drawings; the applicable WMATA Construction Safety and Environmental Manual or Coordinated Safety Program and Reporting Procedures Manual and associated Insurance Specifications for Construction Projects; the Safety and Security Certification Program Plan and the System Safety Program Plan; and other design related information) for the Design-Builder's use in developing the Final Design Specifications and Final Design Drawings.
1. The Authority will furnish to the Design-Builder without charge one (1) set of CD ROM disks in an AutoCAD (.DWG) file format of the original Proposal Set Project Drawings including any amendments, and including if applicable Standard Drawings and Information and Authority Record Drawings from prior

contracts, and one (1) set of CD ROM disks of the original Proposal Set specifications including any amendments in current WordPerfect version, except for the applicable publications referenced in the technical provisions. Additional documents will be furnished on request at the cost of reproduction.

2. The Design-Builder shall produce Final Design Specifications and Final Design Drawings, Shop and Working Drawings, Contract Record Drawings and Specifications and other Contract Documents in the appropriate medium.
 - a. The Final Design and As-Built Specifications shall be in Construction Specifications Institute (CSI) Format (latest edition) per the Authority's requirements.
 - b. The Final Design, Shop, Working and Contract Record Drawings shall be produced in an AutoCAD (.DWG) format and line work shall be shown on designated layers in accordance with the standard CAD guidelines as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. Images shall be clear, sharp and readily legible. For updates to As-Built Drawings, drafting quality shall match the original documents in line weights, symbols and lettering style and size.
 3. By providing the Authority's Design Criteria the Authority does not relieve the Design-Builder of its complete responsibility for the adequacy of the design. Accordingly, the selected Design-Builder must verify that existing site conditions described in the Contract Documents are current and verify all design elements to ensure that the Final Design Specifications and the Final Design Drawings are consistent with the applicable codes and regulations adopted by the governing jurisdictional agencies. In the event that the Authority's Design Criteria exceeds applicable codes and regulations, the Design-Builder shall be responsible for providing a design that is consistent with the Authority's Design Criteria.
- C. Complete approved designs for the following elements will be provided by the Authority:
1. Track alignment and trackwork designs for all three sites.
 2. Conceptual Storm water management designs, for Greenbelt Site only. Design-Builder will be required to develop erosion and sediment plans and obtain final MDE approval.
- D. All work under this Contract shall be performed in accordance with the terms and conditions of the Contract and in a logical sequence as developed by the Design-Builder. The Authority reserves the right to review and approve the sequence of work.

00102 GENERAL SCOPE OF WORK:

Rail Yards Expansion Project at Brentwood, Greenbelt, and Shady Grove Yards

- A. Background: Projected increases in ridership require the Washington Metropolitan Area Transit Authority (WMATA) to exercise options within the next year to purchase 120 rail cars to increase current train consists from six to eight-car operations to relieve overcrowding in the 2007 - 2008 time frame. In order to service the enlarged fleet and ensure safe and reliable eight-car operations, additional rail car maintenance capacity is required.
- B. Purpose: The Shops Expansions Project will provide WMATA additional maintenance capacity at three existing rail Yards in the Metro System: Brentwood Yard on the Red Line in the District of Columbia, Greenbelt Yard on the Green Line in Prince George's County, Maryland, and Shady Grove Yard on the Red Line in Montgomery County, Maryland. All construction work is to be completed by September 2007.
- C. Scope: There are two completely separate projects which will be evaluated separately for award. One project involves the modifications at the Greenbelt and Shady Grove Yards and the other modifications at the Brentwood Yard. Award of the Brentwood Yard Project is predicated on funding availability. The scope of the first project is for the construction of a new, two-story 72,000 s.f. back shop building at the Greenbelt Yard facility. Wheel and axle repairs will be expanded in the existing Greenbelt S & I shop. Construction of a new 16 bay S & I double ended maintenance shop with necessary trackwork and systems will be constructed at the Shady Grove Yard immediately adjacent to the existing shop. Expanded back shop, parking and laydown areas will also be constructed at Shady Grove. The Brentwood Yard Project involves the construction of three new tracks and four S & I bays. The Target Price for the Greenbelt and Shady Grove Yard Project is \$79 million and for the Brentwood Yard Project is \$41 million. The Period of Performance is approximately 27 months, or 825 calendar days for Greenbelt/Shady Grove Project and 910 calendar days for the Brentwood Project. Specific Project Milestones are shown in Section 00825. In addition, similar expansion at Alexandria Yard may be considered for inclusion at a later date once scope and funding have been finalized.
- D. Intent of the Project: The intent of the project is to provide improvements at three Yards in a design consistent with the aesthetic quality and locations contained in the Project Drawings and as specified in the Project Manual.
- E. Basis of Design: The Project shall be designed in accordance with the established requirements described in the following:
1. Project Manual:

- a. Introductory Information (Project Title Page, Certifications Page, Table of Contents and List of Project Drawings).
 - b. Procurement Requirements (Proposal Solicitation including RFP, Project Solicitation Schedule, General Statement of Work and General Scope of Work; Instructions to Proposers including General Instructions, Technical and Price Proposal Instructions and Evaluation Factors, Supplementary Instructions to Proposers and Pre-Proposal Meetings; Information Available to Proposers including Informational Documents, Geotechnical Data, Existing Conditions and Environmental Assessment Information; and Proposal Forms and Supplements including Proposal Form, Proposal Guarantee, Compliance/Exception Information, Brand Name or Equal Form, Price Schedule, Reps & Certs, Proposal Data Form, DBE Data, Proposing Addenda including Technical Proposal As Finally Accepted), and Wage Determination Rates.
 - c. Contracting Requirements (Agreement, Bonds and Certificates, General Conditions, Supplementary Conditions, and Addenda and Modifications including Addenda Amendment Letters, Claims, Clarifications and Proposals, and Modifications).
 - d. General Requirements including Design Requirements and Program Criteria in Section 01112.
 - e. The pertinent requirements of the WMATA Standard Specifications and WMATA Technical Specifications.
2. Attachments to the Project Manual:
- a. Project Drawings.
 - b. Other Authority-issued documents or drawings.
 1. WMATA's Automatic Train Control System Integrity Maintenance Practices, Revision 1, dated March 25, 2003.
 - c. The appropriate WMATA Construction Safety and Environmental Manual as specified in Section 00371, the Safety and Security Certification Program Plan as specified in Section 00381, and the System Safety Program Plan as specified in Section 00391, and the Metrorail Safety Rules and Procedures Handbook (MSRPH), January 2004.
 - d. WMATA Manual of Design Criteria (CD with electronic file)
3. Applicable codes, regulations, reference standards and specifications.

- F. **Design Criteria:** The Design Criteria (Design Requirements and Program Criteria in Section 01112; pertinent requirements of the WMATA Standard Specifications and Technical Specifications; Project Drawings; other Authority-issued documents or drawings) and applicable codes, regulations, reference standards and specifications are not the final design; however, the Design Criteria shall be utilized as the basis for design and shall be used as shown and/or as specified, unless the latest Codes and Regulations of the governing jurisdictional agencies are more stringent, in which case the Codes/Regulations shall apply. The Design-Builder shall develop, coordinate and prepare the final design including but not limited to Final Design Drawings with design calculations and details for all elements to be used in carrying out the work and provide Final Design Specifications in CSI Format, latest edition. The design shall be submitted to the Authority in accordance with the requirements of this Section and other Sections of the Project Manual.
- G. **Materials:** The principal criteria that govern the selection of materials are consistency with the Authority-required materials, appropriateness of construction, maintainability, operational efficiency, safety, and economy. The materials to be specified for the Project shall be as set forth in the Design Criteria. The materials specified in the Standard Specifications and Technical Specifications represent the minimum standards to be used for construction. If the codes and regulations of the jurisdictional agencies exceed the Authority requirements, then the more stringent standard shall be utilized.
- H. **Safety/Security:** The Project shall be designed to provide an optimum level of safety and security for users and Authority employees at all times and shall conform to the applicable WMATA Construction Safety and Environmental Manual; Safety and Security Certification Program Plan and the System Safety Program Plan; the Safety Rules and Procedures Manual and the Metrorail Safety Rules and Procedures Handbook as applicable. Dark, confined and indefensible spaces shall be avoided. The lighting in all areas shall conform to the Design Criteria.
- I. **Project Phasing/Scheduling:** The Project is divided in two phases, the Design Phase and the Construction Phase, however, there is an overlap between the Phases. The Construction for any Design Element will not be approved until the balance of the Design is advanced to a stage where in the judgement of the Authority the Design Element can be adequately evaluated. The Design-Builder shall receive approval by the Authority of the Design by Element before proceeding to Construction for that Element.
- J. **Permits and Jurisdictional and Utility Approvals:** To facilitate meeting the timetables indicated in Section 00870, except to the extent those milestones are modified by the Authority, the Authority has been conducting discussions with the affected jurisdictional agencies concerning site environmental, storm water management, wetlands mitigation, and utility issues, and the proposed work as shown and specified in the plans has to date been favorably received by those agencies. It is

the Design-Builder's responsibility to obtain the necessary approvals and permits; however, the Authority will work with the Design-Builder to support this effort. The Design-Builder is also required to submit an application for Building Permits to the three jurisdictions affected, and the Designer shall advance the design so that securing of these jurisdictional permits by the Design-Builder will occur in a timely fashion. In addition, the Design-Builder is responsible for obtaining all the necessary utility approvals with the exception of the following:

1. WMATA will obtain conceptual storm water management approvals from MDE for the Greenbelt site only.
- K. Coordination with Others: The Design-Builder shall coordinate for this Project with the following as applicable:
1. The Authority Representative or his designee. The Design-Builder shall designate a single liaison to coordinate with operating personnel through the Authority Representative for any work that may have a potential impact on any operations at existing facilities.
 2. Utility companies and jurisdictional agencies affected by or having jurisdiction over the Project through the Authority Representative.
 3. Other Authority personnel, Authority consultants and contractors associated with adjacent projects through the Authority Representative for this Contract.
- L. Minimal Interference with Existing Operations: The Design-Builder shall perform the Work such that the operation of the existing facility is not adversely impacted. The Design-Builder shall submit plans including, but not limited to, a maintenance of traffic plan as specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING at minimum for the following:
1. Non-restricted access by the Authority's forces to the existing facilities and temporary access for the Design-Builder to the facility.
 2. The maintenance of traffic plan shall ensure that the on-going operations of the facility are not adversely affected by the Project.
 - a. The Design-Builder shall minimize interference with the operations and maintenance functions of the Authority's RAIL or BUSV Transportation personnel. An Authority-approved routing, signage and striping plan will be required prior to the commencement of work.

- b. The Design-Builder shall propose a Work Plan that provides for minimal disruption to ongoing operations in the existing facilities which must be coordinated with Rail Car Maintenance (CMNT).

M. Design Phase

1. The Design-Builder shall schedule a Pre-Design Meeting with the Authority prior to beginning any design work in order to review Project requirements and discuss any issues for clarification.
2. The Designer of the Design/Build Team shall perform the Design services for the Project required by the Contract Documents and in accordance with the approved Quality Control/Quality Assurance Plan. The Authority will review and approve the design as being in general conformance with the functional requirements contained in the Contract Documents. The Design-Builder shall use the firms and personnel identified in the Technical Proposal as finally accepted. The Design-Builder shall not change the designated design firms(s) and personnel or shift design and engineering Work from one firm to another (including changes in Work performed by Subcontractors) without the prior written approval of the Authority Representative.
3. Designer: All design and field engineering Work required to be performed by the Design-Builder hereunder shall be performed by or under the supervision of licensed professionals under the laws of the State of Maryland and the District of Columbia or who have the ability to obtain such through reciprocity.
4. Code Requirements: The designs shall be carried out in accordance with the latest version of the applicable codes of the District of Columbia and Prince George's County, Montgomery County and the State of Maryland, as well as other codes and regulations that apply to the work being performed on the Project Site. In addition, the Design-Builder shall adhere to the Code Requirements as set out in the Design Criteria including using the above cited District, County and State where county and/or state codes are referred to, and also shall verify that the requirements of the Contract comply with the above-mentioned codes and regulations.
5. Conflicts in Requirements and /or Criteria: The Design-Builder shall identify and make known to the Authority as soon as practicable, but in no case less than five (5) days after the Designer knows of such, any potential conflicts among the requirements and criteria either indicated in the Project Manual and/or Project Drawings or required by local, state or federal jurisdictions that affect the scope, cost or quality of this work. The notification shall include a clear statement of the conflict, the source of the requirement and/or criteria and a recommended solution to the potential conflict. The Authority will determine solely the solution to the conflict based on either the Designer's recommendation or its own evaluation. The Designer shall incorporate that

decision into the design with a minimum of impact to the scope, cost and/or quality of the work.

6. Technical Specifications in CSI Format: The Designer shall develop and provide the Design Specifications for this project in the latest edition of CSI Format, and also cross reference these to the Section Numbers of the WMATA Standard and Technical Specifications of the Project Manual.
7. Design Submittal Review:
 - a. Design Review: The Designer of the Design-Build Team is responsible for preparing, reviewing and approving the Design Drawings and Design Specifications before submittal to Prince George's County, other jurisdictional authorities, and utility companies through the Authority Representative. The Designer shall be responsible for obtaining all the necessary utility and jurisdictional approvals for the design. Submittal review and approval and certification milestones shall be included in the Design-Builder's schedule in accordance with the Schedule requirements of this Project Manual.
 - b. Authority Review: The Authority explicitly reserves the right to also review and approve the Design items identified in subparagraph c. of this subparagraph. Such approval (or disapproval) shall be given to the Design-Builder within twenty-one (21) calendar days after receipt by the Authority. The Design-Builder shall incorporate any comments or corrections and deliver a revised submittal to the Authority within fourteen (14) calendar days following receipt of such by the Design-Builder. Review and approval by the Authority will not relieve the Design-Builder from its responsibility for accuracy of submittals, for conformity of submittals to and for prosecution and completion of the Contract in accordance with the Contract Documents, and for compatibility of described product with contiguous products and the rest of the systems that they impact. Authority review and approval of a separate item will not constitute review and approval of an assembly in which the item functions. Authority approval is general in nature and shall not be construed as relieving the Design-Builder of their responsibility for the adequacy and functionality of the Final Design within the given parameters.
 - c. Design Review:
 - 1.) S&I Yard Improvements: Includes all elements of the Base Items listed in Section 00100, Project Information.
 - 2.) S&I Shop Expansion Facility: Includes all elements of the Base and Option Items listed in Section 00100, Project Information.

- a) 60% level of design details for elements shown in project Documents (Intermediate Design Specifications in CSI format).
 - b) 90% level of design details for elements shown in project Documents (Pre-Final Designs Specifications in CSI format)
 - c) 100% level of design for what the Designer will submit to the jurisdictional authorities during the permitting/approval process (Final Design Drawings and Final Design Specifications in CSI format).
 - d) Other Design Reviews: The Authority retains the right to review and approve any other submittals that it deems necessary during the Design Phase of this Contract. In addition, the Design-Builder shall provide all other submittals to the Authority that are specified in the Project Manual beyond those referenced above and as listed on the approved Schedule of Submittals.
8. Design: In all aspects of the design, the proposed facilities shall operate as one entity upon completion of the Contract.
- N. Construction Phase
1. The Builder of the Design/Build Team shall perform all construction, provide all construction materials and equipment, install all equipment and Systems, and undertake all efforts necessary or appropriate to construct the Project in accordance with the approved Final Design Drawings and Final Design Specifications; the Project Schedule; all applicable jurisdictional codes and regulations; jurisdictional approvals and permits and utility approvals; the approved QC/QA Plan; the approved Safety Plan; and all safety, environmental and other applicable requirements so as to complete the Project and achieve Final Acceptance by the dates specified. All personnel involved in performance of construction work shall be experienced and qualified to perform their trade and all construction work shall be performed in a skilled and workmanlike manner. The work shall include field engineering, quality control, manufacturing, procuring, delivering, storing, setting up, constructing, installing, testing, documenting, and quality assurance by the Designer, and warranting and placing in service the complete project. The Design-Builder shall use the firms and personnel identified in the Technical Proposal as finally accepted. The Design-Builder shall not change the designated construction firms(s) and personnel or shift construction and field engineering Work from one firm to another (including changes in Work performed by Subcontractors) without the prior written approval of the Authority Representative.
 2. Construction Submittal Review:
 - a. Submittal, Review and Inspection: The Design-Builder shall provide field engineering and all professional services during construction for on-site

observation, attendance at project meetings, and general consultation as required to complete the Project. The Designer of the Design/Build Team shall have primary responsibility for these tasks. The Designer is also responsible for reviewing and approving all required construction submittals as specified in the Design Criteria, before submittal to the Authority and to Prince George's County and other jurisdictional agencies and utility companies. The Design-Builder shall be responsible for obtaining all necessary approvals and permits. The Design-Builder shall also provide all testing services required during construction. In addition, the Design-Builder is responsible for submitting to the Authority the Designer's certifications that the Builder's Quality Control Program is functioning and certifications for the final products, the overall construction and the functioning of systems and equipment installations. These certifications are to be turned over to the Authority for the project records. Submittal review and approval and certification milestones shall be included in the Design-Builder's schedule in accordance with the Schedule requirements of this Project Manual.

- b. **Authority Review:** The Authority explicitly reserves the right to also review and approve the Construction items identified in this subparagraph. Such approval (or disapproval) shall be given to the Design-Builder within no less than twenty-one (21) calendar days after receipt by the Authority. The Design-Builder shall incorporate any comments or corrections and deliver a revised submittal to the Authority within fourteen (14) calendar days following receipt of such by the Design-Builder. Review and approval by the Authority will not relieve the Design-Builder from its responsibility for accuracy of submittals, for conformity of submittals to and for prosecution and completion of the Contract in accordance with the Contract Documents, and for compatibility of described product with contiguous products and the rest of the systems that they impact. Authority review and approval of a separate item will not constitute review and approval of an assembly in which the item functions. Authority approval is general in nature and shall not be construed as relieving the Design-Builder of their responsibility for the adequacy and functionality of the constructed facilities.
3. **Construction Review:**
All elements of S&I Shop and Yard Improvements including the following:
 - a. Factory visit to pre-caster to approve fabrication of insulated architectural pre-cast concrete panels, if used.
 - b. Design-Builder's schedules and reports, submittal logs, and daily progress reports.
 - c. Working Drawings.

- d. Shop, Schematic and Installation Drawings, manufacturer's literature, product data and product substitution requests.
 - e. Samples.
 - f. Certifications.
 - g. Miscellaneous documentation.
 - h. Testing and Inspection Reports.
 - i. Calculations.
 - j. Licenses and Permits.
 - k. Applications for Payment.
 - l. Bound sets of Contract Record Drawings including As-built Contract Drawings, Shop Drawings, Working Drawings, Standard Drawings, Information Drawings, Authority Record Drawings, Manufacturers' Shop Drawings, Field Drawings, and installation details.
 - m. Bound sets of As-built Contract Specifications in CSI format.
 - n. Bound sets of Operation and Maintenance Manuals.
 - o. Bound sets of Instructor's Training Manual, Lesson Plans, and Student's Training Manual.
 - p. Electronic Media Drawing Files for Operation and Maintenance Manuals; Instructor's Training Manual, Lesson Plans, and Student's Training Manual; As-built Contract Specifications; Contract Record Drawings; and As-built CPM Schedule.
4. Other Construction Reviews: The Authority retains the right to review and approve any other submittals that it deems necessary during the Construction Phase of this Contract. In addition, the Design-Builder shall provide all other submittals to the Authority that are specified in the Project Manual beyond those referenced above and as listed on the approved Schedule of Submittals.
5. Start of Construction: The Design-Builder shall not start construction until the Authority has approved the Design for that Element as listed in Section 00103, Paragraph H., except by the express consent of the Authority. The Construction for any Design Element listed in Section 00103, Paragraph H., will not be approved until the balance of the Design is advanced to a stage where in the judgment of the Authority the Design Element can be adequately evaluated.
6. Performance of Inspections and Tests by the Design-Builder: The Design-Builder shall perform all inspection and testing in accordance with the Contract Documents and the procedures in the Design-Builder's approved Quality Control/Quality Assurance (QC/QA) Plan.
- O. S&I Yard Improvements and S&I Shop Expansion Facility:
- 1. Construction:
 - a. Design-Builder Responsibilities: The Builder of the Design/Build Team shall construct the S&I Yard Improvements in accordance with the

approved Final Design Drawings and Final Design Specifications, with the approved shop drawings, with the permits and approvals issued by the Authority, District of Columbia, Prince George's County, Montgomery County and other jurisdictional agencies, and in accordance with all codes and regulations of the jurisdictional authorities or the Design Criteria, whichever is more stringent. The Design-Builder shall submit to the Authority all items as set forth in subparagraph J.2.c.(1) of this Section and all submittals required per the Final Design Specifications as reviewed and approved, per the Design Criteria, and others that are specified in the Project Manual beyond those referenced above, and all items listed in the approved Schedule of Submittals. The Builder shall not install any materials until approvals of submittals are obtained. The Builder is responsible for performing Quality Control for construction, the Designer is responsible for performing Quality Assurance during construction, and the Authority shall perform an oversight function, all as specified in Section 01470 and in the approved QC/QA Plan.

b. Environmental Concerns:

- 1) Landscape Factors: The Builder shall install the landscape plantings required in the approved plans that have been tagged at the nursery by the Designer and that are listed on the approved plant schedule in conformance with the appropriate planting seasons. The Designer shall coordinate delivery of the plantings to the worksite for installation by the Builder. The Design-Builder shall coordinate the maintenance by the Builder of the landscape plantings during this entire period.
- 2) Air Pollution : The Design-Builder will minimize fugitive dust.
- 3) Earth, sediment control and storm drainage work shall be performed in accordance with the jurisdictional requirements and as shown in the Final Design Drawings, and as specified in the Final Design Specifications. The Builder shall also provide a Low-Impact Stormwater Management System (LID) for stormwater runoff.
- 4) Oil/grit separators for the S&I Shop Expansion Facility floor drains shall be installed that discharge into the existing sanitary sewer system.
- 5) Waste Disposal: The Design-Builder shall properly characterize, handle, and dispose of all waste. Known wastes include trash, asbestos cement waterlines, asbestos tiles and insulation, and lead based paint.

- c. The Builder shall provide access roads, sidewalks, curb and gutter, and parking area/lot in accordance with the jurisdictional requirements, as shown in the Final Design Drawings, and as specified in the Final Design Specifications. The Design-Builder shall coordinate with the affected public agencies for inspections and approvals of handicapped curb cuts through the Authority Representative.

- d. The Builder shall site the new Greenbelt Annex Building and Shady grove S&I Expansion as shown in the Final Design Drawings.
- e. The Design-Builder shall be responsible for providing all new site utility systems and connections and for demolition of portions of existing utility systems (including, but not limited to, sanitary sewer, storm drainage, water supply, electrical, and Systems) as needed for a complete and workable system. All utility services must remain operational until new utilities and utility connections are installed by the Builder and before any portion of existing systems can be demolished or abandoned, as applicable. Also, coordinate with the Authority and affected utility agencies through the Authority Representative for obtaining approvals, permits, easements, installation, tie-ins, inspections, and testing
 - 1) Availability of Utilities: The Builder shall provide all temporary utility systems that are required for his use during performance of the work.
- f. If the Design-Builder decides to procure insulated architectural precast concrete panels, he shall coordinate with the panel supplier for Designer and Authority approval at the plant for fabrication.
- g. Signage and Graphics: S&I Shop Expansion Facility's and S&I Yard Improvements' signage and graphics shall be fabricated and installed as approved by the Authority.
- h. Foundation and Superstructure Construction and Architectural Finishes: The Builder shall construct the S&I Shop Expansion Facility as shown on the Final Design Drawings and as specified in the Final Design Specifications. Foundation construction may commence only after the foundation design has been approved by the Authority and a permit for the construction is issued by the governing jurisdiction.
- i. Electrical Service and Supply: Sufficient capacity exists to supply the new facilities. The Design-Builder shall provide feeder, conduit, wiring, cabling, convenience outlets, lighting, and all other necessary electrical items for the Shop Improvements to meet codes and regulations of governing jurisdictions and other jurisdictional agencies and in accordance with the Final Design Drawings and the Final Design Specifications including providing power to all Shop equipment and COMM and other Systems equipment. All site and building lighting shall be shaded to eliminate glare.
- j. Mechanical Items: The Design-Builder shall procure and install materials and install fire protection, plumbing items, eyewash, heating, air conditioning and ventilation, and roof and floor drainage systems and oil/grit separators for the Shop and yad improvements as necessary to meet codes and regulations of the governing jurisdiction and in accordance with the Final Design Drawings and the Final Design Specifications.
- k. Fixed and Additional Shop Equipment: The Design-Builder shall procure the Shop equipment for as specified in the Final Design Specifications



and shall coordinate with the equipment manufacturers for the delivery of the equipment to meet the Builder's installation schedule. The Builder shall install the Fixed Shop Equipment in accordance with jurisdictional codes and the Final Design Documents.

- I. Systems Equipment and Cabling: The Design-Builder shall coordinate with equipment manufacturers for the delivery of the equipment to meet the Builder's installation schedule. The work shall include procuring, installing, integrating and testing of equipment, material, racks, cables, cable trays, conduit, outside plant cabling, ductbank, hardware and all appurtenances and final system and component configuration as required to ensure the new Systems or additional Systems are compatible with and will not degrade the existing Systems and to provide a complete and coordinated operating system, with functional subsystems and elements, all which meet the requirements described in the Final Design Drawings and Final Design Specifications and operate as an entity for: Voice and Data Communications, i.e., Administrative and Emergency Trip Telephones and Elevator Emergency Telephone, CTS, FIA, Yard Talkback, PAS, and CCTV; and Trackwork; Traction Power; and ATC Systems.

P. Operations and Maintenance Training

- 1. The Design-Builder shall provide operations and maintenance training classes as specified in Section 01820.

Q. Operations and Maintenance Manuals

- 1. The Design-Builder shall provide to the Authority all manuals as specified in Section 01780.

R. As-built Drawings and As-built Specifications

- 1. The Design-Builder shall provide to the Authority all as-built drawings and as-built specifications as specified in Section 01780.

00103 PROJECT SOLICITATION SCHEDULE

A. The solicitation schedule for this project is as follows:

Issue Phase Two - Request for Proposals:	12/03/04	Sections 00412 & 00413
Proposals due date:	01/21/05	Sections 00412 & 00413
Projected Award date:	03/21/05	
Final Completion	09/01/07	Section 00825.

- B. Contract milestones interim completion dates, if any, and final completion date of Contract work are specified in Section 00825, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE REQUIREMENTS of the Supplementary Conditions.

END OF SECTION



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PROCUREMENT REQUIREMENTS

00200 INSTRUCTIONS FOR PROCUREMENT

- A. This solicitation is a competitive, "best value" selection process as described herein for the award of a Design-Build contract.
- B. This Section includes procedures with which proposers must comply and conditions affecting award of the Contract.

00201 GENERAL INSTRUCTIONS

- A. Definitions as used herein:
 - 1. The term "solicitation" used in this document means this Request for Proposals ("RFP").
 - 2. The term "offer" and "proposal" are synonymous and mean a response to this solicitation.
 - 3. The terms "offeror" and "proposer" are synonymous and refer to the Design-Builder that submits a response to this solicitation.
 - 4. For further explanation of Contract terms, refer to Section 00701 DEFINITIONS of the General Conditions.

- B. Method of Procurement:

This is a competitive, negotiated acquisition with a "best value" (Fixed Price / Best Design) selection process. Proposers shall submit separate proposal volumes in accordance with this Section, which the Authority will evaluate in accordance with the Authority's evaluation criteria as specified in this Section.

- C. Basis for Award:

- 1. The Authority will make multiple awards from this solicitation, one for each Project as described. Award(s) will be made to that proposer or proposers:
 - (a) whose offer is judged by an integrated assessment of the evaluation criteria to be the most advantageous to the Authority based on technical merit and value provided within the established Target price for each Project; and



- (b) that the Authority deems responsible in accordance with the WMATA Procurement Procedures Manual.

 - 2. This a Two-Phase Design-Build selection to be awarded on a "Fixed-Price / Best-Design" basis. For Phase One, the proposers were asked to submit certain technical qualifications. The Authority evaluated the Phase One proposals to determine which proposers would be asked to participate under Phase Two of the project. Phase Two proposers are required to submit a Technical and Cost proposal which the Authority will evaluate using source selection procedures.

 - 3. The Authority reserves the right to (1) reject any or all offers at any time prior to acceptance of proposals or award of Contract if such action is in WMATA's or the public's interest, (2) negotiate with all proposers, (3) waive informalities and minor irregularities in offers received, and (4) evaluate Price Proposals from proposers whose Technical Proposals conform to this Request for Proposal.

 - 4. The Authority anticipates making multiple awards as the result of this solicitation. See Notes to Proposers on Section 00434 PRICE SCHEDULE for further Award information.

 - 5. A written award or acceptance of offer mailed or otherwise furnished by the Authority to the successful proposer within the specified Acceptance Period shall result in a binding contract. The Authority may accept an offer whether or not it conducts discussions, unless the Authority receives from the proposer a written notice of withdrawal before award.
- D. Type of Contract:
- The Authority contemplates award of a Firm Fixed Price, Design-Build contract(s) resulting from this solicitation consistent with the Price Schedule.
- E. Preparation of Offers:
- 1. The proposer shall complete the Proposal Forms furnished in Section 00400, or copies thereof, submit them according to the instructions given in this RFP. If erasures or other changes appear on the forms, such erasures and changes must be initialed by the person signing the proposal.

 - 2. Each proposer shall furnish the information required by the solicitation. Proposers are expected to examine the drawings, specifications, schedule, and all instructions and exhibits. Failure to do so will be at the proposer's risk.
- F. Explanation to Proposers:

1. Any explanation desired by a Proposer regarding the meaning or the interpretation of this RFP or any other solicitation document must be requested in writing and with sufficient time allowed for a reply to reach all proposers before the submittal of their proposals. Oral explanations or instructions given before the award of the Contract will not be binding. Any information given to a prospective proposer concerning the solicitation will be furnished promptly to all prospective proposers as an amendment to this RFP, if the information is necessary in submitting offers or if lack of such information would be prejudicial to other prospective proposers.
2. The Authority reserves the right to revise or amend the RFP prior to the date set for receipt of proposals or final offers. Such revisions and amendments, if any, will be announced by an amendment or amendments to this RFP. Copies of such amendments as may be issued will be furnished to all prospective proposers prior to receipt of proposals or to all proposers within the competitive range thereafter.
3. If amendments would require material changes in the proposals, the date set for the receipt of proposals may be postponed by such number of days as in the opinion of the Authority will enable proposers to revise their proposals. In such cases, the amendment will include an announcement of the new date for the receipt of proposals.

G. Acknowledgment of Amendments:

1. Proposers are required to acknowledge receipt of all amendments to this solicitation on copies of the Proposal Forms, Sections 00412 and 00413, in the space provided. Failure to acknowledge all amendments may cause the proposal to be considered not responsive to the solicitation and may be ineligible for award.
2. Modifications of proposals already submitted due to the revisions listed in an amendment will be considered if received at the office designated in this Request For Proposal by the time set for receipt of proposals. Modifications shall be enclosed and sealed in separate proposal volume packages.
3. If this solicitation is amended, all terms and conditions which are not modified remain unchanged.

H. Submission/Withdrawal of Proposals/Offer:

1. Proposals shall be sealed, marked, addressed and submitted in separate packages by volume number as directed in this Section H.

2. The proposer shall show on the face of each separately sealed proposal volume package the hour and date specified in the solicitation for receipt of proposals, the solicitation number, the name and address of the proposer and the volume content of the proposal. Failure to do so may result in a premature opening of or a failure to open such proposal.
 3. Proposals may be mailed or delivered in person to the Washington Metropolitan Area Transit Authority, Office of Procurement, Room **3C-02**, 600 Fifth St. N.W., Washington D.C., 20001 prior to the date for receipt of proposals unless otherwise specified. Receipt of hand-delivered proposals shall be prior to the date and hour specified in Sections 00412 and 00413 at the Office of Procurement, Room **3C-02**. Please be advised that the Authority has security screening facilities in place for personnel and packages at the lobby level entrance.
 4. Electronic and facsimile proposals will not be considered, unless authorized by the Authority.
 5. Proposals may be withdrawn by written or electronic notice before award. Proposals may be withdrawn in person by a proposer or an authorized representative, if the representative's identity is made known and the representative signs a receipt for return of the proposal before award.
- I. Late Proposals, Modifications or Withdrawals:
1. Any offer received at the office designated in the solicitation after the date specified for receipt will not be considered unless it is received before award is made and it:
 - a. Was sent by registered or certified U.S. mail not later than the fifth calendar day before the date specified for receipt of offers (e.g., an offer submitted in response to a solicitation requiring receipt of offers by the 20th of the month must have been sent by registered or certified mail by the 15th);
 - b. Was sent by U.S. mail or a recognized commercial carrier, and it is determined by the Authority that the late receipt was due solely to mishandling by the Authority after receipt;
 - c. Was sent by U.S. Postal Service Express Mail Next Day Service-Post Office or similar express service from a recognized commercial carrier to Addressee, not later than 5:00 p.m. at the place of mailing two working days prior to the date specified for receipt of offers. The term "working days" excludes weekends and U.S. Federal holidays; or

- d. Is the only offer received.
2. Any modification of an offer, except a modification resulting from the Contracting Officer's request for a final proposal revision (FPR), is subject to the conditions stated above.
3. A modification resulting from the Authority's request for a final proposal revision received after the time and date specified in the request will not be considered unless it is received before award, and the late receipt is due solely to mishandling by the Authority.
4. The Authority may in its sole discretion accept a late proposal in instances where it is clear that the proposal left the hands of the proposer before the time set for receipt of proposals and acceptance of the late proposal will not delay the procurement or prejudice the other proposers.
5. Notwithstanding these requirements, a late modification of any otherwise successful offer that makes its terms more favorable to the Authority will be considered at any time it is received prior to an award and may be accepted.

J. Proposal Guarantee:

1. A proposal guarantee in the penal amount of five (5) percent of the proposal price is required by the Request for Proposal. Failure to furnish a proposal guarantee in the proper form and amount with the Price Proposal, by the time set for the receipt of Proposals, may be cause for rejection of the proposal.
2. A proposal guarantee shall be in the form of a firm commitment, such as a proposal bond (form supplied in Section 00431), postal money order, certified check, cashier's check, irrevocable letter of credit from a State or Federally chartered bank or, in accordance with Treasury Department regulations, certain bonds or notes of the United States. Corporations executing the proposal bond as sureties must be among those appearing on the Treasury Department's list of approved sureties and must be acting within the limitations set forth therein. Proposal guarantees, other than proposal bonds, will be returned as follows:
 - a. To unsuccessful proposers: As soon as practicable after they are eliminated from further consideration.
 - b. To the successful proposer: Upon execution of such further contractual documents and bonds as may be required by the proposal as accepted.
3. If the successful proposer, upon acceptance of its Proposal by the Authority within the Acceptance Period, fails to execute such further contract documents

and give such bond(s) as may be required by the terms of the Contract, its Contract may be terminated for default. In such event, the successful proposer shall be liable for any cost of reprocurring the work which exceeds the amount of its proposal, and the proposal guarantee shall be applied toward offsetting such difference.

K. Minimum Proposal Acceptance Period:

1. "Acceptance Period", as used in this provision, means the number of calendar days available to the Authority for awarding a contract from the date of receipt of the most current proposal.
2. This provision supersedes any language pertaining to any period for acceptance that may appear elsewhere in this solicitation.
3. The Authority requires a minimum Acceptance Period of **60** calendar days from the date of receipt of the most current proposal.

L. Contract and Bonds:

The proposer whose Proposal is accepted shall, within the time established in the Contract Documents, enter into a written contract with the Authority and furnish performance and payment bonds on standard Authority forms in the amounts indicated in Section 00600, BONDS AND CERTIFICATES.

M. Solicitation Documents:

1. One set of project documents for will be furnished free of charge. Additional sets may be purchased at the following non-refundable price for each:
 - a. Project Manual \$50.00
 - b. Half-size Project Drawing \$50.00
 - c. The appropriate WMATA Safety Manual, and associated insurance document if applicable, as specified in Section 00371 \$10.00
 - d. The Safety and Security Certification Program Plan as specified in Section 00381 \$10.00
 - e. The System Safety Program Plan as Specified in Section 00391 \$10.00

2. Payment shall be made with the request and shall be by company check or money order (personal checks will not be accepted) made payable to the Washington Metropolitan Area Transit Authority.
4. Unless otherwise stated, plans and specifications may be obtained from:

WMATA
Jackson Graham Building
Office of Procurement and Materials
Attn: Fred M. Pohlmann, Rm. 3E-01
600 Fifth Street, N. W.
Washington, D.C. 20001
Phone: (202) 962-1529
Fax: (202) 962-6247

N. Conditions Affecting the Work:

1. Proposers are strongly urged to visit the site and take such other steps as may be reasonably necessary to ascertain the nature and location of the work and the general and local conditions which can affect the work or the cost thereof. Failure to do so will not relieve proposers from the responsibility for estimating properly the difficulty and cost of successfully performing the work. See Section 00252 for further details.
2. The Authority will assume no responsibility for any understanding or representations concerning conditions made by any of its officers or agents prior to the execution of the Contract, unless included or referenced in this Request for Proposal.
3. As discussed in Section 00300, INFORMATION AVAILABLE TO PROPOSERS, proposers may examine records of all borings, test excavations, and other subsurface investigations and existing utilities and environmental investigations, if any, made for the Authority prior to the design and construction of the project and As-Built Information Drawings if initially provided in the Project Drawings. Said investigations and drawings are provided to assist the proposer in the preparation of its proposal. The proposer shall be responsible for interpretation of the data to determine actual conditions and for conducting further investigations prior to commencement of design work.

O. Opportunity for Disadvantaged Business Enterprises to Propose:

Proposer shall affirmatively ensure that in regard to any contract entered into pursuant to this solicitation, disadvantaged business enterprises will be afforded full opportunity to submit proposals in response to this solicitation and will not be

discriminated against on the grounds of race, color or national origin in consideration for award.

- P. Disadvantaged Business Enterprises: (See Section 00453 [aka Appendix B])*
1. It is the policy of the Authority that Disadvantaged Business Enterprises (DBEs) shall have an equal opportunity to receive and participate in performing WMATA contracts, including contracts and subcontracts at any tier, and also of the Federal Transit Administration (FTA) and the U. S. Department of Transportation (US DOT) in receiving and participating in federally assisted contracts. The DBE requirements, if any, are set forth in Section 00453, DBE DATA (aka Appendix B) and are applicable if the proposal is \$500,000 or more for construction (and construction-related) contracts; and for supply and service contracts having a total dollar value of \$100,000 or greater. The DBE goal percentages, if applicable, are listed in Section 00453, DBE Data.
 2. If the proposer is not a DBE, then the DBE goal set forth in Section 00453, if any, shall be met by subcontracts or joint ventures with DBEs.
 3. If a DBE goal is specified, the proposer shall submit with its initial Price Proposal a list of WMATA certified DBE firms with which it intends to enter into subcontract agreements for this contract. The documentation requirements of Section 00453 shall be completed and submitted to the Authority at the time set forth for the submittal of final proposal revisions for any contract in which a DBE goal is applicable. Also, if no goal is specified in Section 00453, but the proposer still intends to utilize DBEs in the performance of this contract, the proposer shall submit with its initial Price Proposal a list of those WMATA-certified DBE firms. Further, if the Authority elects to award a contract without discussions and/or final proposal revisions, that proposer with which the Authority intends to award a contract shall submit the requisite DBE data as may be required by the Contracting Officer before contract award. Any proposer which fails to complete and return this information, if applicable, may be deemed to be not responsible and may be ineligible for contract award. The documentation requirements , if applicable, are as follows:
 - a. SCHEDULE OF DBE PARTICIPATION and executed LETTER(S) OF INTENT TO PERFORM AS A SUBCONTRACTOR/JOINT VENTURE with agreed price sufficient to meet the DBE goal set forth in Section 00453; or
 - b. A request for waiver of the DBE goal or portion of the goal , if any, and reasons therefor as stipulate in Paragraph F.3. of Section 00453. Request must be made on company stationary and signed by the responsible official.

4. Proposers that fail to meet the DBE goal set forth in Section 00453, if any, and fail to demonstrate "good faith efforts" to justify waiver of the DBE goal, if any, may be deemed non-responsible and ineligible for contract award.
5. In connection with the performance of this Contract, the Design-Builder agrees to cooperate with the Authority in meeting its commitments and goals with regard to the maximum utilization of Disadvantaged Business Enterprises (DBE), and further agrees to exert good faith efforts to satisfy the requirements of Section 00453, if applicable, by subcontracting portions of the work to disadvantaged firms, by entering into joint ventures with disadvantaged firms, or both.
6. The DBE policy of the Authority underwent a complete revision October 1, 1999 to meet revised Federal requirements. The DBE provisions of this solicitation are subject to revision by amendment.
7. If there is no goal in this Contract, DBE participation is encouraged and pursuant to the Authority's race neutral program, is anticipated to be as specified in Section 00453.

***Applies only if Design Proposal price is \$100,000 or more and/or if Construction Proposal price is \$500,000 or more.**

Q. Civil Rights:

The Design-Builder will be required to comply with all applicable Equal Employment Opportunity laws and regulations of Section 00770, CIVIL RIGHTS, of this Contract.

R. Debarred or Ineligible Proposers:

Proposers will be required to certify that neither it nor its "principals" [as defined at 49 C.F.R. § 29.105(p)] is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency (see Section 00451, Representations and Certifications).

S. Notice of Protest Policy:

1. WMATA policy and procedure for the administrative resolution of protests is set forth in Chapter 20 of the Procurement Policy Manual (PPM). The PPM contains strict rules for filing a timely protest, for responding to a notice that a protest has been filed, and other procedural matters. The Contracting Officer can furnish a copy of Chapter 20 upon request.

2. FTA Circular 4220.IE, paragraph 7.I addresses Bid Protests. Review of protests by FTA is discretionary and will be limited to:
 - a. a grantee's failure to follow its protest procedures, or its failure to review a complaint or protest; or
 - b. violations of Federal law or regulation.

A protester must exhaust all administrative remedies with the Authority before filling an appeal to the FTA. An appeal to FTA must be received by the cognizant FTA regional or Headquarters Office within five (5) working days of the date the protester learned or should have learned of an adverse decision by the Authority of other basis of appeal to FTA.

3. Alleged violations on other grounds must be submitted to the Contracting Officer who will decide the protest.
4. The judicial authorities having jurisdiction over court actions concerning protest decisions are the United States District Courts for the Districts of Maryland, Virginia, and the District of Columbia, and the local courts in Maryland, Virginia, and the District of Columbia.

T. Requirement for Cost Data Prior to Contract Award (Not Used):

U. Davis-Bacon Wage Determination Decision:

The Authority's Compact requires that all mechanics and laborers employed by the Design-Builder or subcontractors on construction related activities on this contract be paid wages not less than those prevailing on similar contracts in this locality as determined by the Secretary of Labor in accordance with Section 00774, LABOR PROVISIONS. The Wage Determination Decision of the Secretary of Labor is referred to in Section 00776, WAGE RATES and attached as APPENDIX D in Section 00800.

V. WMATA's Tax Exempt Status:

1. Pursuant to Article XVI., Paragraph 78., of the Washington Area Metropolitan Transit Authority Compact, as adopted by the State of Maryland, the District of Columbia, and the Commonwealth of Virginia, with the authorization and consent of the Congress of the United States, the Authority has been accorded exemption from taxes as follows:

"the Authority and the Board shall not be required to pay taxes or assessments upon any of the property acquired by it or under its jurisdiction, control, possession or supervision, or upon its activities in the

operation and maintenance of any transit facility or upon any revenues therefrom, and the property and income derived therefrom shall be exempted from all Federal, State, District of Columbia, municipal, and local taxation. This exemption shall include without limitation, all motor vehicle license fees, sales taxes and motor fuel taxes."

2. It has been the practice of the District of Columbia to apply the Authority's tax exempt status to certain purchases of materials required under Authority construction contracts and acquired by Design-Builders for physical incorporation into the project work. This has not been the practice in either Maryland or Virginia. The Authority does not represent or warrant that the District of Columbia practice applies to this project or, if it does, that it will continue in effect during the term of this project. It is the responsibility of the Design-Builder to determine its liability for any and all taxes applicable to this project. Assessment or payment of taxes by the Design-Builder, including taxes resulting from changes in existing laws or the application thereof or of new or additional taxes, shall not constitute the basis for an increase in the Contract price, except as otherwise allowed under Section 00779, FEDERAL, STATE AND LOCAL TAXES.
3. By submission of its proposal, the proposer certifies that none of the taxes as to which the Authority is exempt are included in its proposal price(s) or the final Contract Price. In the event that the Authority learns that any taxes to which the Authority is exempt are included in the final Contract Price, the Authority shall be entitled to a reduction in the Contract Price reflecting such amount and a refund of monies paid related to such taxes, plus applicable interest.

W. Advance Cost Agreement:

Within 30 days after Notice of Award, the Design-Builder shall make available for audit review, information on its accounting system used to project fixed and variable overhead rates applicable to possible Contract changes. The Authority's Office of the Auditor General, to the extent possible, will review and approve said accounting system. When appropriate and if possible, as a result of the audit review, Advance Cost Agreements may be executed between the Contracting Officer and the Design-Builder. The Cost Agreements shall be a supplemental agreement to the Contract.

X. Proprietary Data in Proposals:

1. The Authority shall provide all reasonable precautions to insure that proprietary, technical and pricing information remains within the review process except where otherwise ordered by an administrative or judicial body, as necessary to use in a judicial or administrative proceeding. Proposers shall attach to each page of any proprietary data submitted with the solicitation the following legend:

"The data contained on this page shall not be disclosed outside the Authority, be duplicated, or used in whole or in part, for any purpose other than to evaluate the offer; provided that, if a contract is awarded on the basis of that offer, the Authority shall have the right to duplicate, use, and disclose this data, in any manner and for any purpose whatsoever."

2. This information does not limit the Authority's right to use information contained in this data if it is or has been obtained by the Authority from another independent legitimate source.
3. Except for the foregoing limitation, the Authority may duplicate, use, and disclose in any manner and for any purpose whatsoever and have others so do, all data furnished in response to this solicitation.

Y. Contract Performance Evaluation:

The Proposer is advised that a Performance Evaluation will be completed at the end of the Contract. Factors to be included in the Performance Evaluation are as follows: Quality of Work, Timely Performance, Effectiveness of Management, Compliance with Labor Standards, Compliance with Safety Standards and Overall Evaluation. The Performance Evaluation may be used in determinations of responsibility for future WMATA contracts.

00202 GENERAL PROPOSAL INSTRUCTIONS

- A. Proposal Page and Character Size: The page size shall not exceed 8-1/2 by 11 inches, except for foldouts which may not exceed 11 by 17 inches. The page margins shall not be smaller than one inch on all four sides. The type size for text shall not be smaller than 10 point, with at least a line spacing of 1. The type size for figures and tables shall be no smaller than 8 point.
- B. Identification: Identify each volume with the RFP number, the Contract Title and Contract Number, the Volume Number of the total number of volumes (i.e., Volume 1 of 3, etc.), the Volume Title, and the Proposer's identity, all printed on the Cover Page of the Volume. Dividers shall be placed between separate Parts and Parts shall be identified on the dividers by Part Letter Designation. Provide one unbound original, and the number of copies specified in this Section.
- C. Proposal Page Count Limits: Proposals are limited to the page limits listed in Subparagraph A. 1. b. of Section 00204, and will be evaluated up to these page limits. Page limits include all text, charts, figures, diagrams, and schematics. Cover pages, title pages, tables of contents, tabbed dividers and blank pages are not included in the page limitations. If both sides of the sheet are used, it will be counted as two pages. Foldouts shall be printed on one side only, but will count as two

pages. Foldouts shall not be used for text. Material exceeding the page limits may not be evaluated and may be returned to the proposer.

- D. Elaboration: Legibility, clarity, and completeness are essential. Unnecessarily elaborate brochures or other presentations beyond that sufficient to present a complete and effective proposal are not desired and may be construed as an indication of the proposer's lack of cost consciousness. Elaborate artwork, expensive paper and bindings, and expensive visual and other presentation aids are neither necessary nor wanted.
- E. Completeness: Include all forms and project specific information as required in this Section. Include pre-printed literature if directly relevant to this project. Failure to provide forms or any other information required in the response to this solicitation may cause the offer to be deemed unacceptable, and the offer may be subsequently rejected.

00203 PHASE ONE QUALIFICATIONS PROPOSAL FORMAT, EVALUATION PROCEDURES AND FACTORS, AND INSTRUCTIONS - NOT USED

00204 PROPOSAL FORMAT, PROCEDURES AND EVALUATION FACTORS, AND INSTRUCTIONS

A. General:

1. Proposal Format:

- a. Organization: The Proposal shall be submitted in separate volumes as required herein.
- b. The Proposal shall be divided into three volumes, with the following number of copies (not including originals and 1 electronic copy, as required) and with the following page limits:

Volume 1: Technical Proposal, Greenbelt & Shady Grove Project				
Volume	Part	Title	Copies	Page Limits
1	A	Value of Design Solutions	6	N/A
1	B	WorkApproach/ScheduleCompliance	6	N/A
1	C	Management Resources	6	N/A

Volume 2: Technical Proposal, Brentwood Project				
<u>Volume</u>	<u>Part</u>	<u>Title</u>	<u>Copies</u>	<u>Page Limits</u>
2	A	Value of Design Solutions	6	N/A
2	B	WorkApproach/ScheduleCompliance	6	N/A
2	C	Management Resources	6	N/A

Volume 3: Price / Contract Proposal				
<u>Volume</u>	<u>Part</u>	<u>Title</u>	<u>Copies</u>	<u>Page Limits</u>
3	A	Shady Grove & Greenbelt Project Price w/ Detailed Narrative	6	N/A
3	B	Brentwood Project Price w/ Detailed Narrative	6	N/A
3	C	Forms and Contractual Information	4	N/A

2. Proposer Information:

Proposers shall submit within the proposal volumes, as may be further required below, sufficient information for the following general evaluation factors for both the design and construction phases as applicable: Experience/Past Performance; Organization including Key Personnel; Safety and QA/QC Programs; Project Approach, Schedule and Work Element Description; Compliance / Exception; Pricing information; and Responsibility information.

3. Subcontractor Information:

- a. Within the proposal volumes, provide applicable information required in the paragraphs below for all major subcontractors (design or construction) including DBE's, that are proposed to participate in this project (unless otherwise specified, a major subcontractor at any tier is one performing 10 percent or more of the work [i.e., design or construction] involved based on proposed dollar value). If appropriate identify by name three subcontractors to whom you would consider awarding these subcontracts and include copies of all licenses/certifications required by the jurisdictional agencies for all firms. The Authority reserves the right to approve any change during the performance of the work (both design and construction) to the Design-

Build Team firms and/or sub-contractor firms identified in the Proposal as finally accepted.

- b. Before entering into any subcontracts, the Design-Builder shall submit a written statement to the Authority giving the name and address of the proposed subcontractor, the portion of the work and material which it is to perform and furnish, and any other information tending to prove that the proposed subcontractor has the necessary facilities, skill, integrity, past experience and financial resources to perform the work in accordance with the terms and conditions of this Project. Subcontract agreements at any tier shall be in accordance with Section 00704, paragraph F. No subcontractor shall be permitted to perform work on the site until it fully complies with the applicable requirements for Indemnification and Insurance, and abides by the approved project safety program.

B. Technical Proposal Evaluation Procedures:

1. Each Technical Proposal will be reviewed and evaluated individually by the Authority in accordance with procurement policy and procedures.
2. Proposals will be evaluated by their strengths, weaknesses and deficiencies against the evaluation factors and these attributes will be communicated to the proposers for follow-up action as appropriate.
3. Definitions:
 - a. Discussions: Oral or written communications including negotiations between the Authority and an offeror (other than clarifications) that involves information essential for determining the acceptability of the proposal or to cure identified defects in the proposal.
 - b. Clarifications: Communication with an offeror for the sole purpose of eliminating minor irregularities, informalities or apparent clerical mistakes in the proposal. Unlike discussions, clarification does not give the offeror an opportunity to revise or modify its proposal, except to the extent that correction of apparent clerical mistakes results in revision.
 - c. Deficiencies: Any defects in the proposal which preclude acceptance. Involves any part of the offeror's proposal which would not satisfy the Authority's minimum requirements established in the solicitation. Includes failures to meet specifications, submit information, or questionable technical or management approaches. Items disclosed during discussions will be evaluated in two categories: material-basis for rejection because further discussions would be meaningless; curable-

- may be corrected by clarifications or discussions and brought into the competitive range.
- d. **Weakness:** Aspect of or omission from a proposer's proposal that includes ambiguities and conflicts within the proposal, lack of complete descriptions, errors in interpretation, omissions of essential information, inadequate information that prevents the evaluators from knowing the intent of the proposal, all of which are considered curable in discussions. An excessive number of clarifications may in itself constitute a weakness.
 - e. **Strengths:** Elements of the proposal that exceed the minimum requirements of the solicitation and provide an identified benefit to the Authority.
4. **Ratings.** Based upon the evaluations, an adjectival rating will be given depicting how well the proposer's proposal meets the stated evaluation factors and solicitation requirements for the Technical Proposal. The adjectival criteria are as follows:
- a. **Exceptional:** Exceeds requirement in a beneficial way to the Authority, has no significant weaknesses or deficiencies and is innovative, comprehensive, and complete in all details.
 - b. **Acceptable:** Meets evaluation standards and any weaknesses are readily corrected.
 - c. **Marginal:** Fails to meet evaluation standards, however, any significant deficiencies are correctable. Lacks essential information to support the proposal.
 - d. **Unacceptable:** Fails to meet the evaluation standard and the deficiency is uncorrectable. Proposal would have to undergo major revision to become acceptable. Demonstrated lack of understanding of the Authority's requirements or omissions of major areas.
- C. **Price Proposal Evaluation Procedures:** Price offers will be evaluated only for those proposers whose technical offers have been determined to be acceptable. The Authority will evaluate the price proposal for its completeness, clarity, conciseness, realism and responsiveness to the RFP-requested information.
- 1. The Authority will evaluate the Price proposal for price design value, alternate value engineering options, and cost realism by facility within the provided project target price.
 - 2. Proposers in Phase Two will be required to demonstrate their ability to obtain

the required performance and payment bonds for the project as part of their Phase Two response. The Authority may consider alternate methods of obtaining adequate security for contract performance and payment at its discretion.

3. The Authority may give consideration to that offeror who indicates that they will be paying lower premium costs for Workmen's Compensation insurance as a result of their favorable Experience Modification Rating (EMR). The reason for this is that in a fixed price / best design procurement, lower insurance costs translate into greater value being incorporated into the design and construction of the project. Accordingly, offerors are required to provide the Worker's Compensation rates which are applicable for all design-build team members and major subcontractors including any deductible associated with those costs.
- D. Phase II - Technical Proposal Evaluation Factors: Factors under Phase Two will be ranked as follows: Factors 1. and 2. are considered to be most important followed by Factor 3. Since it is anticipated that multiple awards will result from this solicitation, Proposers must submit information requested under Phase Two separately as follows: Shady Grove and Greenbelt combined and Brentwood as a standalone project.

1. Value of Design Solutions

A. Stated below are several design and construction challenges or major activities that if not fully addressed would produce detrimental effects to the project. The proposers are required to address these and any other situations with detailed solutions that demonstrate that they understand the issues, have developed viable solutions and can implement these solutions in a timely manner to meet the schedule. These will include but are not limited to:

Shady Grove Site:

1. Relocation of Underground Utilities:
 - a. 24W ATC and Comm. ductbank running diagonally under the proposed Shop. Comm. includes some fiber optic cable.
 - b. 78" and 8" Storm sewer, 6" Water main
 - c. Water lines and electrical ductbanks of various sizes.
2. Relocation of a buried fuel tank.
3. Relocation of Salt Dome, Trailers, Storage containers, sundry materials.
4. Removal of excess material form the earth stockpile in the loop track area.
5. Construction of the Blow Down Pit extension during months of March through September only.
6. Replacement or modification of the Yard Control Panel to reflect all the added tracks and switches.
7. Completing the shop and blow down pit extension in the least time to allow beneficial occupancy and operations before project completion.

Brentwood Site (to be evaluated separately for award):

1. Working in an operating and electrified yard with minimal work and storage area while causing minimal disruption of the ongoing work process.
2. Maintaining the top of rail to ceiling height of 11'-2" minimum throughout the shop, particularly under the existing mezzanine area.
3. Environmental mitigation of the work area and adjacent areas for noise, dust and hazardous materials such as asbestos tile and lead paint.
4. Installation of tracks in the existing floor area to the same top of rail elevation as the existing tracks in the shop area while supporting the existing floors to accommodate the lifts and the loading of trains.
5. Sequencing of work, laydown areas and WMATA employee parking within the limited area of the site.
6. Replacement or modification of the Yard Control Panel to reflect all the added tracks and switches.

Greenbelt Site:

1. Construction of facilities within an electrified yard with consideration of the adjacent wetlands and stream.
2. Relocation of the facilities from the existing shop to the shop to be constructed in a manner that will cause the least disruption.
3. Completing the new shop within the least possible time to allow beneficial occupancy.
4. Room arrangement for Greenbelt Annex to meet space requirements provided for the various shop functions and to accommodate orderly and efficient work flow.

B. Major Shop Equipment: Provide a detailed life cycle analyses for the identified major shop equipment to be provided and installed in accordance with Appendix A of Section 11001. Such analyses are to take into consideration the following: Acquisition costs, including non-recurring costs such as purchase cost, spare parts, facility and construction modifications, O & M training, and technical data, as well as recurring costs such as Parts upgrades, support of equipment upgrades, and system integration; in addition it should include an analyses of Sustaining Costs, such as; scheduled and unscheduled maintenance, utility costs, operations costs, and disposal costs and salvage value, if any. A separate listing is provided of the existing major shop equipment in use in Authority facilities as Appendix A to Section 11001.

In addition to the life cycle analyses a "system effectiveness analyses" is to be provided. This involves the following criteria to determine overall quality and dependability of the proposed equipment:

- a. Availability –the duration of time the system is available for use
- b. Reliability – the reduction of the frequency of failures over a given time, usually

- expressed as mean time between failure (MTBF)
- c. Maintainability – the duration of outages for maintenance in accordance with manufacturer’s recommendations, usually expressed as mean time to repair (MTTR) and includes the time necessary for diagnostics, troubleshooting, tear-down, removal/replacement of parts, active repair time, system testing, and administrative actions.

The standard manufacturer’s recommended timeframe for a mid-life retrofit should also be provided as well as standard warranties or extended warranties offered.

2. Work Approach / Schedule Compliance

- A. A detailed description of the design approach that will be implemented to design the Project within the target price.
- B. A detailed description of the construction methodology, including equipment, materials and manpower to be employed to construct the project.
- C. A detailed description of the plans and procedures for Systems Integration testing.
- D. A detailed description of the plan for final acceptance, training of operating personnel, and warranty implementation.
- E. A detailed narrative which clearly indicates how the proposed design solutions will be implemented and the cost/schedule impact and/or quality betterments that will be provided.
- F. Adherence to schedule is of paramount importance. A detailed CPM schedule with narrative description of the construction methodology, including equipment, materials and manpower to be employed to construct the project. The schedule must identify the critical path and explain how the critical activities will be controlled to meet schedule dates. The schedule should include the staffing requirements for each activity.
- G. Early completion is very important to WMATA. The proposers are encouraged to explore a compressed schedule, however, it must be reasonable, realistic, and achievable. Those proposers that elect to pursue an early completion, should submit a separate schedule, of the same detail as that for the “base” period, to demonstrate the Proposer’s ability to achieve timely completion as well as detailed information as to how this affects the project in terms of providing additional value. WMATA will determine whether the stated benefits for early completion are in its best interest. Additional consideration will be given for a compressed schedule only if it meets the criteria stated and the offeror can provide evidence of a record of solid schedule compliance or accelerated performance on other projects.

3. Management Resources

A. The Authority will evaluate and rate the Key Personnel proposed for design and construction management in the proposal package. The resumes and levels of responsibility of the principal managers and technical personnel who will be directly responsible for the day-to-day design and construction activities will be evaluated. All designers must be registered and familiar with local codes and regulatory and permitting requirements. Data should indicate whether each individual has had a significant part in any of the project examples cited under Past Performance in Phase One. If reassignment of personnel is considered possible, the names and resumes of the alternative professionals for each assignment will be evaluated.

B. The following are the minimum qualifications for the key project personnel (all Key Personnel must be identified separately for each project and the same personnel cannot be utilized for more than one project. However, should it be determined that a single proposer represents the best value for both projects, the Authority reserves the right to maximize project efficiency by combining Key Personnel where possible)::

1. Design manager and other design staff for each major component of the design activity. They should each have a minimum of 8 years of experience, relevant experience designing facilities such as this and professional engineering certification in the jurisdiction where their installation will be constructed.
2. Project Manager should each have a minimum of 8 years of experience, relevant experience managing a design-build facility such as this and professional engineering certification.
3. Superintendents shall have a minimum of 8 years experience on projects of similar scope and have worked in an operating facility.
4. Quality Control Manager shall have worked for a minimum of 5 years as a QC manager and be certified as Lead Auditor.
5. Safety Superintendent shall have knowledge of industry safety practices and a minimum of 8 years experience as a safety officer and possess current Red Cross First Aid/Bloodborne Pathogen/CPR Certificate. Safety Superintendents are to be full-time dedicated with one per facility, not per Project.

C. The qualifications and experience of the proposed key personnel accepted by the Authority will be considered the minimum acceptable criteria for any proposed replacements during contract performance. Any substitutions must be approved by the Authority.

D. Provide a project organization chart and narrative to show the make-up and staffing capabilities of the Design-Build Team (ie. Show how this project management structure fits into the corporate management structure). Show the limits of authority and lines of authority of specific personnel to be assigned to the Contract(s). Identify the person responsible for all major decisions pertaining to the

overall project, to include person responsible for coordinating with local jurisdictions, procurement of materials, liaison, safety, quality/control, and design integration. Identify all major subcontractors who will be performing twenty (20) percent or more of the work based on the target price for the project and provide narrative of experience for these firms which shows their relevant experience over the past five (5) years. Identify proposed WMATA-Certified DBE subcontractors and provide information on relevant experience in the past five (5) years along with a copy of their current DBE Certification Letter from WMATA.

E. Demonstrate how the organization utilizes, implements, and administers their Disadvantaged Business Enterprise (DBE) participation program on current and past projects and how it intends to do so on this project. Identify the person(s) responsible for assuring that the DBE program and its goal are in compliance with the Authority, state/local, and organizational policies.

E. Price Proposal Evaluation Factors:

1. The Authority will evaluate price proposals for reasonableness, completeness, and realism as appropriate.
2. All offers with separately priced line items or subline items shall be analyzed to determine if the prices are unbalanced. Unbalanced pricing exists when, despite an acceptable total evaluated price, the price of one or more contract line items is significantly over or understated as indicated by the application of cost or price analysis techniques. An offer may be rejected if the Contracting Officer determines that the lack of balance poses an unacceptable risk to the Authority.
3. The Authority will award separate contracts for each Project based on that proposer(s) who offers the best value to the Authority within the stated target price for each Project. If there are Options, Price Proposals will be evaluated based on the Total Base Proposal Plus Option Price(s) in accordance with Notes to Proposers. The Authority reserves the right to award the initial Contract for only the Base Proposal Price or the Base Proposal Price and the most favorable Options to the Authority within budget as may be further described in Section 00434, PRICE SCHEDULE and the accompanying Notes to Proposers.

F. Technical Proposal Instructions: The information provided should be complete and clearly presented. If the information requested under a factor is presented elsewhere in the proposal, the proposer should cross reference this information rather than duplicate it.

1. Complete, sign and submit the TECHNICAL PROPOSAL FORM (Section 00412)

- G. Price Proposal Instructions: The information provided should be complete and clearly presented. If the information requested under a factor is presented elsewhere in the proposal, the proposer should cross reference this information that is provided elsewhere rather than duplicate it.
1. Complete, sign and submit the PRICE PROPOSAL FORM, Section 00413 and also submit the following:
 - a. Signed and completed REPRESENTATIONS AND CERTIFICATIONS (Section 00451).
 - b. Provide a completed PRICE SCHEDULE Form (Section 00434). Provide an amount on each line item where one is requested and a total amount representing the sum of individual amounts requested.
 - (1) Price Schedule prices shall include all services, labor, material, equipment, overhead, incidentals, and profit, unless otherwise specified.
 - (2) In case of a discrepancy between a unit price and an extended price, the unit price will be presumed to be correct, subject however, to correction to the same extent and in the same manner as any other clarification.
 - (3) Where the Price Schedule explicitly requires that the proposer propose on all items, failure to do so will disqualify the proposal. When submittal of a price on all items is not required, proposers shall insert the words NO PROPOSAL in the space provided for any item on which no price is submitted.
 - (4) Offers for design and/or construction services other than those specified will not be considered unless authorized by the solicitation. Unless specifically called for, alternate proposals will not be considered.
 - c. The Proposer shall submit with its initial Price Proposal a list of WMATA certified DBE firms that it intends to enter into subcontract agreements with for this contract. The completed Section 00453, DBE DATA (aka Appendix B) forms or waiver if applicable, are not required to be submitted with the initial Price Proposal, but shall be submitted with the final proposal revision or, if award is made without discussions, by the successful proposer before award per requirements of Appendix B, Section 00453.

Note: If a DBE goal is established in these documents and the offer is

\$500,000 or greater, or if there is no DBE goal established and the Proposer proposes to utilize DBE subcontractors on this project, the submittal of certain completed DBE documents is required with the Final Proposal Revision or if award is made without discussions, by the successful proposer before award. Failure to submit Section 00453 forms B-12 and B-13, or form B-14 waiver (if applicable), may cause the offer to be found non-responsive and may therefore be ineligible for award.

- d. An executed Proposal Guarantee with Surety Certificate (PROPOSAL BOND Form Section 00431). The Proposal Guarantee shall be based on the Total Base Proposal Plus Total Option Price, if any. (The Performance and Payment Bonds shall be based on the award amount.)
- e. A signed and completed PROPOSAL DATA FORM with attachments (Section 00452). Forms shall also be submitted for each proposed major subcontractor including DBEs.
- f. Other documents, forms and agreements as may be necessary to adequately evaluate the proposer. Should the proposer or joint venture entities have a parent company(ies), a letter(s) guaranteeing performance may be required.

2. Instructions for Supplementary Items to Price Proposal

- a. Provide an estimated cash flow curve for the planned duration of the project showing the dollar values.
- b. Price proposals shall be supported by a detailed narrative which clearly explains the quality of design, construction, major equipment, etc. that is being offered in sufficient detail to permit a value analysis as well as cost information.

H. Oral Presentations:

- 1. The Authority reserves the right to schedule oral presentations. If oral presentations are scheduled, the oral presentations shall be requested only from proposers which have not been eliminated from the competition. The oral presentation shall address items and issues identified by the Authority. The oral presentation shall be provided by the proposed key members of the proposer's project team. Proposers' proposed major subcontractors/DBE representatives are also urged to attend. Total presentation time, including clarifications, shall be no longer than **two** hours with additional time allotted for technical discussions.

2. At its sole discretion, the Authority will schedule oral presentations at the Headquarters of the Washington Metropolitan Area Transit Authority at 600 Fifth Street, N.W., Washington, D.C. 20001. Requests from proposers to reschedule their oral presentations are discouraged. No rescheduling will be done unless determined necessary by the Authority.
 3. If held at the Authority Headquarters, the presentations will be held in a conference room with conference room style seating. The Authority will provide only a projection screen.
 4. Oral presentations shall be treated as a discussion.
 5. Offerors will present their corporate background and qualifications and generally describe the following relevant to this requirement:
 - a. Executive Summary/Overview of Qualifications under Phase I
 - b. Design solutions for challenges provided for each site and project overall
 - c. Major Shop Equipment provided including life-cycle cost and system effectiveness analyses
 - d. Design approach, construction methodology, systems integration and testing procedures, training plan, cost/schedule and/or quality betterments
 - e. Schedule compliance with critical path and major activities shown
 - f. Key project personnel qualifications including, Design Manager, Project Manager, Superintendents, QC Manager, and Safety Superintendent
 - g. Project Specific Organization Chart and lines of authority/communication
 - h. DBE compliance procedures and proposed DBE subcontractors
 - i. Pricing assumptions and considerations
 6. The proposer shall provide seven printed copies of its presentation in 8.5" x 11" format to the Contract Administrator at the time of the presentation. No other documentation of the oral presentations will be accepted.
 7. The Authority reserves the right to video or audio tape each proposer's oral presentation for its exclusive use. All such information will remain confidential and will not be disclosed.
 8. Items that augment or revise the proposal must be submitted in subsequent proposal revisions.
- I. Discussions:

1. The Authority contemplates that discussions will be necessary to maximize the Authority's ability to obtain best value on a "Fixed Price / Best Design" basis. The Authority will maintain confidentiality of all proposals.
 2. Discussions will be held at the Headquarters of the Washington Metropolitan Area Transit Authority at 600 Fifth Street, N.W., Washington, D.C. 20001. Requests from proposers to reschedule their discussions are discouraged, and no rescheduling will be done unless determined necessary by the Authority.
 3. A description of proposal deficiencies will be provided in advance of discussions if possible to proposers for revision or modification of their proposal. Technical Proposal weaknesses and deficiencies will be discussed as well as adverse past performance information with each proposer.
 4. The Authority will conduct negotiations tailored to each proposal as required in order to determine that proposal which provides the best value in terms of quality for the established target price. To support these negotiations, the Authority may request the offerors to submit offers, quotes, price supports, identify major cost drivers, and provide pricing assumptions and any basis for any contingencies that have been incorporated into the price proposal. The Authority may negotiate with proposers to increase their performance for additional technical merit. Also, the Authority may suggest to proposers that they decrease their performance and reduce their costs to make their proposals more competitive. The proposers will also be given an opportunity to correct errors and omissions in their Price Proposals.
 5. After discussions have begun, the Authority may determine that a proposer is no longer considered within the competitive range and may eliminate that proposer from the competition whether or not all material aspects have been discussed or the proposer afforded the opportunity to submit a proposal revision.
 6. The Authority will request Final Proposal Revisions (FPRs, formerly BAFOs), as appropriate from all proposers remaining in the competitive range.
- J. Best Value Determination:
1. The technical merit of the proposal and the value engineering contained in the design within the specified target price will be the basis for selection. However, the price for each facility, not just the overall contract amount, must be fair and reasonable.
- K. Responsibility:
1. Material submitted under the proposal volumes shall be used to determine the

responsibility of the Design-Builder and proposed subcontractors as appropriate.

2. In accordance with the WMATA Procurement Procedures Manual, to be considered responsible, the proposer must meet the following general standards:
 - a. Have adequate financial resources to perform the contract, or the ability to obtain them;
 - b. Be able to comply with the required or proposed delivery or performance schedule, taking into consideration all existing commercial and governmental business commitments;
 - c. Have a satisfactory performance record;
 - d. Have a satisfactory record of integrity and business ethics;
 - e. Have the necessary organization, experience, accounting and operational controls, and technical skills, or the ability to obtain them (including, as appropriate, such elements as production control procedures, property control systems, quality assurance measures, and safety programs applicable to materials to be produced or services to be performed by the prospective contractor and subcontractors);
 - f. Have the necessary production, construction, and technical equipment and facilities, or the ability to obtain them; and
 - g. Be otherwise qualified and eligible to receive an award under applicable laws and regulations.

00210 SUPPLEMENTARY INSTRUCTIONS TO PROPOSERS

This Section includes procedures for product substitutions during the proposal period.

00211 BRAND NAME OR EQUAL

- A. Use of brand names within the technical requirements:

(As used in this clause, the term "brand name" includes identification of products by make and model in either the Technical Proposal or the design submittals approved by the Authority.)

1. If items called for by the Standard and Technical Specifications have been

identified by a "brand name or equal" description, such identification is intended to be descriptive, but not restrictive, and is to indicate the quality and characteristics of products that will be satisfactory. Proposers offering "equal" products including products of the brand name manufacturer other than the one described by brand name will be considered by the Authority if such products are clearly identified in the Technical Proposal and are determined by the Authority to meet fully the salient characteristics requirements in the Standard and Technical Specifications.

2. Unless the Proposer clearly indicates that it is offering an "equal" product by submitting Section 00433 BRAND NAME OR EQUAL FORM, the Proposer shall be considered as offering a brand name product referenced in the Standard and Technical Specifications.
3. If the Proposer proposes to furnish an "equal" product, the brand name, if any, of the product to be furnished shall be otherwise clearly identified and the determination as to equality of the product offered shall be the responsibility of the Authority and will be based on information reasonably available to the Authority.
4. If the Proposer proposes to modify a product so as to make it conform to the requirements of the Standard and Technical Specifications, he shall (i) include a clear description of such proposed modifications, and (ii) clearly mark any descriptive material to show the proposed modifications.
5. **CAUTION TO PROPOSERS:** The Authority is not responsible for locating or securing any information which is not identified and reasonably available to the Authority. Accordingly, to insure that sufficient information is available, the Proposer must furnish all descriptive material (such as cuts, illustrations, drawings, or other information) necessary for the Authority to (i) determine whether the product offered meets the salient characteristics requirements of the Standard and Technical Specifications and (ii) establish exactly what the Proposer proposes to furnish and what the Authority would be binding itself to purchase by approval by the Authority. The information furnished may include specific references to information previously furnished or to information otherwise available to the Authority.

00250 PRE-PROPOSAL MEETINGS SCHEDULE

This Section includes requirements and schedules for pre-proposal meetings.

00251 PRE-PROPOSAL CONFERENCE - NOT USED

00252 SITE INSPECTION

- A. Proposers are strongly urged to visit the site of the work and inform themselves of all local conditions that may affect the work or the cost thereof.
- B. A general industry conference and site visit will not be held, however, site visits will be scheduled individually upon proposer request. Proposers are permitted to take photographs/video tapes for use in preparing their proposals.
- C. Requests for site visits should be provided in writing to the Contract Administrator, Fred M. Pohlmann, and should include the number of attendees so arrangements can be made. Requests may be mailed to the Contract Administrators' attention at WMATA , Office of Procurement, Rm 3E-01, 600 Fifth Street N.W., Washington, D.C. 20001, or e-mailed to fpohlmann@wmata.com or faxed to (202) 962-6247. It is suggested that the proposer wear casual clothing, but safety footwear is mandatory. No transportation will be provided by the Authority.
- D. The proposer acknowledges and agrees that it shall be bound by all the terms of the Contract regardless the lack of a formal pre-proposal conference, official site visit, or the thoroughness of its site investigations prior to submitting its proposal.

00260 PRE-AWARD MEETING

This Section includes requirements and schedules for a pre-award meeting.

00261 PRE-AWARD CONFERENCE

A Pre-Award Conference with the successful proposer may be held by the Authority as specified in Section 01312, PROJECT MEETINGS.

00262 PROVISION FOR STIPEND

This procurement provides for the payment of a \$100,000 "stipend" to those unsuccessful Phase Two offerors, not selected for award of either Project. An otherwise eligible, unsuccessful Phase Two offeror may decline acceptance of a stipend. In that event, the offeror shall retain full rights to its Phase Two proposal. Upon acceptance of a stipend by the unsuccessful Phase Two offeror, the Authority may utilize all or any part of the offeror's technical design proposal in the resulting design for this project or in solicitations for other projects. To be eligible for the stipend, the unsuccessful offeror's technical design proposal must be rated as "acceptable". Payment of a stipend shall only be made if the technical design proposal provides "something of value" to the Authority such as the following which is typical in a project design: Presentation drawings, sketch details, Architects or artists rendering of project, renderings of interior design and layout, rendered site plan showing any grading or utility improvements, selected cross sections and details, exterior elevations, other information that clearly defines the scope and quality levels being offered including implementation plans for overcoming identified project and schedule challenges. Designs of unsuccessful proposers who choose to accept payment may

be used post-award if such is determined to be in the best interests of the Authority. They will not be used for technical leveling of the proposals prior to award.

END OF SECTION

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PROCUREMENT REQUIREMENTS

00300 AVAILABLE INFORMATION

This Section includes information made available to the proposer.

00301 INFORMATION DOCUMENTS

The preliminary documents referenced in this Section are Informational in nature. The information contained in the documents is provided as an aid for the proposer's preparation of their proposals. The Design-Builder shall be solely responsible for its design, whether or not it was based in part on information provided on Information Documents.

00302 DESIGN CRITERIA

A. Design Criteria (the WMATA-provided Program Criteria in Section 01112 of this Project Manual, WMATA Standard and Technical Specifications in Divisions 2 through 16 of this Project Manual, Drawings in the Project Drawings Attachment to this Project Manual), and other design-related information.

1. The Program Criteria in Section 01112 is provided as an aid for the proposer's preparation of their proposals and for preparation of the Final Design by the Design-Builder. The Program Criteria represent the minimum criteria to be used unless jurisdictional codes and regulations are more stringent, in which case the codes and regulations shall govern. The WMATA Program Criteria has been prepared to serve as standard requirements for the design of the Project.
2. The WMATA Standard and Technical Specifications in Divisions 2 through 16 are provided as an aid for the proposer's preparation of their proposals and for preparation of the Final Design Specifications by the Design-Builder. The Standard and Technical Specifications represent the minimum standards to be used unless jurisdictional codes and regulations are more stringent, in which case the codes and regulations shall govern. The WMATA Standard Specifications have been prepared to serve as standard requirements for materials and construction methods for all WMATA projects and are unedited. The Design-Builder shall use the Standard Specifications and edit accordingly in the preparation of the Contract-specific Final Design Specifications, and shall indicate these revisions made to the Standard Specifications utilizing strikeouts on deleted text, bolding on new text, sidebars in the page margin (redline method), and also by adding the date of revision to the footer. Some of the Technical Specifications Sections have already been edited by WMATA to specify Contract-specific project requirements for materials and construction methods. The Design-Builder shall use the WMATA Technical Specifications in the preparation of the Contract-specific Final Design Specifications. If further editing is required, the revisions shall be notated as specified above.

3. The Project Description Drawings and Design Directive Drawings as applicable in the Project Drawings Attachment to the Project Manual illustrate an approach to the Work based on a preliminary engineering level of effort and are provided as an aid for the proposer's preparation of their proposals and for preparation of the Final Design Drawings by the Design-Builder. Since the solutions developed are of a preliminary nature and have not had the benefit of detailed design development work, the final designs necessary to comply with the Requirements set out in the Contract Documents may, as approved, differ slightly from the preliminary designs shown. The Standard Drawings as applicable in the Project Drawings Attachment to the Project Manual illustrate WMATA standards for various items and are provided as an aid for the proposer's preparation of their proposals and for inclusion in the Final Design Drawings as applicable by the Design-Builder. The Project Drawings include the following:
 - a. Exhibit A, Project Description Drawings.
 - b. Exhibit B, Standard and Design Directive Drawings as applicable.
- B. Compact Disc containing electronic files in PDF format of the WMATA Manual of Design Criteria, Release 6, Books 1-3.

00303 INFORMATION DRAWINGS

- A. The Information Drawings in the Project Drawings Attachment to the Project Manual are Recommended Layout and Details Drawings as applicable and As-Built Drawings reproduced from similar or previous Authority projects as applicable and are provided only as an aid for the proposer's preparation of their proposals and for preparation of the Final Design Drawings at the option of the Design-Builder and include the following:
 1. Exhibit C, Information Drawings as applicable
- B. After award of the Contract, the Design-Builder shall conduct its own additional detailed investigation to verify that the As-Built Information Drawings initially provided by the Authority as applicable reflect the current conditions.
- C. Compact disc containing electronic files in TIF format of the following as-built contract drawings:
 1. Contract 1A0162, Shady Grove Service and Inspection Shop, Section A-16b.
 2. Contract 1Z4202, Major Repair Shop, Brentwood, Section B-5a
 3. Contract 1B4054, Brentwood Major Repair Shop, Office and Shop Renovation.
 4. Contract 1E0112, Greenbelt Service and Inspection Shop, Section E-11b.

00320 GEOTECHNICAL INFORMATION DATA

This Section includes Geotechnical Information made available to the proposer. This information is not guaranteed and is provided as information only as an aid for the proposers' preparation of their proposals.

00321 GEOTECHNICAL INFORMATION

- A. The Geotechnical Information provided by the Authority for this Project is comprised of the following Documents:
1. Greenbelt Yard Consolidated Heavy Repairs
 - a. Greenbelt Yard Geotechnical Engineering Report, Contract FN5008, by GeoConcepts Engineering, Inc.
 2. Brentwood Shop Expansion
 - a. Brentwood Yard Geotechnical Engineering Report, Contract FN5008, by GeoConcepts Engineering, Inc.
 3. Shady Grove Shop Expansion
 - a. Shady Grove Yard Geotechnical Engineering Report, Contract FN5008, by GeoConcepts Engineering, Inc.
- B. Post-Award Investigation/Coordination - Not Used.
- C. Previous Geotechnical Information available from the Authority regarding soils in the vicinity of the proposed work is as follows:
1. Greenbelt Yard Consolidated Heavy Repairs
 - a. MRCE Report No. 228 - Contract 3Z7256- Greenbelt S & I Yard-Section E011a/c, Greenbelt Route Supplementary Subsurface Investigation, March 25, 1991.
 - b. MRCE Report No. 229 - Contract 3Z7256- Greenbelt S & I Yard-Section E011a/c, Greenbelt Route Supplementary Subsurface Investigation, July 30, 1991.
 2. Brentwood Shop Expansion
 - a. MRCE Second Supplementary Report - Modification No. 5 - Contract No. TAC 20-68-E - East Coach Yard Buildings - Subsurface Investigation, April 9, 1969.
 - b. MRCE Supplementary Report - Modification No. 6 - Contract No. TAC 20-68-E - B & O Route, East Coach Yard Buildings - Subsurface Investigation, May 13, 1969.
 3. Shady Grove Shop Expansion

- a. MRCE Report No. 147 - Contract Mod. No. 3Z725M-012- Section A016a - Rockville Route - Subsurface Investigation, May 24, 1976.
- b. MRCE Report No. 120 - Contract Mod. No. 3Z725K-022- Section A016a & A017 - Rockville Route - Subsurface Investigation, December 23, 1974.
- c. MRCE Report No. 152 - Contract No. 3Z725N- Section A016b - Rockville Route - Subsurface Investigation, July 29, 1977.

00322 MISCELLANEOUS REPORTS AND DATA - (NOT USED)

00330 EXISTING CONDITIONS

This Section includes information about survey data, existing site and existing buildings and the Specifications and Drawings provided by the Authority.

00331 DESCRIPTION OF PROJECT CONDITIONS

- A. Existing site conditions are shown in the Project Drawings. The information is not guaranteed to be complete and is provided as information only as an aid for the proposers' preparation of their proposals.
- B. After award of the Contract, the Design-Builder should conduct its own additional detailed surveys and investigations to verify that the site conditions shown on the Project Drawings initially provided by the Authority reflect the current conditions.

00340 ENVIRONMENTAL ASSESSMENT INFORMATION

This Section includes information about the environmental data for the project. This information is not guaranteed and is provided as information only as an aid for the proposers' preparation of their proposals.

00341 ENVIRONMENTAL REPORT

- A. The Authority anticipates Categorical Exclusions (CE) as a result of its own environmental investigations. Copies of the CE's are available for the Authority upon request.
- B. After award of the Contract, the Design-Builder should conduct its own additional detailed environmental assessment and coordinate with the jurisdictional agencies as necessary as a basis for it's final design and for obtaining all necessary permits. All work performed under this Contract shall meet the requirements of the Authority's Design Criteria and/or the jurisdictional codes and regulations, whichever is more stringent.
- C. Copies of Environmental Reports provided by the Authority for this Project are as follows:

1. Greenbelt Yard Consolidated Heavy Repairs
 - a. Phase I ESA, Greenbelt Metro Rail Yard, by EEE Consulting, Inc., August 2004.
 - b. Consolidated Plan (Hazardous Waste Contingency Plan; Spill Prevention; Control and Countermeasures Plan; Stormwater Pollution Prevention Plan) Greenbelt Rail Yard, June 30, 2002.
2. Brentwood Shop Expansion
 - a. Asbestos-Containing Material Survey at Brentwood Major Repair Yard, by Connor Environmental Services and Engineering Assessments, May 18 and 19, 1998.
 - b. Results of Asbestos and Lead Paint Survey, WMATA Brentwood Maintenance Facility, by EEE Consulting, Inc., September 28, 2004.
 - c. Phase II ESA, Subsurface Soil Investigation, WMATA Brentwood Maintenance Facility, by EEE Consulting, Inc., September 29, 2004.
 - d. Consolidated Plan (Hazardous Waste Contingency Plan; Spill Prevention; Control and Countermeasures Plan; Stormwater Pollution Prevention Plan) Brentwood Major Repair and Overhaul Yard, June 30, 2002.
3. Shady Grove Shop Expansion
 - a. Results of Asbestos and Lead Paint Survey, WMATA Shady Grove Maintenance Facility, by EEE Consulting, Inc., September 28, 2004.
 - b. Phase II ESA, Subsurface Soil Investigation, WMATA Shady Grove Maintenance Facility, by EEE Consulting, Inc., September 29, 2004.
 - c. Consolidated Plan (Hazardous Waste Contingency Plan; Spill Prevention; Control and Countermeasures Plan; Stormwater Pollution Prevention Plan) Shady Grove Rail Yard, June 30, 2002.

00370 SAFETY MANUAL

This Section lists the Safety Manual for the Project and is provided as an aid for the proposer's preparation of their proposals.

00371 WMATA CONSTRUCTION SAFETY AND ENVIRONMENTAL MANUAL REQUIREMENTS

The WMATA Construction Safety and Environmental Manual is an attachment to the Project Manual and is a compilation of the Safety and Reporting Requirements for the project.

00381 SAFETY AND SECURITY CERTIFICATION PROGRAM PLAN REQUIREMENTS

The WMATA Safety and Security Certification Program Plan is an attachment to the Project Manual and is a compilation of the safety and security certification requirements for the project.

00390 SYSTEM SAFETY PROGRAM PLAN

This Section lists the WMATA System Safety Program Plan for the Project and is provided as an aid for the proposer's preparation of their proposals.

00391 SYSTEM SAFETY PROGRAM PLAN REQUIREMENTS

The WMATA System Safety Program Plan is an attachment to the Project Manual and is a compilation of the system safety requirements for the project. Also provided is the Metrorail Safety Rules and Procedures Handbook (MSRPH), January 2004, referred to in the SSPP.

END OF SECTION

PROCUREMENT REQUIREMENTS

00400 PROCUREMENT FORMS AND SUPPLEMENTS

This Section includes forms and supplements for submitting proposals.

00410 PROPOSAL FORMS

This Section includes Proposal Forms that are required to be submitted with the Offeror's Proposal.

00411 REQUEST FOR QUALIFICATIONS PROPOSAL FORM - NOT USED



THIS PAGE NOT USED

00412 TECHNICAL PROPOSAL FORM

DATE OF REQUEST: PHASE 2 - December 3, 2004

PROJECT: FN5008 METRO MATTERS: RAIL YARDS EXPANSION PROJECT AT BRENTWOOD, GREENBELT, AND SHADY GROVE YARDS

REQUEST FOR TECHNICAL PROPOSAL containing information requested herein shall be submitted by the Proposer so as to be received before: **2:00 p.m.** on **January 21, 2005** at the Washington Metropolitan Area Transit Authority, Office of Procurement, PRMT FILE Room 3C-02, 600 Fifth Street, N.W., Washington, D.C. 20001. Questions may be directed to the Contract Administrator, Fred M. Pohlmann at (202) 962-1529, FAX to (202) 962-6247.

In response to your Request For Technical Proposal for the above referenced Contract, the undersigned hereby proposes to furnish all labor, equipment and materials and perform all work to design and construct the Project in strict accordance with the Contract requirements for the consideration of the amount proposed on the Price Schedule under the Price Proposal. If awarded the Contract within the Proposal Acceptance Period, the undersigned agrees to execute the Design-Build Contract within 10 calendar days and to furnish, if required, performance and payment bonds on standard Authority forms with good and sufficient surety or sureties.

If the Contract is executed, the undersigned further agrees to commence the work within 10 calendar days after the receipt of Notice to Proceed and to complete the work within the time specified in the Contract.

The undersigned acknowledges receipt of the following amendments to the Request for Technical Proposal under RFP - FN5008/FMP (give number and date of each):

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Note: Failure to acknowledge receipt of all amendments may cause the Technical Proposal to be considered not responsive to the request, which would require rejection of the Technical Proposal as unacceptable.



00412 TECHNICAL PROPOSAL FORM (CONT.)

PROPOSER:

_____	By _____
Firm Name	
_____	_____
Address	Printed name
_____	_____
Zip Code	Title
_____	_____
Telephone	DUNS Number
_____	_____
Representative Authorized To Act on Proposer's Behalf	Alternate Authorized Representative

DIRECTIONS FOR SUBMITTING OFFER:

1. Read and comply with the Solicitation Instructions. This form is to be submitted with your Technical Proposal. The Price Proposal and Price Proposal Attachments shall be submitted separately from the Technical Proposal, and the Technical Proposal shall not contain any information relating to costs.
2. The Technical Proposal Form and related required documents must be sealed, marked, and addressed as follows:

WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY
PRMT FILE ROOM 3C-02
600 FIFTH STREET, N.W.
WASHINGTON, D.C. 20001

TECHNICAL OFFER UNDER FN5008/FMP

**TECHNICAL PROPOSALS SHALL BE TIMELY MAILED OR HAND DELIVERED TO REACH
WMATA BEFORE 2:00 p.m. (LOCAL TIME) ON DAY OF PROPOSAL CLOSING.**



00413 PRICE PROPOSAL FORM

DATE OF REQUEST: PHASE 2 - December 3, 2004

PROJECT: FN5008 METRO MATTERS: RAIL YARDS EXPANSION PROJECT
AT BRENTWOOD, GREENBELT, AND SHADY GROVE YARDS

REQUEST FOR PRICE PROPOSAL containing information requested herein shall be submitted by the Proposer so as to be received before: **2:00 p.m.** on **January 21, 2005** at the Washington Metropolitan Area Transit Authority, Office of Procurement, PRMT FILE Room 3C-02, 600 Fifth Street, N.W., Washington, D.C. 20001. Questions may be directed to the Contract Administrator, Fred M. Pohlmann at (202) 962-1529, FAX to (202) 962-6247.

In response to your Request For Price Proposal for the above referenced Contract, the undersigned hereby proposes to furnish all labor, equipment and materials and perform all work to design and construct the Project in strict accordance with the Contract requirements for the consideration of the amount proposed on the Price Schedule. If awarded the Contract within the Proposal Acceptance Period, the undersigned agrees to execute the Design-Build Contract within 10 calendar days and to furnish, if required, performance and payment bonds on standard Authority forms with good and sufficient surety or sureties.

If the Contract is executed, the undersigned further agrees to commence the work within 10 calendar days after the receipt of Notice to Proceed and to complete the work within the time specified in the Contract.

The undersigned acknowledges receipt of the following amendments to the **Request for Price Proposal under FN5008/FMP** (give number and date of each):

- Amendment Number ____, dated _____.
- Amendment Number ____, dated _____.
- Amendment Number ____, dated _____.
- Amendment Number ____, dated _____.

Note: Failure to acknowledge receipt of all amendments may cause the Price Proposal to be considered not responsive to the request, which would require rejection of the Price Proposal as unacceptable.



00413 PRICE PROPOSAL FORM (CONT.)

PROPOSER:

_____	By _____
Firm Name	
_____	_____
Address	Printed name
_____	_____
Zip Code	Title
_____	_____
Telephone	DUNS Number
_____	_____
Representative Authorized To Act on Proposer's Behalf	Alternate Authorized Representative

DIRECTIONS FOR SUBMITTING OFFER:

1. Read and comply with the Solicitation Instructions. This form is to be submitted with your Price Proposal. The Price Proposal and Price Proposal Attachments shall be submitted separately from the Technical Proposal, and the Technical Proposal shall not contain any information relating to costs.
2. The Price Proposal Form and related required documents must be sealed, marked, and addressed as follows:

WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY
PRMT FILE ROOM 3C-02
600 FIFTH STREET, N.W.
WASHINGTON, D.C. 20001

PRICE OFFER UNDER FN5008/FMP

**PRICE PROPOSALS SHALL BE TIMELY MAILED OR HAND DELIVERED TO REACH WMATA
BEFORE 2:00 p.m. (LOCAL TIME) ON DAY OF PROPOSAL CLOSING.**



00430 PROCUREMENT FORM SUPPLEMENTS

This Section includes the Supplementary Proposal Forms that are required to be submitted with either the Technical Proposal or with the Price Proposal.



THIS PAGE NOT USED

00431 PROPOSAL SECURITY (PROPOSAL BOND FORM) - Submit with Price Proposal

PROPOSAL BOND

Request for Proposal No.: Proposal Closing Date:
Penal Sum of Bond: 5% of Offered Price or Amount, \$:
Date Bond Executed:

KNOW ALL MEN BY THESE PRESENTS, that we, the Principal and Surety(ies) hereto, are firmly bound to the Washington Metropolitan Area Transit Authority in the above penal sum for the payment of which we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally: provided, that, where the Sureties are corporations acting as co-sureties, we, the Sureties, bind ourselves in such sum "jointly and severally" as well as "severally" only for the purpose of allowing a joint action or actions against any or all of us, and for all other purposes each Surety binds itself, jointly and severally with the Principal, for the payment of such sum only as set forth opposite the name of such Surety, but if no limit of liability is indicated, the limit of liability shall be the full amount of the penal sum.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has submitted the proposal identified above:

NOW, THEREFORE, if the Principal, upon acceptance by the Authority of his proposal identified above, within the period specified therein for acceptance (sixty [60] days if no period is specified), shall execute such further contractual documents, if any, and give such bond(s) as may be required by the terms of the proposal as accepted within the time specified (ten [10] days if no period is specified) after receipt of the forms by him, or in the event of failure so to execute such further contractual documents and give such bonds, if the Principal shall pay the Authority for any cost of procuring the work which exceeds the amount of his proposal, then the above obligation shall be void and of no effect.

Each Surety executing this instrument hereby agrees that its obligation shall not be impaired by any extension(s) of the time for acceptance of the proposal that the Principal may grant to the Authority notice of which extension(s) to the Surety(ies) being hereby waived provided that such waiver shall apply only with respect to extensions aggregating not more than sixty (60) calendar days in addition to the period originally allowed for acceptance of the proposal.

Principal(s)

1. Firm Name and Address: Corporate Seal
Signature: _____
Name and Title: State of Inc.:

2. Firm Name and Address: Corporate Seal
Signature: _____
Name and Title: State of Inc.:

3. Firm Name and Address: Corporate Seal
Signature: _____
Name and Title: State of Inc.:



00431 PROPOSAL SECURITY (PROPOSAL BOND FORM) (CONT.)

Corporate Surety(ies)			
Surety A	Surety Name and Address: Signature: _____ Name and Title:	Liability Limit \$	(Seal)
State of Inc.:			
Surety B	Surety Name and Address: Signature: _____ Name and Title:	Liability Limit \$	(Seal)
State of Inc.:			
Surety C	Surety Name and Address: Signature: _____ Name and Title:	Liability Limit \$	(Seal)
State of Inc.:			
Attach additional pages as needed.			
Instructions			
1. This form is authorized for use whenever a proposal guaranty is required in connection with design-build work.			
2. The full legal name and business address of the Principal shall be inserted in the space designated "Principal" on the face of this form. The bond shall be signed by an authorized person. Where such person is signing in a representative capacity (e.g., an attorney-in-fact), but is not a member of the firm, partnership or joint venture, or an officer of the corporation involved, evidence of his authority must be furnished.			
3. The penal sum of the bond may be expressed as a percentage of the proposal price (e.g., 5% of the proposal price) if desired or may be expressed in dollars and cents.			
4. Corporation executing the bond as sureties must be among those appearing on the Treasury Department's list of approved sureties and must be acting within the limitations set forth therein. Where more than a single corporate surety is involved, their names and addresses (city and State) shall be inserted in the spaces (Surety A, Surety B, etc.) headed "Corporate Surety(ies)".			
5. Corporations executing the bond shall affix their corporate seals.			
6. The name of each person signing this proposal bond should be typed in the space provided.			



00432 COMPLIANCE / EXCEPTION INFORMATION - **Submit with Technical Proposal**

Indicate whether the proposal submitted is intended to fully comply with the Requirements of this Request for Proposals, or if certain exceptions are taken. If exceptions are taken, the proposer shall clearly identify any exception to the requirements, terms, or conditions of any part of this RFP. Each exception must be specifically related to the particular part of the RFP to which the exception is taken. The proposer must support and explain the reason for any exceptions taken and explain the impact, if any, on the RFP requirements and state the necessity for or advantage of the exception.

Check one statement below. If exceptions are taken, explain the exceptions per the following instructions.

- The proposer certifies that its proposal is intended to comply fully with all Requirements.
- The proposer certifies that its proposal is intended to comply fully with all Requirements, except as noted (add additional sheets to explain).



THIS PAGE NOT USED



00433 BRAND NAME OR EQUAL FORM - Submit with Technical Proposal

Proposer is required to state in the spaces below the Manufacturer's Name, Part/Product Number, Description, and to provide relevant specifications, including technical data and Material Safety Data Sheets. Be advised that these items, if any, are only set apart for identification. If products, other than those specified if any, are not listed here, the proposal will be viewed as providing the as-specified products, if any.

Spec Section/Product Specified: _____
Manufacturer: _____
Product Offered: _____
Manufacturer: _____

Spec Section/Product Specified: _____
Manufacturer: _____
Product Offered: _____
Manufacturer: _____

Spec Section/Product Specified: _____
Manufacturer: _____
Product Offered: _____
Manufacturer: _____

Spec Section/Product Specified: _____
Manufacturer: _____
Product Offered: _____
Manufacturer: _____

NOTE: If applicable, attach additional sheets as necessary in this format. This form is included to establish a format for submission by the Proposer of an "or Equal" and will be utilized for the Technical Proposal submittal to the Authority for equal products by the Design-Builder. This form may also be used during the Design and Construction Phases of the Contract.



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00434 PRICE SCHEDULE - Submit with Price Proposal

A. DESCRIPTION OF WORK:

The Design-Builder shall Design and Build the Facilities satisfactorily completed for its intended use in the manner and at the locations set forth in the Requirements of the Project Manual and the Project Drawings of this solicitation, and in accordance with the Technical and Price Proposals as finally accepted by the Authority. The Design-Builder shall design the facility pursuant to the Authority's Design Criteria, and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities, and shall construct the facility in strict accordance with the Final Design Specifications and Final Design Drawings and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities.

Schedule A: GREENBELT YARD EXPANSION

Item	Description	Unit	Amount
1	Sitework		
1-A	Demolition	LS	\$ _____
1-B	Earthwork	LS	\$ _____
1-C	Paving and Surfacing	LS	\$ _____
1-D	Piped Utilities	LS	\$ _____
1-E	Site Improvements	LS	\$ _____
1-F	Yard Electrical Work	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration		
2-A	Demolition and Earthworks	LS	\$ _____
2-B	Concrete and Masonry	LS	\$ _____
2-C	Metals	LS	\$ _____
2-D	Thermal and Moisture Protection	LS	\$ _____
2-E	Interior Construction and Finishes	LS	\$ _____
2-F	Conveying Systems	LS	\$ _____
2-G	Mechanical	LS	\$ _____



Item	Description	Unit	Amount
2-H	Electrical	LS	\$ _____
2-I	Building Communication and Electrical Specialties	LS	\$ _____
3	Major Shop Equipment (Drwg. E11a-A-06, Sections 1003 - 1009, 1012 - 1021, 1024, 1044-1046, 1048)	LS	\$ _____
4	Environmental Mitigation	LS	\$ _____
5	Systems	LS	\$ _____
5-A	Trackwork	LS	\$ _____
5-B	Traction Power	LS	\$ _____
5-C	Automatic Train Control	LS	\$ _____
5-D	Train Control Communications	LS	\$ _____
6	Design for Items 1 thru 5	LS	\$ _____
7	Project General Conditions	LS	\$ _____
SUBTOTAL Schedule A			\$ 29,447,000

Schedule B: SHADY GROVE YARD EXPANSION

Item	Description	Unit	Amount
1	Sitework		
1-A	Demolition	LS	\$ _____
1-B	Earthwork	LS	\$ _____
1-C	Paving and Surfacing	LS	\$ _____
1-D	Piped Utilities	LS	\$ _____
1-E	Site Improvements	LS	\$ _____
1-F	Yard Electrical Work	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration		
2-A	Demolition and Earthworks	LS	\$ _____
2-B	Concrete and Masonry	LS	\$ _____



**Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP**

**Contract No. FN5008
Date: December 3, 2004**

Item	Description	Unit	Amount
2-C	Metals	LS	\$ _____
2-D	Thermal and Moisture Protection	LS	\$ _____
2-E	Interior Construction and Finishes	LS	\$ _____
2-F	Conveying Systems	LS	\$ _____
2-G	Mechanical	LS	\$ _____
2-H	Electrical	LS	\$ _____
2-I	Building Communication and Electrical Specialties	LS	\$ _____
3	Shop Equipment Tools & Supplies	LS	\$ _____
4	Environmental Mitigation	LS	\$ _____
5	Systems	LS	\$ _____
5-A	Trackwork	LS	\$ _____
5-B	Traction Power	LS	\$ _____
5-C	Automatic Train Control	LS	\$ _____
5-D	Train Control Communications	LS	\$ _____
6	Design for Items 1 thru 5	LS	\$ _____
7	Project General Conditions	LS	\$ _____

SUBTOTAL Schedule B \$ 47,447,000

Schedule C: MISCELLANEOUS ALLOWANCES FOR GREENBELT/SHADY GROVE PROJECT

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ <u>20,000</u>
2	Disputes Review Board (Section 01260)	LS	\$ <u>86,000</u>
3	Minor Shop Equipment (Greenbelt Yard Only)	LS	\$ <u>1,500,000</u>
4	Spare Parts (Section 01780 1.07)	LS	\$ <u>500,000</u>

TOTAL Schedules A, B, C \$ 79,000,000



Schedule D: BRENTWOOD YARD EXPANSION

Item	Description	Unit	Amount
1	Sitework		
1-A	Demolition	LS	\$ _____
1-B	Earthwork	LS	\$ _____
1-C	Paving and Surfacing	LS	\$ _____
1-D	Piped Utilities	LS	\$ _____
1-E	Site Improvements	LS	\$ _____
1-F	Yard Electrical Work	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration		
2-A	Demolition and Earthworks	LS	\$ _____
2-B	Concrete and Masonry	LS	\$ _____
2-C	Metals	LS	\$ _____
2-D	Thermal and Moisture Protection	LS	\$ _____
2-E	Interior Construction and Finishes	LS	\$ _____
2-F	Conveying Systems	LS	\$ _____
2-G	Mechanical	LS	\$ _____
2-H	Electrical	LS	\$ _____
2-I	Building Communication and Electrical Specialties	LS	\$ _____
3	Shop Equipment Tools & Supplies	LS	\$ _____
4	Environmental Mitigation	LS	\$ _____
5	Systems	LS	\$ _____
5-A	Trackwork	LS	\$ _____
5-B	Traction Power	LS	\$ _____
5-C	Automatic Train Control	LS	\$ _____
5-D	Train Control Communications	LS	\$ _____



**Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP**

**Contract No. FN5008
Date: December 3, 2004**

Item	Description	Unit	Amount
6	Design for Items 1 thru 5	LS	\$ _____
7	Project General Conditions	LS	\$ _____

SUBTOTAL Schedule D \$ 40,437,000

Schedule E: MISCELLANEOUS ALLOWANCES FOR BRENTWOOD PROJECT

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ <u>20,000</u>
2	Disputes Review Board (Section 01260)	LS	\$ <u>43,000</u>
3	Spare Parts (Section 01780 1.07)	LS	\$ <u>500,000</u>

TOTAL Schedules D + E \$ 41,000,000

TOTAL PROPOSAL PRICE (SCHEDULES A + B + C + D + E) \$120,000,000

NOTES TO PROPOSERS:

1. The Contract(s) will be awarded to responsible contractor(s) on the basis of the proposal that provides the overall best value to the Authority in terms of design solutions, innovativeness, and technical factors based on an integrated assessment within the stated target price as shown in the Price Schedule for each Project. Multiple contracts will be awarded, however, it is required that proposals be submitted for both Projects and all items, therefore failure to submit an offer on all items may result in rejection of the proposal.
2. Unless otherwise specified, each LUMP SUM priced line item includes all labor, material, equipment, and other incidentals, ready for its intended use including, but not limited to, furnishing, installation and testing. The successful Offeror will be required to provide a detailed breakdown to the Authority Representative of all LUMP SUM items for payment purposes.
3. Schedules C and E of the Price Schedule is for items where a specific allowance is set-aside by the Authority for payment. This is an estimated amount subject to negotiation and is not guaranteed. Schedule C, Item 3 is for Minor Greenbelt Shop Equipment only, all Major Shop Equipment for Greenbelt Yard is to be priced under Schedule A, Item 3 as shown.
4. As part of the determination of responsibility, the pre-award data submitted must indicate

compliance with the requirement that 15% of the work is to be performed by the Design/Build contractor.

5. The proposers are advised that this contract contains Davis-Bacon provisions. The Contractor will be required to submit certified payrolls on a weekly basis. Also, the Authority will monitor compliance by performing Labor Standards Interviews of the labor force. The Authority will hold retainage in a sufficient amount as may be considered necessary for any under payments of wages and/or fringes until they are fully resolved in accordance with the Labor Provisions of the contract.
6. The offerors are advised that the Authority will complete a "Performance Evaluation" at the end of the contract. The Performance Elements will include: Quality of Work, Timely Performance, Effectiveness of Management, Compliance with labor Standards, Compliance with Safety Standards and an Overall Evaluation. The Performance Evaluation may be used in determinations of responsibility for future WMATA contracts.
7. DBE data (See Appendix B) shall be submitted with the Final Proposal Revisions (FPR) if the Total Proposal Price is \$500,000 or more. It is required that in order to be counted towards meeting the DBE goal established for each Project, proposed DBE firms must be pre-certified by WMATA prior to submittal of FPRs. Although non-certified DBE firms can be utilized, they will not be counted towards meeting the goal.

END OF PRICE SCHEDULE

00450 REPRESENTATIONS AND CERTIFICATIONS - Submit with Price Proposal

- A. This Section includes the Representations and Certifications that are required to be submitted with the Price Proposal.

00451 REPRESENTATIONS AND CERTIFICATIONS

The Offeror represents as part of its offer that:

A. TYPE OF BUSINESS ORGANIZATION

It operates as an individual, a partnership, a joint venture, a nonprofit organization, or a corporation incorporated under the laws of the _____ State/Commonwealth/District

B. PARENT COMPANY AND EMPLOYER IDENTIFICATION NUMBER (AFFILIATION AND IDENTIFYING DATA):

1. The proposer represents that it is, is not owned or controlled by a parent company. For this purpose a parent company is defined as one which either owns or controls the activities and basic business policies of the proposer. To own another company means the parent company must own at least a majority, i.e., more than 50 percent, of the voting rights in that company. To control another company, such ownership is not required; if another company is able to formulate, determine or veto basic business policy decisions of the proposer, such other company is considered the parent of the proposer. This control may be exercised through the use of dominant minority voting rights, use of proxy voting, contractual arrangements or otherwise.
2. If the proposer is owned or controlled by a parent company, insert in the space below the name and address of the main office of the parent company:

Name

Address (Including Zip Code)

3. If the proposer has no parent company, he shall provide in the applicable space below his own Employer's Identification Number (E.I. No.), i.e., Federal Social Security Identification Number used on Federal Tax Returns or, if he has a parent company, the E.I. No. of his parent company:

Proposer's E.I. Number: _____

Parent Company's E.I. Number: _____

4. With respect to the Data Universal Numbering Systems (DUNS), the following applies:

The offeror shall insert the DUNS number applicable to the offeror's address entered on the Proposal Form: _____

00451 Reprs and Certs
Page 1 of 8

C. NONDISCRIMINATION CLAUSE:

1. The proposer represents that he [] has, [] has not participated in a previous contract or subcontract subject to either the Nondiscrimination in Employment clause herein, or the clause originally contained in Executive Order 10925, Section 301, or the clause contained in Section 201 of Executive Order Number 11114, or the CIVIL RIGHTS Section 00770 included in this Contract, that he [] has, [] has not filed all required compliance reports; and that representations indicating submittal of required compliance reports signed by proposed subcontractors will be obtained prior to subcontract awards.
2. The above representation need not be submitted in connection with contracts or subcontracts which are exempt from the clause.

D. DISADVANTAGED BUSINESS ENTERPRISE:

It is [], is not [], a disadvantaged business enterprise.

1. "Disadvantaged Business Enterprise" means a for-profit small business concern (as defined by 49 CFR Part 26) (1) which is at least 51% owned by one or more socially and economically disadvantaged individuals, or in the case of a corporation, at least 51% of the stock is owned by one or more socially and economically disadvantaged individuals; and (2) whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals who own it. "Socially and Economically Disadvantaged Individuals" means those individuals who are citizens of the United States (or lawfully admitted permanent residents) who are women, Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, or Subcontinent Asian Americans, and any additional groups whose members are designated as socially and economically disadvantaged by the Small Business Administration (SBA) at such time as the designation becomes effective.

E. CERTIFICATION OF NONCOLLUSION (INDEPENDENT PRICE DETERMINATION):

1. By the submittal of this proposal, the proposer certifies in connection with this procurement that he, and in the case of a joint offer, each party thereto, that:
 - a. The prices in this proposal or bid have been independently arrived at without collusion (without consultation, communication or agreement for the purpose of restricting competition as to any matter relating to such prices) with any other proposer, bidder or competitor;
 - b. Unless otherwise required by law, the prices in this proposal or bid have not been knowingly disclosed and will not be knowingly disclosed by the offeror prior to opening in the case of a bid, or prior to award, in the case of a proposal, directly or indirectly, to any other proposer, bidder or competitor; and
 - c. No attempt has been made or will be made to induce any other person or firm to submit or not to submit a proposal or bid .

2. Each person signing this proposal or bid certifies that he has fully informed himself regarding the accuracy of the statements contained in this certification:
 - a. He or she is the person in the offeror's organization responsible within that organization for the decision as to the prices being offered herein and that he/she has not participated, and will not participate, in any action contrary to 1.a. through 1.c. above; or
 - b. (1) He/she is not the person in the offeror's organization responsible within that organization for the decision as to the prices being offered herein, but that he/she has been authorized in writing to act as agent for the persons responsible for such decision in certifying that such persons have not participated and will not participate, in any action contrary to 1.a. through 1.c.) above, and as their agent does hereby so certify; and
(2) He/she has not participated, and will not participate, in any action contrary to 1.a. through 1.c. above.
3. A proposal or bid will not be considered for award where 1.a., 1.c. or 2. above has been deleted or modified. Where 1.b. above has been deleted or modified, the proposal or bid will not be considered for award unless the proposer or bidder furnishes with the proposal or bid a signed statement which sets forth in detail the circumstances of the disclosure and the head of the agency, or his designee, determines that the disclosure was not made with collusive intent.

F. REGULAR DEALER - MANUFACTURER NOT USED

G. CERTIFICATION OF NAMING CERTAIN SUBCONTRACTORS:

By submittal of this proposal, the proposer certifies that he will comply with the provisions concerning approval of certain subcontractors as set forth in Section 00200, INSTRUCTIONS TO PROPOSERS or 01300, ADMINISTRATIVE REQUIREMENTS, if any.

H. CERTIFICATION OF REVIEW OF DATA AVAILABLE:

By submittal of this proposal, the proposer certifies that he has examined, or caused to be examined, all of the information and data listed in Section 00100, PROJECT INFORMATION and Section 00300, INFORMATION AVAILABLE TO PROPOSERS of this Contract and has satisfied himself as to their contents for the work under this Contract.

I. GOVERNMENT-WIDE DEBARMENT AND SUSPENSION (NONPROCUREMENT):

49CFR Part 29
Executive Order 12549

Certification Regarding Debarment, Suspension, and Other Responsibility Matters -Lower Tier Covered Transactions (Third Party Contracts over \$100,000)

1. Instruction for Certification:

- a. By signing and submitting this proposal, the prospective proposer is providing the signed certification set out below.
- b. The certification in this Section is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective proposer knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, WMATA may pursue available remedies, including suspension and/or debarment.
- c. The prospective proposer shall provide immediate written notice to WMATA if at any time a prospective subcontractor (at any tier) learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
- d. The terms "covered transaction", "debarred", "suspended", "ineligible", "lower tier covered transaction", "participant", "person", "principal", "bid", "proposal", and "voluntarily excluded", as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549 [49 CFR Part 29]. You may contact the Contracting Officer for assistance in obtain a copy of those regulations.
- e. The proposer agrees by submitting this proposal that, should the contract be entered into, it shall not knowingly enter into any subcontract (at any tier) with a firm which is debarred, suspended, declared ineligible, or voluntarily excluded, unless authorized in writing by the Contracting Officer.
- f. The proposer further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction", without modification, in all subcontracts and solicitations for subcontracts anticipated to exceed \$100,000 in value.
- g. A Design-Builder may rely upon a certification of a subcontractor that it is not debarred, suspended, ineligible, or voluntarily excluded for the contracting, unless it knows that the certification is erroneous. A Design-Builder may decide the method and frequency by which it determines the eligibility of its principals. Each Design-Builder may, but is not required to, check the Nonprocurement List issued by the U.S. General Service Administration.

00451 Reps and Certs
Page 4 of 8

- h. Nothing contained in the foregoing shall be construed to require establishment of system of records in order to render in good faith the certification required by this Section. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.
 - i. Except for transactions authorized under Paragraph e. of these instructions, if a Design-Builder under a WMATA contract knowingly enters into a subcontract (at any tier) with a firm which is suspended, debarred, ineligible, or voluntarily excluded from contracting, in addition to all remedies available to the Federal Government, WMATA may pursue available remedies including suspension and/or debarment.
2. "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction":
- a. The prospective proposer certifies, by submission of this proposal that neither it nor its "principals" (as defined at 49 C.F.R.- ¶ 29.105) is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
 - b. When the prospective proposer is unable to certify to the statements in this certification, such prospective proposer shall attach an explanation to this proposal.

Name of Design-Builder

*By _____
Signature

Title

* As the proposer/bidder, the Certification is required ONLY for a contract over \$100,000.

J. CLEAN AIR AND WATER ACTS

[Applicable if the offer exceeds \$100,000, or the Contracting Officer believes that orders under an indefinite contract in any year will exceed \$100,000, or a facility to be used has been the subject of a conviction under the Clean Air Act (42 U.S.C. 7413(c)(1)) or the Water Act (33 U.S.C. 1319(c)) and is listed by the Environmental Protection Agency (EPA) as a violating facility, and the acquisition is not otherwise exempt.]: The Proposer certifies that-

- 1. Any facility to be used in the performance of this proposed Contract is [] is not [] listed on the Environmental Protection Agency List of Violating Facilities;
- 2. The Proposer will immediately notify the Contracting Officer, before award, of the receipt of any communication from the Administrator, or a designee, of the Environmental Protection Agency, indicating that any facility that the Proposer proposes to use for the performance of the Contract is under consideration to be listed on the EPA List of Violating Facilities; and



3. The Proposer will include a certification substantially the same as this certification, including this Paragraph 3. in every nonexempt subcontract.

K. BUY AMERICA CERTIFICATE:

The Design-Builder agrees to comply with 49 U.S.C. 5323(j) and 49 CFR Part 661, which provide that Federal funds may not be obligated unless steel, iron, and manufactured products used in FTA-funded projects are produced in the United States, unless a waiver has been granted by FTA or the product is subject to a general waiver. General waivers are listed in 49 CFR 661.7, and include final assembly in the United States for 15 passenger vans and 15 passenger wagons produced by Chrysler Corporation, microcomputer equipment, software, and small purchases (currently less than \$100,000) made with capital, operating, or planning funds. Separate requirements for rolling stock are set out at 5323(j)(2)(C) and 49 CFR 661.11. Rolling stock not subject to a general waiver must be manufactured in the United States and have a 60 percent domestic content.

A proposer must submit to the FTA recipient the appropriate Buy America certification (below) with all bids on FTA-funded contracts, except those subject to a general waiver. Proposals or bids that are not accompanied by a completed Buy America certification must be rejected as nonresponsive. This requirement does not apply to lower tier subcontractors.

Proposers shall note that certain electrical equipment must be considered in the "rolling stock" category for the purposes of Buy America.

Certification requirement for procurement of steel, iron, or manufactured products.
Certificate of Compliance with 49 U.S.C. 5323(j)(1)

The proposer hereby certifies that it will meet the requirements of 49 U.S.C. 5323(j)(1) and the applicable regulations in 49 CFR Part 661.

Date _____
Signature _____
Company Name _____
Title _____

Certificate of Non-Compliance with 49 U.S.C. 5323(j)(1)

The proposer hereby certifies that it cannot comply with the requirements of 49 U.S.C. 5323(j)(1), but it may qualify for an exception pursuant to 49 U.S.C. 5323(j)(2)(B) or (j)(2)(D) and the regulations in 49 CFR 661.7.

Date _____
Signature _____
Company Name _____
Title _____

Certification requirement for procurement of buses, other rolling stock and associated equipment.

Certificate of Compliance with 49 U.S.C. 5323(j)(2)(C).

The bidder or offeror hereby certifies that it will comply with the requirements of 49 U.S.C. 5323(j)(2)(C) and the regulations at 49 CFR Part 661.

Date _____
Signature _____
Company Name _____
Title _____

Certificate of Non-Compliance with 49 U.S.C. 5323(j)(2)(C)

The bidder or offeror hereby certifies that it cannot comply with the requirements of 49 U.S.C. 5323(j)(2)(C), but may qualify for an exception pursuant to 49 U.S.C. 5323(j)(2)(B) or (j)(2)(D) and the regulations in 49 CFR 661.7.

Date _____
Signature _____
Company Name _____
Title _____

Whether or not the proposer certifies that it will comply with the applicable requirement, such proposer is bound by its original certification and is not permitted to change its certification after receipt of proposals. A proposer that certifies it will comply with the applicable Buy America requirements is not eligible for a waiver of those requirements.

L. CERTIFICATION AND DISCLOSURE REGARDING PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS (November 2000)

1. The definitions and prohibitions contained in the clause, at Federal Acquisition Regulation, 52.203-12, Limitation on Payments to Influence Certain Federal Transactions, are hereby incorporated by reference in Paragraph 2. of this certification.
2. The undersigned certifies, to the best of his or her knowledge and belief, that
 - a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.



- b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form LLL, "Disclosure Form to Report Lobbying", in accordance with its instructions.
 - c. The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers and require that all recipients of subcontract awards in excess of \$100,000 (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.
3. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000, and not more than \$100,000, for each such failure.

Name of Design-Builder

By: _____
Signature

Title

00452 PROPOSAL DATA FORM (Submit with Price Proposal)

PROJECT: FN5008 - METRO MATTERS: RAIL YARDS EXPANSION PROJECT

1. Name of Firm: _____
2. Legal Address: _____

3. Individual Partnership Corporation Joint Venture
4. Date Organized _____.
State in which incorporated _____.
5. Names and Addresses of Officers or Partners:
 - a. _____
 - b. _____
 - c. _____
 - d. _____
 - e. _____
 - f. _____
6. How long has your firm been in business under its present name? _____
7. Attach as SCHEDULE 7 a list of current contracts, each with contract amount, owner, architect-engineer, character or type of work and percentage of completion. Also, include those projects on which you are apparent low bidder, but for which you have not received an award of contract.
8. Attach as SCHEDULE 8 a list of contracts, each with contract amount, owner, architect-engineer and character or type of work, for contracts completed in the last five years.
9. What is the estimated work placement value required per year to complete the work described in SCHEDULE 7.

2005: _____ 2006: _____ 2007: _____ 2008: _____



00452 PROPOSAL DATA FORM (CONT.)

10. Have you ever been denied an award on which you were low bidder? _____ If the answer is YES, attach as SCHEDULE 10 the full particulars regarding each occurrence.
11. Have you ever failed to complete any contract, other than current, on which you were the low bidder? _____ If the answer is YES, attach as SCHEDULE 11, the full particulars regarding each occurrence.
12. Have you ever been assessed liquidated damages or actual damages for late completion within the last five years? _____ If the answer is YES, attach as SCHEDULE 12 the full particulars regarding each occurrence.
13. Financial resources available as working capital for this Contract:
 - a. Cash on hand: \$ _____ Date: _____
 - b. Sources of credit: _____
14. Attach as SCHEDULE 14 certified financial statements and letters from banks regarding credit as required by Section 00200 of this Contract.
15. Attach as SCHEDULE 15 the design and construction experience of each officer and principal individual of your organization; include present position, years of design and construction experience, magnitude and type of work and in what capacity.
16. What percentage of the work (contract amount) do you intend performing with your own personnel? _____%
17. Attach as SCHEDULE 17 a list of all principal subcontractors and the percentage and character of work (contract amount) which each will perform.
18. Attach as exhibits completed Proposal Data Forms for each of the subcontractors listed in SCHEDULE 17. above.
19. If the Design-Builder or subcontractor is a joint venture, submit Proposal Data Forms for each member of the joint venture.

The above information is confidential and will not be divulged to any unauthorized person or persons.

The signatory of this questionnaire certifies to the truth and accuracy of all statements, answers and attachments.

FOR: _____ DUNS Number _____
(Name of Firm)

SIGNATURE: _____

TITLE: _____

DATED: _____

LOCATION: _____

00453 DBE DATA (aka APPENDIX B) (Submit with the Final Proposal Revision [FPR, formerly BAFO] Price Proposal or by the selected proposer before award if discussions are not held)

Pursuant to the policy of the Authority (WMATA) that businesses owned by socially and economically disadvantaged persons (Disadvantaged Business Enterprises [DBE's]) shall compete fairly to receive and participate in performing WMATA contracts, including contracts and subcontracts at any tier, and also of the Federal Transit Administration (FTA) and the United States Department of Transportation (U.S. DOT) to receive and participate in performing federally assisted contracts.

Under its DBE Program, WMATA applies a DBE participation goal on construction (and construction-related) contracts having a total dollar value of \$500,000 or greater and a DBE participation goal on supply and service contracts having a total dollar value of \$100,000 or greater.



THIS PAGE NOT USED

~APPENDIX B

DISADVANTAGED BUSINESS ENTERPRISE (DBE)
NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION PLAN (REVISED SEPTEMBER 2001)

A. Disadvantaged Business Enterprise (DBE) Requirement:

1. The DBE requirements of the Authority's DBE Program Plan apply to this Contract. Accordingly, the Design-Builder shall carry out the requirements of the Authority's DBE Program Plan and this Appendix in the award and administration of U.S. Department of Transportation (US DOT) assisted contracts.

B. Policy:

1. It is the policy of the Authority (WMATA) that Disadvantaged Business Enterprises (DBE's) shall compete fairly to receive and participate in performing WMATA contracts, and of the Federal Transit Administration (FTA) and the US DOT that Disadvantaged Business Enterprises (DBE's) shall compete fairly to receive and participate in performing federally assisted contracts, and also including contracts and subcontracts at any tier. It is further the policy of the Authority, the FTA and the U.S. DOT that its prime contractors establish procedures to ensure the timely payment of amounts due pursuant to the terms of their subcontracts. The Design-Builder hereby agrees to carry out this policy in the award and administration of subcontracts to the fullest extent possible consistent with efficient Contract performance.

C. Contract Goal:

1. If the proposer is not a DBE, then the proposer agrees that the DBE goal for this Contract will be met by subcontracts or by joint ventures with DBE's. The percentage goal of the final Contract price, including amendments and modifications, set forth for each of these Projects is established at **21%**. The amount of DBE participation will be determined by the dollar value of the work performed and/or supplies furnished by DBE firms as compared to the total value of all work performed and/or supplies furnished under this Contract. The Design-Builder shall have met this goal if the Design-Builder's DBE participation meets or exceeds this goal.
2. In cases where work is added to the Contract by modification such that additional DBE participation is necessary to meet this goal, the Design-Builder shall increase the participation of one or more firms listed on the "Schedule of DBE Participation" or submit additional DBE firms to meet the goal. In cases where work is deleted from the Contract, the goal shall be applicable to the new Contract amount. The Design-Builder shall be permitted to meet the goal by revising its DBE participation, provided, however, that the revision shall not result in DBE participation that is less than the original goal.

D. Definitions:

1. Design-Builder. Design-Builder means one who participates, through a contract or subcontract (at any tier), in a US DOT assisted highway, transit or airport program.
2. DBE. A DBE means a for-profit small business concern that is at least 51% owned by one or more individuals who are both socially and economically disadvantaged individuals or, in the case of a corporation, in which 51 percent of the stock is owned by one or more such individuals; and whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it.
3. Good Faith Efforts. "Good faith efforts" means efforts to achieve a DBE goal or other requirements of the Authority's DBE Program Plan which by their scope, intensity, and appropriateness to the objective, can reasonably be expected to fulfill the goal program requirement.
4. Joint Venture. Joint Venture means an association of a DBE firm and one or more other firms to carry out a single, for-profit business enterprise, for which the parties combine their property, capital, efforts, skills and knowledge, and in which the DBE is responsible for a distinct, clearly defined portion of the work of the contract and whose share in the capital contribution, control, management, risks, and profits of the joint venture is commensurate with its ownership interest.
5. Personal Net Worth. Personal net worth means the net value of the assets of an individual remaining after total liabilities are deducted. An individual's personal net worth does not include the individual's ownership interest in an applicant or participant DBE firm; or the individual's equity in his or her primary place of residence. An individual's personal net worth includes only his or her own share of assets held jointly or as community property with the individual's spouse.
6. Race-conscious. Race-conscious means a measure or program that is focused specifically on assisting only DBE's, including women-owned DBE's.
7. Race-neutral. Race-neutral means a measure or program that is, or can be, used to assist all small businesses. For the purposes of the DBE program, race-neutral includes gender-neutrality.
8. Small Business Concern. Small business concern means, with respect to firms seeking to participate as DBE's in US DOT assisted contracts, a small business concern as defined pursuant to Section 3 of the Small Business Act and Small Business Administration regulations implementing it (13 CFR Part 121) that also does not exceed the cap on average annual gross receipts specified in 49 CFR Part 26.65(b).
9. Socially and Economically Disadvantaged Individual. The phrase "socially and economically disadvantaged individual" means any individual who is a citizen (or other lawfully admitted permanent resident) of the United States and who is any individual who the Authority finds to be a socially and economically disadvantaged individual on a case-by-case basis, and any individual in the following groups, members of which are rebuttably presumed to be socially and economically disadvantaged:

- a. Black Americans, which includes persons having origins in any of the Black racial groups of Africa;
 - b. Hispanic Americans, which includes persons of Mexican, Puerto Rican, Cuban, Dominican, Central or South American, or other Spanish or Portuguese culture or origin, regardless of race;
 - c. Native Americans, which includes persons who are American Indians, Eskimos, Aleuts, or Native Hawaiians;
 - d. Asian-Pacific Americans, which includes persons whose origins are from Japan, China, Taiwan, Korea, Burma (Myanmar), Vietnam, Laos, Cambodia (Kampuchea), Thailand, Malaysia, Indonesia, the Philippines, Brunei, Samoa, Guam, the U.S. Trust Territories of the Pacific Islands (Republic of Palau), the Commonwealth of the North Marianas Islands, Macao, Fiji, Tonga, Kiribati, Juvalu, Nauru, Federated States of Micronesia, or Hong Kong;
 - e. Subcontinent Asian Americans, which includes persons whose origins are from India, Pakistan, Bangladesh, Bhutan, the Maldives Islands, Nepal or Sri Lanka;
 - f. Women; and
 - g. Any additional groups whose members are designated as socially and economically disadvantaged by the SBA, at such time as the SBA designation becomes effective.
10. US DOT Assisted Contract. US DOT assisted contract means any contract between the Authority and a contractor (at any tier) funded in whole or in part with US DOT financial assistance, including letters of credit or loan guarantees.

E. How DBE Participation Is Counted Towards the Contract Goal:

DBE participation shall be counted towards meeting the DBE goal in accordance with the following:

1. When a DBE participates in a contract, only the value of the work actually performed by the DBE is counted towards the DBE goal.
 - a. This amount includes the entire amount of that portion of a construction contract that is performed by the DBE's own forces. This amount includes the cost of supplies and materials obtained by the DBE for the work of the contract, including supplies purchased or equipment leased by the DBE (except supplies and equipment the DBE subcontractor purchases or leases from the Design-Builder or its affiliate).
 - b. This amount includes the entire amount of fees or commissions charged by a DBE firm for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of the contract, towards the DBE goal, provided the fee is reasonable and not excessive as compared with fees customarily allowed for similar services.
 - c. When a DBE subcontracts part of its work under the contract to another firm, the value of the subcontract work may be counted towards the DBE goal only if the DBE's subcontractor is itself a DBE. Work that a DBE subcontracts to a non-DBE firm does not count towards the DBE goal.
2. When a DBE performs as a participant in a joint venture, the portion of the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that a DBE performs with its own forces towards the DBE goal may be counted.



3. Expenditures to a DBE contractor towards the DBE goal may be counted only if the DBE is performing a commercially useful function on that Contract.
 - a. A DBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a commercially useful function, the DBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, and installing (where applicable) and paying for the material itself. To determine whether a DBE is performing a commercially useful function, the Authority will consider the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is actually performing and the DBE credit claimed for its performance of the work, and other relevant factors.
 - b. A DBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of DBE participation.
 - c. If a DBE does not perform or exercise responsibility for at least 30 percent of the total cost of its contract with its own work force, or if the DBE subcontracts a greater portion of the work of a contract than would be expected on the basis of normal industry practice for the type of work, the Authority will presume that the DBE is not performing a commercially useful function.
4. The following factors will be used by the Authority in determining whether a DBE trucking company is performing a commercial useful function:
 - a. The DBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible for on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting the DBE goal.
 - b. The DBE must itself own and operate at least one fully licensed, insured and operational truck used on the contract.
 - c. The DBE receives credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers, it employs.
 - d. The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the contract.
 - e. The DBE may also lease trucks from a non-DBE firm, including an owner-operator. The DBE who leases trucks from a non-DBE is entitled to credit only for the fee or commission it receives as a result of the lease arrangement. The DBE does not receive credit for the total value of the transportation services provided by the lessee, since these services are not provided by a DBE.
 - f. The lease must indicate that the DBE has exclusive use of and control over the truck. This does not preclude the leased truck from working for others during the terms of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE.



5. The following factors will be used to count expenditures with DBE's for materials or supplies towards the DBE goal:
 - a. If the materials or supplies are obtained from a DBE manufacturer, 100 percent of the cost of the materials or supplies will be counted towards the DBE goal. A manufacturer is a firm that operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the Contract and of the general character described by the Contract.
 - b. If the materials or supplies are purchased from a DBE regular dealer, 60 percent of the cost of the materials or supplies will be counted towards the DBE goal. A regular dealer is a firm that owns, operates or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business. To be a regular dealer, the firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question. A person may be a regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone or asphalt without owning, operating, or maintaining a place of business as provided in this paragraph if this person both owns and operates distribution equipment for the products. Any supplementing of regular dealers' own distribution equipment shall be by long-term lease agreement and not on an ad hoc or contract-by-contract basis. Packagers, brokers, manufacturers' representatives, or other persons who arrange or expedite transactions are not regular dealers within the meaning of this paragraph.
 - c. With respect to materials or supplies purchased from a DBE which is neither a manufacturer nor a regular dealer, the entire amount of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the delivery of materials and supplies required on a job site, may be counted towards the DBE goal, provided the fees are reasonable and are not excessive as compared with fees customarily allowed for similar services. The cost of the materials and supplies themselves may not be counted towards the DBE goal.
6. Participation by a firm that is not currently certified as a DBE by the Authority at the time of Contract award, does not count towards the DBE goal. Effective March 4, 2002, all DBE firms must be pre-certified: certification of firms must be in place prior to the due date of proposals on which the firm wishes to participate as a DBE.
7. The dollar value of work performed under the Contract by a firm whose DBE certification has expired, does not count towards the DBE goal.
8. The participation of a DBE subcontractor does not count towards the Design-Builder's DBE goal until the amount being counted towards the goal has been paid to the DBE.



F. Proposal Requirements (With the Initial Price Proposal and with the Final Proposal Revision [FPR]):

If a DBE goal is specified, the proposer shall submit with its initial Price Proposal a list of DBE-certified firms that it intends to enter into subcontract agreements with for this Contract. If no goal is specified and the proposer still intends to utilize DBE's in the performance of this Contract, the proposer shall submit with its initial Price Proposal a list of those DBE-certified firms. The documentation requirements of this Section 00453 shall be completed and submitted at the time set forth for the submittal of the FPR or if based on the initial proposals without discussions by the selected proposer before award as requested by the Authority for any Contract in which a DBE goal is applicable or for any Contract in which there was no goal established, but the proposer identified DBE-certified firms that it intends to enter into subcontract agreements with in its initial Price Proposal. Any proposer who fails to complete and return the following information, if applicable, as required may be deemed to be not responsible and may be ineligible for contract award. Proposers that fail to meet the DBE goal, if any, and fail to demonstrate "good faith efforts" to justify waiver of the DBE goal (see paragraph F.3. below) may be deemed to be not responsible and may be ineligible for contract award.

1. Completed "Schedule of DBE Participation" (Page B-12) sufficient to meet the above goal. If the proposer is a DBE firm and intends to satisfy the appropriate DBE requirement with its own firm, he/she must indicate in the Schedule the area of work and percentage it will perform to satisfy the goal.
 - a. For Design-Build negotiated procurements where a DBE goal is applicable, "the "Schedule of DBE Participation" need not be completed with initial proposals that are subject to further negotiations. However, the proposer shall provide a list of DBE-certified firms that it intends to enter into a subcontract agreement with as an element of the initial Price Proposal. A completed "Schedule of DBE Participation" shall be submitted with the final proposal revision (FPR) or by the selected proposer before award if discussions are not held.
2. Executed "Letters of Intent to Perform as a Subcontractor/Joint Venture" (Page B-13). If the proposer is not a DBE then he/she must attach these letters from each DBE listed on the Schedule.
 - a. For Design-Build, negotiated procurements where a DBE goal is applicable, the "Letters of Intent to Perform as a Subcontractor/Joint Venture" need not be submitted with initial proposals that are subject to further negotiations. Executed "Letters of Intent to Perform as a Subcontractor/Joint Venture" shall be submitted with the final proposal revision (FPR) or by the selected proposer before award if discussions are not held.
3. Justification for grant of relief (waiver of DBE goal). If in the submittal of its DBE Data, the proposer fails to meet the DBE goal, above if applicable, the proposer has the burden of furnishing sufficient documentation with its FPR of its "good faith efforts" to justify a grant of relief (waiver) from the goal or portion of the goal. Such justification shall be in the form of a detailed report. The following is a list of actions which shall be considered as part of the proposer's good faith efforts to obtain DBE participation. This list is neither a mandatory checklist nor is it intended to be exclusive or exhaustive. Other factors or types of efforts may be relevant in appropriate cases:
 - a. Soliciting through all reasonable and available means (e.g. attendance at pre-proposal meetings, advertising and/or written notices) the interest of all certified DBE's who have the capability to perform the work of the Contract. The proposer must solicit this interest within sufficient time to allow the DBE's to respond to the solicitation. The proposer must determine with certainty if the DBE's are interested by taking appropriate steps to follow up initial solicitations.

- b. Selecting portions of the work to be performed by DBE's in order to increase the likelihood that the DBE goal will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate DBE participation, even when the Design-Builder might otherwise prefer to perform these work items with its own forces.
- c. Providing interested DBE's with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.
- d.
 - (1) Negotiating in good faith with interested DBE's. It is the proposer's responsibility to make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBE's that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBE's to perform the work. "DBE Unavailability Certifications" (Page B-14) shall be completed as appropriate.
 - (2) A proposer using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as the contract goal into consideration. However, the fact that there may be some additional costs involved in finding and using DBE's is not in itself sufficient reason for a proposer's failure to meet the contract DBE goal, as long as such costs are reasonable. Also, the ability or desire of a Design-Builder to perform the work of a contract with its own organization does not relieve the proposer of the responsibility to make good faith efforts. Design-Builders are not, however, required to accept higher quotes from DBE's if the price difference is excessive or unreasonable.
- e. Not rejecting DBE's as being unqualified without sound reasons based on a thorough investigation of their capabilities. The Design-Builder's standing within its industry, membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. non-union employee status) are not legitimate causes for the rejection or non-solicitation of proposals in the Design-Builder's efforts to meet the project goal.
- f. Making efforts to assist interested DBE's in obtaining bonding, lines of credit, or insurance as required by the recipient or Design-Builder.
- g. Making efforts to assist interested DBE's in obtaining necessary equipment, supplies, materials, or related assistance or services.
- h. Effectively using the services of available minority/women community organizations; minority/women contractors' groups; local, state, and Federal minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBE's.



G. PROPOSING REQUIREMENTS (APPARENT SUCCESSFUL PROPOSER):

As applicable, the proposer shall submit the following items within ten (10) calendar days after notification that they are the apparent successful proposer:

1. The documents itemized on the DBE Certification Instructions (Page B-15) and the "DBE Disclosure Affidavit" (Pages B-16, B-17 & B-18) are for DBE firms not currently certified with WMATA. For those DBE's certified by WMATA within the past three years, a copy of the current WMATA certification letters may be attached in lieu of the Disclosure Affidavit and related documents.
2. DBE Manufacturer's Affidavit, if applicable, must be submitted in order to receive 100 percent of the allowable credit for expenditures to DBE manufacturers/suppliers (page B-19). By submission of this Affidavit, the proposer certifies this it is satisfied that the manufacturer meets the requirements of 49 CFR Part 26.
3. Schedule B Information for Determining Joint Venture Eligibility, if applicable (pages B-22, B-23, B-24 & B-25*). Submittal shall be signed by all parties, dated and notarized.
4. Copy of Joint Venture Agreement, if applicable. Submittal shall be signed by all parties, dated and notarized.
5. Certification letter of the DBE regular dealer/supplier, if applicable. If the proposer wants to receive the maximum allowable credit of its expenditures for material(s) or supplies required under this Contract, from DBE regular dealers/suppliers, the DBE must submit a signed and notarized statement on their letterhead, that they are a regular dealer of the material(s) or supplies. By submission of this statement, the proposer certifies that it is satisfied that the subcontractor is a regular dealer/supplier that meets the requirements of 49 CFR Part 26.

H. CONTRACT ADMINISTRATION REQUIREMENTS:

The following requirements apply after contract award:

1. The Design-Builder shall include the following provision in each subcontract it awards in support of the Appendix B DBE goal:

The Design-Builder shall not discriminate on the basis of race, color, national origin or sex in the performance of this Contract. The Design-Builder shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of US DOT assisted contracts and Authority Contracts. Failure by the Design-Builder to carry out these requirements is a material breach of this Contract, which may result in termination of this Contract or such other remedy as the Authority deems appropriate.
2. The Design-Builder shall monitor the performance of, collect and report data on DBE participation to the Authority's Office of Civil Rights, on the attached "Prompt Payment Report-Design-Builder's Report" (page B-20) and "Prompt Payment Report Prime Sub-Contractor's Report" (page B-21), which shall be submitted monthly with each payment request to the Authority Representative. Failure to submit these reports may result in suspension of Contract payments. The Design-Builder shall certify with each payment request that payment has been or will be made to all subcontractors due payment, within ten (10) days after receipt of payment from the Authority for work by that subcontractor. The Design-Builder shall inform the Authority Representative, with their payment request, of any situation in which scheduled subcontractor payments have not been made.

3. The Design-Builder shall have a continuing obligation to maintain a schedule for participation by DBE contractor(s) to meet its goal set forth above in this Appendix. The Design-Builder shall not have work performed nor the materials or supplies furnished by any individual or firm other than those named in the "Schedule of DBE Participation". If at any time, the Design-Builder believes or has reason to believe that it needs to obtain a substitute for a DBE contractor named in the "Schedule of DBE Participation", the Design-Builder shall, within ten (10) days, notify the Contracting Officer or other delegated Authority Representative of that fact in writing. Situations which may warrant substitution for a DBE firm include, but are not limited to the following:
 - a. Failure to qualify as a DBE.
 - b. Death or physical disability, if the named subcontractor or DBE partner of the joint venture is an individual.
 - c. Dissolution, if a corporation or partnership.
 - d. Bankruptcy of the subcontractor, subject to applicable bankruptcy law, and only instances where the bankruptcy affects the Design-Builder's ability to perform.
 - e. Inability to furnish a reasonable performance or payment bond, if required.
 - f. Inability to obtain, or loss of, a license necessary for the performance of the particular category of work.
 - g. Failure or inability to comply with a requirement of law applicable to contractors and subcontractors on a construction, alteration or repair project.
 - h. Failure or refusal to execute the subcontract in accordance with the terms of an offer submitted to the Design-Builder prior to the Design-Builder's submission of its proposal, but only where the Contracting Officer or other delegated Authority Representative can ascertain with reasonable certainty the terms of such offer. In the absence of any other factors, such a failure or refusal will be considered an unusual situation only if the bidder/proposer obtained, prior to bidding/proposing, an enforcement commitment from the subcontractor involved.
 - i. Failure to comply with the terms and conditions of this Contract or those of its subcontract or joint venture agreement.

Within 30 days thereafter, the Design-Builder shall, if necessary to achieve the Appendix B goal, make every reasonable effort to subcontract the same or other work to other DBE firms. The Design-Builder must have the prior written approval of the Contracting Officer or other delegated Authority Representative and the Authority's Office of Civil Rights before substitution for a DBE subcontractor, regardless of the reason for substitution. Failure to obtain Authority approval could result in the Design-Builder being found non-compliant with the requirements of Appendix B.

4. The Design-Builder shall forward copies of all subcontracts at the time of their execution to the Authority's Office of Civil Rights through the Authority Representative.

5. If the Contracting Officer or other delegated Authority Representative determines that the Design-Builder has failed to comply with this Appendix B, he will notify the Design-Builder of such non-compliance and the action to be taken. The Design-Builder shall, after receipt of such notice, take corrective action. If the Design-Builder fails or refuses to comply promptly, the Contracting Officer may issue a "stop work order" stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop work order shall be made the subject of claim for extension of time or for excess costs or damages by the Design-Builder. When the Authority proceeds with such formal actions, it has the burden of proving that the Design-Builder has not met the requirements of this Appendix, but the Design-Builder's failure to meet its Appendix B goal shall shift to it the requirement to come forward with evidence to show that it has met the good faith requirements of this Appendix. Where the Design-Builder, after exhausting all its administrative and legal remedies and procedures is found to have failed to exert a "good faith effort" to involve DBE's in the work as herein provided, the Authority may declare the Design-Builder ineligible to receive further Authority contracts for three years from the date of the finding.
6. The Design-Builder agrees to cooperate in any studies or surveys as may be conducted by the Authority which are necessary to determine the extent of the Design-Builder's compliance with this Appendix.
7. The Design-Builder shall keep records and documents for two years following performance of this Contract to indicate compliance with this Section 00453. These records and documents, or copies thereof, shall be made available at reasonable times and places for inspection by any Authorized Representative of the Authority and will be submitted upon request together with any other compliance information which such Representative may require.
8. If the Authority, the FTA or the US DOT has reason to believe that any person or firm has willfully and knowingly provided incorrect information or made false statements regarding the DBE Program, the matter shall be referred to the Authority's Office of Civil Rights.
9. Failure by the Design-Builder to carry out the requirements of this Appendix is a material breach of this Contract, which may result in the termination of this Contract under the Default provisions of this Contract or such other remedy as the Authority deems appropriate.

SUMMARY OF SUBMITTALS

With the Initial Price Proposal

1. List of DBE-certified firms that it intends to enter into subcontract agreements with (if a DBE goal is specified in Section 00453, DBE GOAL REQUIREMENTS, or if no goal is specified in Section 00453, but the proposer still intends to utilize DBE's in the performance of this Contract).

With the Price Proposal Final Proposal Revision (FPR) (if a DBE goal is specified in Section 00453, or if no goal is specified in Section 00453, but the proposer submitted with its Initial Price Proposal a list of DBE-certified firms that it intends to enter into subcontract agreements with)

1. Completed "Schedule of DBE Participation" (Page B-12).
2. Executed "Letters of Intent to Perform as a Subcontractor/Joint Venture" (Page B-13).
3. Justification for grant of relief (waiver of DBE goal), if applicable. Include completed "DBE Unavailability Certifications" (Page B-14) as appropriate.

Proposing Requirements (Apparent Successful Proposer) As Applicable

1. Documents itemized on the DBE Certification Instructions (Page B-15) and the "WMATA DBE Disclosure Affidavit" (Pages B-16, B-17 & B-18) for each DBE currently not certified with WMATA. For those DBE's certified by WMATA within the past three years, copy of the current WMATA certification letters.
2. DBE Manufacturer's Affidavit, if applicable, must be submitted in order to receive 100 percent of the allowable credit for expenditures to DBE manufacturers/suppliers (page B-19).
3. Schedule B Information for Determining Joint Venture Eligibility, if applicable (pages B-22, B-23, B-24 & B-25*).
4. Copy of Joint Venture Agreement, if applicable.
5. Certification letter of the DBE regular dealer/supplier, if applicable.

After Contract Award

1. "Prompt Payment Report-Design-Builder's Report" (page B-20) – submitted monthly.
2. "Prompt Payment Report-Sub-Contractor's Report" (page B-21) – submitted monthly.
3. Request to substitute DBE contractor (see paragraph 8.C.) – submitted as required.
4. Copies of subcontracts - submitted at the time of their execution.



SUBMIT WITH FPR
SCHEDULE OF DBE PARTICIPATION

Contract No. _____

Name of Proposer _____ Project Name _____

The proposer shall complete this Schedule by identifying only those DBE firms, with scope of work and price, who have agreed to perform work on this Contract. The prices for the work/supplies of these firms shall be at prices amounting to at least the DBE percentage goal of the total Contract price. The proposer agrees to enter into a formal agreement with the DBE firm(s) listed for the work and at, or greater than, the prices listed in this Schedule subject to award of a Contract with the Authority. If the total amount is less than the DBE percentage goal, a justification for waiver of DBE goal shall be attached to this Schedule.

Name of DBE Subcontractor	DBE	Address	Type of Work (Electrical, Paving, Etc.) and Contract Items or Parts Thereof to be Performed and Work Hours Involved	Agreed Price
Subtotal \$ DBE Subcontractors			Subtotal	
Name of DBE Design-Builder	DBE	Address	Type of Work (Electrical, Paving, Etc.) and Contract Items or Parts Thereof to be Performed and Work Hours Involved	Agreed Price
Subtotal \$ DBE Design-Builder			Subtotal	
TOTAL \$ ALL DBE CONTRACTORS			TOTAL	

Signature of Design-Builder Representative

Title

Date

M 23.26a (Rev 11/99)



Contract Number: _____

Project Name: _____

LETTER OF INTENT TO PERFORM AS A SUBCONTRACTOR/JOINT VENTURE
(ALL ITEMS MUST BE COMPLETED, SUBMIT WITH FPR)

TO: _____
(Name of Proposer)

The undersigned intends to perform work in connection with the above projects as (check one):

- _____ an individual _____ a corporation
- _____ a partnership _____ a joint venture

Specify in detail particular work items or parts thereof to be performed:

at the following price: \$ _____

Please indicate _____ % of the dollar value of the subcontract that will be awarded to non-DBE contractors, if applicable. The undersigned will enter into a formal agreement with you for the above work upon your execution of a contract with the Authority.

Name of DBE Subcontractor/Joint Venture _____ Phone Number _____

Address _____ WMATA Vendor ID Number _____

Signature & Title _____ Date _____

The following is to be completed by the Design-Builder. A copy of this letter must be returned to the DBE subcontractor to indicate acceptance.

To: _____
(Name of DBE)

You have projected your interest and intent for such work, and the undersigned is projecting completion of such work as follows:

<u>WORK ITEMS</u>	<u>PROJECTED DBE COMMENCEMENT DATE</u>	<u>PROJECTED DBE COMPLETION DATE</u>
-----------------------	--	--

_____ (Date)

_____ (Name of Design-Builder & Acceptance Signature)

23.24 (Rev 10/99)





SUBMIT WITH FPR
DBE UNAVAILABILITY CERTIFICATION

I, _____, _____, of _____
(Name) (Title) (Proposer)

certify that on _____ I contacted the following minority contractor to obtain a bid/proposal for
(Date)
work items to be performed on Contract Number _____.

<u>DBE Contractor</u>	<u>Work Items Sought</u>	<u>Form of Bid/Proposal Sought (i.e., Unit Price, Materials and Labor Only, Etc.)</u>
-----------------------	--------------------------	---

To the best of my knowledge and belief, said DBE contractors were unavailable (exclusive of unavailability due to lack of agreement on price) for work on this project, or unable to prepare a proposal, for the following reason(s):

Signature: _____

Date: _____

_____ was offered an opportunity to bid/propose on the above
(Name of DBE Contractor)

identified work on _____ by _____
(Date) (Source)

The above statement is true and accurate account of why I did not submit a bid/proposal on this project.

(Signature of DBE Contractor)

(Title)

M

 23.25 (Rev 10/99)

DBE Certification Instructions

Important Notice

If you do not have a current official letter of certification from WMATA, you must comply with the procedures that follow in order to be eligible to participate in WMATA's Disadvantaged Business Enterprise (DBE) Program.

Instructions

If you currently hold a valid DBE Certification status with either the Maryland Department of Transportation (MDOT); or the U.S. Small Business Administration, 8a Program (SBA-8a), forward a copy of the official certification letter along with the WMATA Affidavit. In addition, submit the pertinent documents for your company listed below. The affidavit form should be completed in full and NOTARIZED.

General (All firms must submit documents under General)

- Current (unaudited) Financial Statements
- Prior three (3) years Federal Tax Returns
- Resume of Principal(s) and Key Personnel
- Third Party Agreements, such as Rental and Management Agreements
- Licenses to Do Business
- Personal Net Worth (PNW) Statement
- Statement of Disadvantage
- No Change Affidavit or Notice of Change (where applicable)

Corporations

- Articles of Incorporation
- By-Laws
- Stock Ownership Options
- Copy of Stock Certifications of Each Holder
- Copy of Voting Rights
- Record of First Organizational Meeting

Partnerships

- Partnership Agreement

Proprietorships

- IRS Employer ID Number
- WMATA Vendor ID#

Recertification Review

Once certified you will be required, every three years, to resubmit for our review an updated NOTARIZED WMATA DBE Affidavit form along with the latest income tax return and copies of any of the above cited documents that may have changed since your initial certification. This should include updated letters of certification from MDOT or SBA-8a if your initial WMATA Certification was based upon prior certification under either of these programs. (NOTICE: In-person interviews may be scheduled at WMATA facilities and scheduled or unscheduled visits to your place of business may be conducted at the direction of WMATA staff.)

AFFIDAVIT ENCLOSURE

NOTE: When completing Disclosure Affidavit, complete all information blocks. Type "N/A" if item does not apply to you or your firm.

23.22 (10/99)



WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
 600 Fifth Street, NW
 Washington, DC 20001
 (202) 962-1086
**DISADVANTAGED BUSINESS ENTERPRISE
 DISCLOSURE AFFIDAVIT**

<p>1. NAME AND ADDRESS: (Company Name, Street Address, City, State, Zip)</p> <p>TELEPHONE: ()</p>	<p>2. PRESUMPTIVE GROUP:</p> <p><input type="checkbox"/> Black American <input type="checkbox"/> Asian-Pacific American <input type="checkbox"/> Other</p> <p><input type="checkbox"/> Hispanic American <input type="checkbox"/> Subcontinent Asian American</p> <p><input type="checkbox"/> Native American <input type="checkbox"/> Women</p> <p>Nation of Family Origin (i.e., Mexico, Korea, Jamaica, Africa, India, etc.): ___</p> <p style="text-align: center;">FURTHER PROOF OF ETHNICITY MAY BE REQUIRED</p>																								
<p>3. CONTACT PERSON: (Name, Title, Telephone)</p>	<p>SEX: <input type="checkbox"/> Male <input type="checkbox"/> Female</p> <p><input type="checkbox"/> U.S. Citizen</p> <p><input type="checkbox"/> Permit Resident (attach copy)</p>																								
<p>4. NATURE OF FIRM'S BUSINESS:</p> <p>NAICS CODE:</p>	<p>6. ARE YOU AFFILIATED WITH ANY CONTRACTOR ORGANIZATIONS? <input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p style="text-align: center;">If so, please list which ones:</p>																								
<p>5. YEARS FIRM HAS BEEN IN BUSINESS:</p>	<p>7. HAS YOUR COMPANY EVER BEEN CERTIFIED AS A MINORITY DISADVANTAGED OR WOMEN-OWNED BUSINESS?</p> <p><input type="checkbox"/> YES WHAT AGENCY?</p> <p><input type="checkbox"/> NO</p>																								
<p>8. HAS YOUR BUSINESS EVER BEEN DENIED CERTIFICATION AS A MINORITY BUSINESS ENTERPRISE?</p> <p><input type="checkbox"/> YES <input type="checkbox"/> NO</p> <p>If yes, explain in REMARKS (#25 Page 3)</p>	<p>9a. NUMBER OF EMPLOYEES:</p> <p>FULL TIME _____</p> <p>PART TIME _____</p> <p>OTHER _____</p> <p>9b. GROSS RECEIPTS (Last 3 Years)</p> <p>YEAR _____ \$ _____</p> <p>YEAR _____ \$ _____</p> <p>YEAR _____ \$ _____</p>																								
<p>10. TYPE OF OWNERSHIP: (Check One)</p> <p><input type="checkbox"/> Sole Proprietorship</p> <p><input type="checkbox"/> Partnership</p> <p><input type="checkbox"/> Joint Venture</p> <p><input type="checkbox"/> Corporation</p> <p><input type="checkbox"/> Limited Liability Corp.</p> <p><input type="checkbox"/> Other _____</p>																									
<p>11. CURRENT BOARD OF DIRECTORS:</p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:30%;">NAME AND POSITION</th> <th style="width:10%;">GROUP</th> <th style="width:10%;">ETHNIC</th> <th style="width:10%;">SEX</th> <th style="width:15%;">DATE OF SERVICE WITH COMPANY</th> <th style="width:25%;">FULL ADDRESS (Number, Street, City, State, Zip)</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>		NAME AND POSITION	GROUP	ETHNIC	SEX	DATE OF SERVICE WITH COMPANY	FULL ADDRESS (Number, Street, City, State, Zip)																		
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<p>12. CURRENT COMPANY OFFICERS:</p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:30%;">NAME AND POSITION</th> <th style="width:10%;">GROUP</th> <th style="width:10%;">ETHNIC</th> <th style="width:10%;">SEX</th> <th style="width:15%;">DATE OF SERVICE WITH COMPANY</th> <th style="width:25%;">FULL ADDRESS (Number, Street, City, State, Zip)</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>		NAME AND POSITION	GROUP	ETHNIC	SEX	DATE OF SERVICE WITH COMPANY	FULL ADDRESS (Number, Street, City, State, Zip)																		
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M 23.06a (Rev 11/99)

**Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP**

**Contract No. FN5008
Date: December 3, 2004**

13. PRIOR BOARD OF DIRECTORS AND/OR COMPANY OFFICERS:

NAME AND POSITION	GROUP	ETHNIC SEX	DATE OF SERVICE WITH COMPANY	FULL ADDRESS (Number, Street, City, State, Zip)

14. CURRENT COMPANY OFFICERS:

NAME AND POSITION	GROUP	ETHNIC SEX	DATE OF OWNERSHIP	INTEREST OR SHARES OWNED (Class & Quantity)	VOTING PERCENTAGE

15. NUMBER OF SHARES AUTHORIZED, ISSUED & OUTSTANDING:

Preferred _____

Common _____

Other _____

16. INDICATE SOURCE(S) AND AMOUNT OF CAPITAL INVESTED IN COMPANY BY PERSONS AFFILIATED WITH THE ENTERPRISE:

Source	Amount

17. IDENTIFY YOUR BONDING COMPANY, BANK AND SOURCES OF LETTERS OF CREDIT:

Bonding Company	Bank	Letter of Credit

18. WHAT IS YOUR BONDING LIMIT?

\$ _____

19. WHO DETERMINES WHAT JOBS THE COMPANY WILL UNDERTAKE? (Name and Title)

20. WHO NEGOTIATES FOR SURETY BONDS AND SIGNS FOR INSURANCE AND PAYROLL?

Surety and/or Performance Bonds	Payroll	Insurance

21. WHO WILL BE RESPONSIBLE FOR ONSITE PROJECT SUPERVISION? (Name and Title)

22. LIST THE THREE LARGEST PROJECTS IN DOLLAR AMOUNTS COMPLETED BY YOUR COMPANY DURING THE LAST THREE YEARS; INDICATE Design-BuilderS OF THESE PROJECTS OR PROCUREMENTS:

PROJECT/PROCUREMENT	DOLLAR AMOUNT	DATE COMPLETED	Design-Builder





23. PRIOR AND CURRENT COMPANY CLIENTS: (Company Name, Street Address, City, State, Zip) (Attach if necessary)

24a. LIST MAJOR EQUIPMENT:
TYPE QUANTITY

24b. LIST ALL PRODUCTS AND/OR SERVICES RENDERED:
PRODUCTS OR SERVICES

25. REMARKS:

The undersigned swears that the foregoing statements are true and correct and include all material information necessary to identify and explain the operations of _____ (name of firm as well as the ownership thereof). Further, the undersigned agrees to provide through the Design-Builder, or if no prime directly to WMATA, current complete and accurate information regarding actual work performed on any project, the payment therefor, and any proposed changes of any of the foregoing arrangements and to permit the audit and examination of books, records and files of the named firm. Any material misrepresentation will be grounds for terminating any contract which may be awarded and for initiating action under Federal and State laws concerning false statements.

If, after filing this Affidavit and before the work of this firm is completed on any contract covered by this regulation, there is any significant change in the information submitted, you must inform WMATA of the change through the Design-Builder or, if no Design-Builder, inform WMATA directly.

It is recognized and acknowledged that the information provided hereinabove may be used by WMATA for the purpose of certifying the authenticity of the disadvantaged status of the applicant firm. Trade secrets, information privileged by law and confidential commercial, financial, geological or geophysical data furnished will be protected by WMATA.

Signature of Affiant Printed Name
Date: _____ State: _____ County: _____
On this _____ day of _____, 19____,
before me appeared _____
(Name)
to me personally known, who, being duly sworn, did execute the foregoing Affidavit, and did state that he
or she was properly authorized by _____
(Name of Firm)
to execute the Affidavit and did so as his or her free act and deed.
Sworn and subscribed before me _____ (Seal)
(Notary Public)
Commission Expires: _____

3 of 3



23.06c (Rev 10/99)

DBE MANUFACTURER'S AFFIDAVIT

I hereby declare and affirm that I am _____ (Title)
and duly authorized representative of _____ (Name of Company),
a _____ owned and controlled enterprise
whose address is _____

I further declare and affirm that company employees (persons not on the payroll of and/or performing the same tasks for disadvantaged owned business having any interest in the affiant's business) operate the following company equipment relative to the manufacturing process:

Equipment				
Type	Function	Model	Age	Make

Number of employees involved in the manufacturing process: _____

The undersigned swears that the foregoing statements are true and correct and fully understands that WMATA may rely on these statements in determining whether a WMATA Design-Builder purchasing goods from the undersigned's manufacturing concern is entitled to a 100% credit of such purchases towards its DBE goal. The undersigned further understands that any material misrepresentation will be grounds for initiating action under Federal or state laws concerning false statements.

Signature of Affiant Printed Name

Date: _____ State: _____ County: _____

On this _____ day of _____, 19 _____,

before me appeared _____
(Name)

to me personally known, who, being duly sworn, did execute the foregoing Affidavit, and did state that he or she was properly authorized by _____
(Name of Firm)

to execute the Affidavit and did so as his or her free act and deed.

(Seal) Sworn and subscribed before me _____
(Notary Public)

Commission Expires: _____

23.29 (10/99)



Washington Metropolitan Area Transit Authority **Contract No. FN5008**
Design-Build Contract RFP-FN5008/FMP **Date: December 3, 2004**

**DISADVANTAGED BUSINESS ENTERPRISE (DBE)
 WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
 PROMPT PAYMENT REPORT
 DESIGN-BUILDER'S REPORT**

This Report is required to be submitted through the Authority Representative to the Authority's Office of Civil Rights, DBE Branch pursuant to requirements of WMATA's DBE Program plan \$2.5 and \$26.29 of 49 CFR Part 26.

Contract No.: _____
 Name of Design-Builder: _____
 Project Name: _____

Name of Subcontractor	DBE (Y/N)	Type of Work	Date Work Accepted	Work Hours	Agreed Upon Price	Amount Paid	Date of Payment

Name and Title _____ Signature _____ Date _____



Washington Metropolitan Area Transit Authority **Contract No. FN5008**
Design-Build Contract RFP-FN5008/FMP **Date: December 3, 2004**

**DISADVANTAGED BUSINESS ENTERPRISE (DBE)
 WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
 PROMPT PAYMENT REPORT
 SUBCONTRACTOR'S REPORT**

This Report is required to be submitted through the Authority Representative to the Authority's Office of Civil Rights, DBE Branch pursuant to requirements of WMATA's DBE Program plan §2.5 and §26.29 of 49 CFR Part 26.

Name of Design-Builder: _____ Contract No.: _____

Project Name: _____

Name of DBE Sub-Contractor: _____

- (Check One)
 Regular Pay
 Return of Retainer

Name of Non-DBE Sub-Contractor: _____

Type of Work	Date Work Accepted	Work Hours	Agreed Upon Price	Amount Received	Date of Payment

Name and Title: _____ Signature: _____ Date: _____



Information For Determining Joint Venture Eligibility

Page 1

.....
Name and address of Joint Venture: _____

Contact Person: _____ Telephone: _____

Have you attached a copy of the Joint Venture agreement? Yes No

NOTE: Affidavit will not be processed without a copy of the Joint Venture agreement.
.....

Name and address of Joint Venture partner: _____

Contact Person: _____ Telephone: _____

Status of firm: DBE. Non-Minority.

Does firm have current WMATA DBE certification? Yes No
.....

Name and address of Joint Venture partner: _____

Contact Person: _____ Telephone: _____

Status of firm: DBE. Non-Minority.

Does firm have current WMATA DBE certification? Yes No
.....

Describe the nature of the Joint Venture business:

Describe the role in the Joint Venture of each partner listed above:

Describe the experience and business qualifications of each partner in the Joint Venture listed above:
.....

23.29 (10/99)



Information For Determining Joint Venture Eligibility

Page 2

Indicate the percentage of ownership in the Joint Venture for each Joint Venture partner, indicating dollar amounts wherever applicable.

Name of Partner	Percentage of Ownership	Profit and Loss Sharing	Capital Contributions including Equipment	Other Agreements
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

TOTALS:

Identify by name, title, race, sex and company affiliation those individuals responsible for the management control of and participation in this contract:

1. Financial decisions, such as payroll, insurance, surety and/or bonding requirements:

Name: _____ Race: _____

Title: _____ Sex: Male Female

Company affiliation: _____

2. Management decisions, such as estimating, marketing and sales, hiring and firing, purchasing supplies:

Name: _____ Race: _____

Title: _____ Sex: Male Female

Company affiliation: _____

3. Supervision of field operations:

Name: _____ Race: _____

Title: _____ Sex: Male Female

Company affiliation: _____

M 23.06c (Rev 10/99)



Information For Determining Joint Venture Eligibility

Page 3

.....
The undersigned swear that the foregoing statements are correct and include all material information necessary to identify and explain the terms and operations of our following named Joint Venture:

.....
and the intended participation by each Joint Venturer in the undertaking. Further the undersigned covenant and agree to provide the Authority current, complete and accurate information regarding actual Joint Venture work and the payment thereof and any proposed changes in any of the Joint Venture arrangements and to permit the audit and examination of the books, records and files of the Joint Venture, or those of each Joint Venturer relevant to the Joint Venture, by authorized representatives of the Authority or the Federal funding agency. Any material misrepresentation will be grounds for terminating any contract which may be awarded and for initiating action under Federal and State laws concerning false statements.

It is recognized and acknowledged that the Authority's DBE Program shall have access to the information provided herein above for the purpose of establishing eligibility and authenticity of the minority status of the Joint Venture.

It is understood that trade secrets and information privileged by law, as well as commercial, financial, geological and geophysical data furnished will be protected.

_____ (NAME OF FIRM)	_____ (NAME OF SECOND FIRM)
_____ (SIGNATURE OF AFFIANT)	_____ (SIGNATURE OF AFFIANT)
_____ (PRINT NAME)	_____ (PRINT NAME)
_____ (TITLE)	_____ (TITLE)
_____ (DATE)	_____ (DATE)

.....
23.29 (10/99)



Information For Determining Joint Venture Eligibility

Page 4

.....
Date: _____ State: _____ County: _____

On this _____ day of _____, 20____,

before me appeared _____
(Name)

to me personally known, who, being duly sworn, did execute the foregoing Affidavit, and did state that he or she was properly authorized by _____
(Name of Firm)

to execute the Affidavit and did so as his or her free act and deed.

(Seal) Sworn and subscribed before me _____
(Notary Public)

Commission Expires: _____

.....
Date: _____ State: _____ County: _____

On this _____ day of _____, 19____,

before me appeared _____
(Name)

to me personally known, who, being duly sworn, did execute the foregoing Affidavit, and did state that he or she was properly authorized by _____
(Name of Firm)

to execute the Affidavit and did so as his or her free act and deed.

(Seal) Sworn and subscribed before me _____
(Notary Public)

Commission Expires: _____

.....

M 23.06c (Rev 10/99)



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00490 PROPOSING ADDENDA

This Section provides an area for conforming the Project Manual with the Technical and Price Proposals as finally accepted.

00491 TECHNICAL PROPOSAL AS FINALLY ACCEPTED

- A. Instructions: Insert here the Technical Proposal as finally accepted.
- B. See Section 00910, ADDENDA for Amendment Letters.



THIS PAGE NOT USED

00492 PRICE PROPOSAL AS NEGOTIATED AND ACCEPTED

- A. Instructions: Insert here the Price Proposal as Negotiated and Accepted.
- B. See Section 00910 ADDENDA for Amendment Letters.

END OF SECTION



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CONTRACTING REQUIREMENTS

00500 CONTRACTING FORMS AND SUPPLEMENTS

This Section includes Contract Forms and Attachments to be executed and submitted by the successful proposer.

00510 NOTICE OF AWARD

This Section provides an area for conforming Award of Contract Letter issued by the Authority.

00511 AGREEMENT FORMS

Instructions: Insert here all award documents issued to conform the Project Manual.



THIS PAGE NOT USED

00520 AGREEMENT FORM

This Section includes the Contract Form to be executed and submitted by the successful proposer and represents the legal instrument binding the two parties to the work once the document is signed by the Authority and the Design-Builder. PROPOSER'S INFORMATION NOTICE: The following form is included for the proposer's information and use in the event he is awarded the Contract. It is not required to be submitted with the proposal.

00521 DESIGN-BUILD CONTRACT FORM

DESIGN/BUILDER:

CONTRACT NUMBER: FN5008

Date:

CONTRACT FOR: RAIL YARDS EXPANSION PROJECT AT GREENBELT AND SHADY GROVE YARDS

CONTRACT TYPE: FIXED-PRICE CONSTRUCTION

CONTRACT PRICE: \$ 79,000,000.00

CONTRACT PERFORMANCE TIME: _____calendar days

In consideration of the covenants contained herein, the Washington Metropolitan Area Transit Authority (hereinafter called the Authority), represented by the Contracting Officer executing this Contract, and the individual, partnership, joint venture or corporation named above (hereinafter, the Design-Builder), mutually agree to perform this Contract in strict accordance with its provisions. The Contract consists of: this RFP and its amendments, if any; all documents referenced or attached to the RFP including the following:

1. Project Manual as defined in the General Conditions including the Project Drawings and other attachments to the Project Manual.
2. Design-Builder's Proposals as finally accepted.
3. Other publications referenced in the Contract Documents.
4. Amendment Number(s): _____



ALTERATIONS: The following alterations were made to this Contract before it was signed by the parties hereto:

In Witness Whereof, the parties hereto have executed this Contract as of the date entered above.

Design-Builder

ATTEST: _____

*By: _____

Design-Builder

ATTEST: _____

*By: _____

Design-Builder

ATTEST: _____

*By: _____

**WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY**

By: _____
Washington Metropolitan Area Transit Authority

***NOTE:** Execution for the Design-Builder that is an individual, corporation or partnership shall be accompanied by the Power of Execution that follows. A Joint Venture Design-Builder must complete the Power of Attorney that follows. All persons executing this Contract must complete the appropriate Certification of the person's authority to act on behalf of the Design-Builder.

00520 AGREEMENT FORM

This Section includes the Contract Form to be executed and submitted by the successful proposer and represents the legal instrument binding the two parties to the work once the document is signed by the Authority and the Design-Builder. PROPOSER'S INFORMATION NOTICE: The following form is included for the proposer's information and use in the event he is awarded the Contract. It is not required to be submitted with the proposal.

00521 DESIGN-BUILD CONTRACT FORM

DESIGN/BUILDER:

CONTRACT NUMBER:

Date:

CONTRACT FOR: RAIL YARDS EXPANSION PROJECT AT BRENTWOOD YARD

CONTRACT TYPE: FIXED-PRICE CONSTRUCTION

CONTRACT PRICE: \$ 41,000,000.00

CONTRACT PERFORMANCE TIME: _____ calendar days

In consideration of the covenants contained herein, the Washington Metropolitan Area Transit Authority (hereinafter called the Authority), represented by the Contracting Officer executing this Contract, and the individual, partnership, joint venture or corporation named above (hereinafter, the Design-Builder), mutually agree to perform this Contract in strict accordance with its provisions. The Contract consists of: this RFP and its amendments, if any; all documents referenced or attached to the RFP including the following:

1. Project Manual as defined in the General Conditions including the Project Drawings and other attachments to the Project Manual.
2. Design-Builder's Proposals as finally accepted.
3. Other publications referenced in the Contract Documents.
4. Amendment Number(s): _____

Design-Build Agreement
Page 1 of 2



ALTERATIONS: The following alterations were made to this Contract before it was signed by the parties hereto:

In Witness Whereof, the parties hereto have executed this Contract as of the date entered above.

Design-Builder

ATTEST: _____ *By: _____

Design-Builder

ATTEST: _____ *By: _____

Design-Builder

ATTEST: _____ *By: _____

**WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY**

By: _____
Washington Metropolitan Area Transit Authority

***NOTE:** Execution for the Design-Builder that is an individual, corporation or partnership shall be accompanied by the Power of Execution that follows. A Joint Venture Design-Builder must complete the Power of Attorney that follows. All persons executing this Contract must complete the appropriate Certification of the person's authority to act on behalf of the Design-Builder.

00540 AGREEMENT FORM SUPPLEMENTS

The following attachments to supplement the Agreement Form are included for the proposer's use.

00541 POWER OF ATTORNEY

POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS,
That _____

constituting all of the venturers of the joint venture known as _____

which is desirous of entering into a contract with the Washington Metropolitan Area Transit Authority, do hereby designate and appoint _____

one of the venturers hereinafter called the "Managing Sponsor", as their true and lawful attorney with the power, on their behalf and in the name and on behalf of the joint venture, to represent and bind the undersigned and the joint venture in all matters in connection with Contract _____, to make, execute, seal and deliver on behalf of the joint venture and as its act and deed, any and all contracts, change orders, monthly and final payment certificates and other like instruments. The undersigned specifically acknowledge and agree that the execution of such proposal or contract by the Managing Sponsor shall constitute the agreement of each venturer to be jointly and severally liable for any and all of the duties and obligations of the joint venture arising from such proposal or contract.

IN WITNESS WHEREOF, the undersigned have executed this Power of Attorney this _____ day of _____, 20____.

Design-Builder

ATTEST: _____ By _____

Design-Builder

ATTEST: _____ By _____

Design-Builder

ATTEST: _____ By _____

Power of Attorney
Page 1 of 1



THIS PAGE NOT USED

00542 POWER OF EXECUTION

POWER OF EXECUTION

The undersigned, a _____ under
corporation, partnership, individual
the laws of the State of _____, having principal office
or registered agent at _____
hereby nominates, constitutes and appoints _____
_____ with full power to act _____
alone or in conjunction with
_____, on behalf of _____
another person name of company

to make, execute, seal and deliver on its behalf as Design-Builder and as its act and deed, any and all contracts, change orders, monthly and final payment certificates and other like instruments.

Such contracts, change orders, monthly and final payment certificates and other like instruments shall be binding upon said company as fully and to all intents and purposes as if such instruments had been duly executed and acknowledged and delivered by the authorized officers of the company when duly executed, as indicated above, by either one of the aforementioned persons.

Design-Builder
By: _____
Signature

Address

ATTEST: _____
Date

Attachment to Contract _____

Complete certification on reverse.



CERTIFICATION

PARTNERSHIP POWER OF EXECUTION

I, _____, certify that I am a Partner of the firm named as Contractor herein; that _____ who signed this Statement on behalf of the Contractor was then a Partner of said partnership; that said Statement was duly signed for and on behalf of said partnership by authority of its partners and is within the scope of their powers.

Date Executed _____

By _____

CORPORATE POWER OF EXECUTION

I, _____, certify that I am an _____ of _____, that _____, who signed this Statement on behalf of said corporation was then an officer of said Corporation; that said Statement was duly signed for and on behalf of said Corporation.

Date Executed _____

By _____

00550 NOTICE TO PROCEED

This Section provides an area for conforming Notice To Proceed Letter issued by the Authority.

00551 NTP LETTER

Instructions: Insert here Notice To Proceed letters issued to conform the Project Manual.

END OF SECTION



THIS PAGE NOT USED

CONTRACTING REQUIREMENTS

00600 PROJECT FORMS

This Section includes documents that are to be submitted relating to the Contracting Requirements.

00610 BOND FORMS

This Section includes bond forms required to be submitted by the Design-Builder.

00611 BOND REQUIREMENTS

- A. Requirements: If the Contract price is \$100,000 or more, the Design-Builder shall submitted to the Contracting Officer within 10 calendar days after the date of Contract Award performance and payment bonds each with good and sufficient surety or sureties acceptable to the Authority. Corporations executing the bonds as sureties must be among those appearing on the Treasury Department's list of approved sureties and must be acting within the limitations set forth therein. The bonds should be submitted with the other contractual forms required in Section 00500. The penal sums of such bonds shall be as follows for each Project:
1. Performance Bond:
 - a. The penal sum of the performance bond shall equal 100 percent of the Contract price.
 2. Payment Bond:
 - a. The penal sum of the payment bond shall be \$2,500,000.
- B. Failure to furnish: In the event the required bonds are not furnished as specified, the Contracting Officer may issue the Notice To Proceed, however, no work will be permitted on site and no payment will be made to the Design-Builder until the required bonds are furnished.
- C. The Authority may consider alternate methods of providing adequate security for contract performance and payment at its discretion.



THIS PAGE NOT USED

00612 PERFORMANCE BOND

PROPOSER'S INFORMATION NOTICE: The following is included for the proposer's information and use in the event he is awarded the Contract. It is not required to be submitted with the proposal.

Contract No.:

Contract Date:

Penal Sum of Bond:

Date Bond Executed:

KNOW ALL MEN BY THESE PRESENTS, that we, the Principal and Surety(ies) hereto, are firmly bound to the Washington Metropolitan Area Transit Authority (hereinafter called the Authority) in the above penal sum for the payment of which we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally: Provided, that, where the Sureties are corporations acting as co-sureties, we, the Sureties, bind ourselves in such sum "jointly and severally" as well as "severally" only for the purpose of allowing a joint action or actions against any or all of us, and for all other purposes each Surety binds itself, jointly and severally with the Principal, for the payment of such sum only as set forth opposite the name of such Surety, but if no limit of liability is indicated, the limit of liability shall be the full amount of the penal sum.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal entered into the contract identified above:

NOW, THEREFORE, if the Principal shall perform and fulfill all the undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the Authority, with or without notice to the Surety(ies), and during the life of any guaranty required under the contract, and shall also perform and fulfill all the undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the Surety(ies) being hereby waived, then the above obligation shall be void and of no effect. Surety acknowledges Authority can advance the date of payments to Contractor, and by so doing the Surety remains liable under the terms of the bond.

IN WITNESS WHEREOF, the Principal and Surety(ies) have executed this performance bond and have affixed their seals on the date set forth above.

Principal(s)

1.	Firm Name and Address: Signature: _____ Name and Title: _____	Corporate Seal
	State of Inc.:	
2.	Firm Name and Address: Signature: _____ Name and Title: _____	Corporate Seal:
	State of Inc.:	
3.	Firm Name and Address: Signature: _____ Name and Title: _____	Corporate Seal:
	State of Inc.:	



Corporate Surety(ies)

Surety A	Surety Name & Address Signature: _____ Name & Title: _____ State of Inc.:	Liability Limit \$	(Seal)
Surety B	Surety Name & Address Signature: _____ Name & Title: _____ State of Inc.:	Liability Limit \$	(Seal)
Surety C	Surety Name & Address Signature: _____ Name & Title: _____ State of Inc.:	Liability Limit \$	(Seal)

Attach additional pages as needed.

Bond Premium Schedule	Total Premium	\$
-----------------------------	---------------	----

Performance Bond Instructions:

1. This form is authorized for use in connection with contracts for design and construction work or the furnishing of labor, materials, equipment, supplies and services.
2. The full legal name and business address of the Principal shall be inserted in the space designated "Principal" on the face of this form. The bond shall be signed by an authorized person. Where such person is signing in a representative capacity (e.g., an attorney-in-fact), but is not a member of the firm, partnership or joint venture, or an officer of the corporation involved, evidence of his authority must be furnished.
3. Corporation executing the bond as sureties must be among those appearing on the Treasury Department's therein. Where more than a single corporate surety is involved, their names and addresses (city and State) shall be inserted in the spaces (Surety A, Surety B, etc.) headed "Corporate Surety(ies)".
4. Corporations executing the bond shall affix their corporate seals.
5. The name of each person signing this performance bond should be typed in the space provided.
6. The date this Bond is executed must be later than the contract execution date.

00613 PAYMENT BOND

Contract No.

Contract Date:

Penal Sum of Bond:

Date Bond Executed:

KNOW ALL MEN BY THESE PRESENTS, that we, the Principal and Surety(ies) hereto, are firmly bound to the Washington Metropolitan Area Transit Authority (hereinafter called the Authority) in the above penal sum for the payment of which we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally: Provided, that, where the Sureties are corporations acting as co-sureties, we, the Sureties, bind ourselves in such sum "jointly and severally" as well as "severally" only for the purpose of allowing a joint action or actions against any or all of us, and for all other purposes each Surety binds itself, jointly and severally with the Principal, for the payment of such sum only as set forth opposite the name of such Surety, but if no limit of liability is indicated, the limit of liability shall be the full amount of the penal sum.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal entered into the contract identified above:

NOW, THEREFORE, if the Principal shall promptly make payment to all claimants as hereinafter defined supplying services, labor material and/or equipment in the prosecution of the Work provided for in said contract, and any and all duly authorized modifications of said Contract that may hereafter be made, notice of which modifications to the Surety(ies) being hereby waived, then the above obligation shall be void and of no effect, otherwise it shall remain in full force and effect, subject, however, to the following conditions:

1. A claimant is defined as one having a direct contract with the Principal or with a subcontractor of the Principal for labor, material, or both, used or reasonably required for use in the performance of the contract, labor and material being construed to include that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental of equipment directly applicable to the Contract.
2. The above-named Principal and Surety hereby jointly and severally agree with the Owner that every claimant as herein defined, who has not been paid in full before the expiration of a period of ninety (90) days after the date on which the last of such claimant's work or labor was done or performed, or materials were furnished by such claimant, may sue on this bond for the use of such claimant, prosecute the suit to final judgment for such sum or sums as may be justly due the claimant, and have execution thereon. The Owner shall not be liable for the payment of any costs or expenses of any such suit.
3. No suit or action shall be commenced hereunder by any claimant:
 - a. Unless claimant, other than one having a direct contract with the Principal, shall have given written notice to the Principal within ninety (90) days after such claimant did or performed the last of the work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail, postage prepaid, in an envelope addressed to the Principal at any place where he maintains an office or conducts business, or his residence or such notice shall be served in any manner in which legal process may be served in the state or District of Columbia in which the aforesaid project is located, save that such service need not be made by a public officer.
 - b. After the expiration of one (1) year following the date of final settlement of said CONTRACT, it being understood, however, that if any limitation embodied in this bond is prohibited by any law controlling the construction hereof, such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.
 - c. Other than in a state court of competent jurisdiction in and for the county or other political subdivision of the state in which the project, or any part thereof, is situated or in the United States District Court for the district in which the project, or any part thereof, is situated, and not elsewhere.

Payment Bond
Page 1 of 2



IN WITNESS WHEREOF, the Principal and Surety(ies) have executed this payment bond and have affixed their seals on the date set forth above.

Principal(s)

1. Firm Name and Address: _____ Corporate Seal
 Signature: _____
 Name and Title: _____ State of Inc.: _____

2. Firm Name and Address: _____ Corporate Seal
 Signature: _____
 Name and Title: _____ State of Inc.: _____

3. Firm Name and Address: _____ Corporate Seal
 Signature: _____
 Name and Title: _____ State of Inc.: _____

Corporate Surety(ies)

Surety A	Surety Name & Address Signature: _____ Name & Title: _____ State of Inc.:	Liability Limit \$	(Seal)
Surety B	Surety Name & Address Signature: _____ Name & Title: _____ State of Inc.:	Liability Limit \$	(Seal)
Surety C	Surety Name & Address Signature: _____ Name & Title: _____ State of Inc.:	Liability Limit \$	(Seal)

Attach additional pages as needed.

Instructions

1. This form is authorized for use in connection with contracts for design work, construction work or the furnishing of labor, materials, equipment, supplies and services.
2. The full legal name and business address of the Principal shall be inserted in the space designated "Principal" on the face of this form. The bond shall be signed by an authorized person. Where such person is signing in a representative capacity (e.g., an attorney-in-fact), but is not a member of the firm, partnership or joint venture, or an officer of the corporation involved, evidence of his authority must be furnished.
3. Corporation executing the bond as sureties must be among those appearing on the Treasury Department's list of approved sureties and must be acting within the limitations set forth therein. Where more than a single corporate surety is involved, their names and addresses (city and State) shall be inserted in the spaces (Surety A, Surety B, etc.) headed "Corporate Surety(ies)".
4. Corporations executing the bond shall affix their corporate seals.
5. The name of each person signing this performance bond should be typed in the space provided.
6. The date this bond is executed must be later than the contract execution date.

00614 PERFORMANCE AND PAYMENT BONDS (Additional Bond Security)

- A. If any surety upon any performance bond furnished in connection with this Contract becomes unacceptable to the Contracting Officer, or if any such surety fails to furnish reports as to its financial condition from time to time as requested by the Contracting Officer, the Design-Builder shall promptly furnish such additional security as may be required from time to time to protect the interest of the Authority and of persons supplying labor or materials in the prosecution of the work contemplated by this Contract.
- B. If any surety upon any payment bond furnished in connection with this Contract becomes unacceptable to the Contracting Officer, or if any such surety fails to furnish reports as to its financial condition from time to time as requested by the Contracting Officer, the Design-Builder shall promptly furnish such additional security as may be required from time to time to protect the interest of the Authority and of persons supplying labor or materials in the prosecution of the work contemplated by this Contract.

00620 CERTIFICATES AND OTHER FORMS

This Section provides an area for conforming the Project Manual with required Affidavits and Certificates provided by the Design-Builder; i.e., Certificates of Acceptance, Application for Payment, Insurance, Compliance including ADAAG Design and Construction Compliance and Checklists, Substantial Completion, Final Performance and Completion, and Final Settlement.

00621 CERTS

Instructions: Insert here all required Certs to conform the Project Manual.

END OF SECTION



THIS PAGE NOT USED

CONTRACTING REQUIREMENTS

00700 CONDITIONS OF THE CONTRACT



THIS PAGE NOT USED

CONTRACTING REQUIREMENTS

00700 GENERAL CONDITIONS (10/28/04)

PHASE II - NOTE: The asterisks (*) at the beginning of the clause number references represent clauses mandated by the Federal Transit Administration (FTA), WMATA's funding agency, and will be incorporated into this Design-Build contract. The provisions without asterisks are negotiable and may be negotiated by either party prior to contract award.

This Section includes a compilation of contractual and legal requirements that list the rights, responsibilities and relationships of the parties to a contract and defines duties and limits of authority for design professionals and construction management in performance of contract administration. This Section 00700 shall be read in conjunction with Section 00800, Supplementary Conditions, which specifies any modifications to these General Conditions, and which will be cited in the 00800 Section using the same last 2 digits of the Section number; i.e., a mod to Section 00724 will be indicated as Section 00824.

*00701 CONTRACTING DEFINITIONS (10/25/04)

- A. As used throughout the Contract Documents the following terms shall have the meanings set forth below:
1. Agreement: The term Agreement means the Authority form titled "Design-Build Contract Form" or "Solicitation, Offer and Award" or other suitable Authority form contained in this RFP, that, upon execution by the Design-Builder and the Authority, creates the Contract between the two parties for the services specified in this Project Manual, and as graphically described in the attachments to the Project Manual.
 2. Amendment and Modifications: Written or graphic instructions issued to clarify, revise, add, or delete Contract requirements that are issued either before or after the execution of the Agreement:
 - a. Amendment: A document which is added to the original Contract Documents during the proposing period.
 - b. Contract Modification: A document which is added to the Contract Documents after the execution of the Agreement.
 3. Approval: Approval of a submittal or any other item shall be solely for the purpose of establishing conformance to the Documents as described in Section 00719, AUTHORITY REVIEWS, Section 00720, SUBMITTALS Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES AND Section 01780, CLOSEOUT SUBMITTALS. Where the specifications require approval

by the Authority, the Design-Builder shall obtain such approval before proceeding with the affected work. Where specifications call for submittals to be made to the Authority but do not state a requirement for Authority approval, the Authority may disapprove such submittals, but it shall not be required to respond to or to approve such submittals.

4. Approved, acceptable, satisfactory or words of like import: Approved by, acceptable to or satisfactory to the Contracting Officer or the Authority Representative or his designated representative, unless otherwise expressly stated.
5. As-built Contract Drawings (Design-Builder Provided): The term As-built Contract Drawings prepared by or through the Design-Builder reflect all known changes from the approved Final Design Drawings, including as applicable As-built Standard Drawings and As-built Information Drawings; and also include As-Built Shop, Working, and Manufacturers' Shop Drawings and Field Installation Details as specified in Section 01780, CLOSEOUT SUBMITTALS.
6. As-Built Specifications (Design-Builder Provided): The term As-Built Specifications means those specifications prepared by or through the Design-Builder in CSI format consisting of written technical descriptions of materials, equipment, construction systems, standards, and workmanship that were actually applied in construction of the Project and annotated to show revisions from the Final Design Specifications as specified in Section 01780, CLOSEOUT SUBMITTALS.
7. As shown, as indicated, as detailed or words of similar import: It shall be understood that the reference is made to the Project Drawings accompanying this Project Manual unless stated otherwise. The word provided as used herein shall be understood to mean provided complete in place, that is furnished and installed.
8. As specified, as described, or words of similar import: It shall be understood that the reference is made to this Project Manual unless stated otherwise.
9. Authority: The term Authority means the Washington Metropolitan Area Transit Authority, created effective February 20, 1967, by Interstate Compact by and between Maryland, Virginia and the District of Columbia, pursuant to Public Law 89-774, approved November 6, 1966.
10. Authority Representative: The Authority Representative is the person responsible for post award execution of an Authority contract in the most effective, economical, and timely manner. The Authority Representative is the Authority's primary point of contact with its Design-Builder. In addition, the Authority Representative is delegated authority to modify this Contract under the Changes clause, within specified dollar limits. The Authority may delegate contracting

officer authority to other project personnel. The Authority Representative may, at his or her discretion, delegate project management responsibilities to a Project Representative. Unless the Design-Builder is directed to the contrary, all correspondence with respect to this Contract shall be sent to the Authority Representative.

11. **Basis of Design:** The Design-Builder shall utilize for the design of any project and for the preparation of the Final Design Specifications and Final Design Drawings, the WMATA Design Criteria consisting of the Program Criteria in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA; the Standard and Technical Specifications in Divisions 2 through 16; and the Project Description, Standard and Design Directive Drawings as applicable in the Project Drawings Attachment to the Project Manual as a minimum. (10/24/03)
12. **Board of Directors:** The term Board of Directors means the Board of Directors of the Washington Metropolitan Area Transit Authority.
13. **Builder:** The term Builder refers to all members in the Design-Build team that take part in the manufacture, fabrication, installation, and construction of the Project. For more detail on the Builder's role and responsibility, refer to Section 01111, KEY DESIGN-BUILDER FUNCTIONS.
14. **Claim:** The term Claim means a written demand or assertion by one of the parties seeking, as a legal right, the payment of money, adjustment or interpretation of Contract terms, or other relief, arising under or relating to this Contract.
15. **Contract:** The term Contract means the written Agreement between the Authority and the Design-Builder covering the Work as set forth in all the Contract Documents.
16. **Contract Documents:** The term Contract Documents means all documents included in the Contract as defined above. The Contract Documents consist of: This Project Manual and the Project Drawings and all documents referenced herein or appended hereto; all addenda or modifications issued before, on, or after the effective date of the Contract; the Notice to Proceed; and the Design-Builder's Price and Technical Proposals, as finally accepted.
17. **Contract Record Drawings (Design-Builder Provided):** The term Contract Record Drawings means those final as-built drawings prepared by or through the Design-Builder consisting of all the tangible, graphic manifestations of the technical descriptions of materials, equipment, construction systems, standards, and workmanship that were actually applied in construction of the Project including the As-built Final Design Drawings, Shop Drawings, Working Drawings, Standard Drawings, Record Drawings for Authority-Provided Information Drawings, Manufacturers' Shop Drawings, Field Drawings, and installation details as



specified in Section 01780, CLOSEOUT SUBMITTALS.

18. **Contracting Officer:** A Contracting Officer is an employee within the Authority's Office of Procurement and Materiel with authority duly delegated from the powers of the General Manager and CEO to legally bind the Authority by signing a contractual instrument. The Office of Procurement and Materiel has been delegated broad authority regarding acquisition functions, independent from the project office. Contracting Officers have the authority to make related determinations and findings, and take other significant actions normally reserved for the Office of Procurement and Materiel including, but not limited to: awards, modifications above the Authority Representative's level of authority, final payments, suspensions, terminations, debarments, assessment of liquidated damages, and issuances of final decisions under Section 00732, DISPUTE RESOLUTION. The term includes certain other representatives of the Authority acting within delegated limits of authority. In general, the Authority's primary point of contact for pre-award administration and fiscal closeout resides with the Contracting Officer, and the primary point of contact for the post-award contract administration is the Authority Representative.
19. **Contracting Requirements:** Documents related to the Contracting Requirements including Contract Forms and Attachments to be submitted by the successful proposer which includes Agreement and Bonds and Certificates.
20. **Contractor:** The term Contractor means the Design-Builder that contracts with the Authority to furnish design and construction (design-build) services for the Project. The term Contractor is synonymous with Design-Builder.
21. **Day:** The term day shall mean calendar day except where the term working day or like term is used.
22. **Design-Builder:** The term Design-Builder means the individual, partnership, firm, corporation, or other business entity that is contractually obligated to the Authority to furnish, through itself or others, the design and construction (design-build) services described in the Contract, including all incidentals which are necessary to complete the Work in accordance with the Contract. The term Design-Builder is synonymous with Contractor. For more detail on the Design-Builder's role and responsibilities, refer to Section 01111, KEY DESIGN-BUILDER FUNCTIONS.
23. **Design Professional:** The term Design Professional or Designer means the individual(s), partnership(s), firm(s), corporation(s) or other business entity(s) that is either the Design-Builder, or employed or retained by the Design-Builder, to manage and perform the design services for the Project. For more detail on the Design Professional's role and responsibility, refer to Section 01111, KEY DESIGN-BUILDER FUNCTIONS.
24. **Directed, required, ordered, designated, prescribed or words of like import:** It

shall be understood that the direction, requirement, order, designation or prescription of the Contracting Officer or his designated representative is intended, unless otherwise expressly stated.

25. Engineer: The term Engineer is used in numerous locations in the specifications. The term Engineer is synonymous with the term Resident Engineer, Project Representative, or if no individual has been so designated, the Authority Representative.
26. Acceptance means that all Work has been substantially completed, has been inspected by the Authority for contract compliance, and is ready for beneficial use of the Authority with only punchlist and administrative items remaining for completion.
27. Final Completion means that all design and construction have been completed; all punch list items completed; all Contract Record Drawings, manuals and other close-out submittals including spare parts completed; all turned over to the Authority; and all parts of the Work are accepted by the Authority.
28. Final Design Drawings (Design-Builder Provided): The term Final Design Drawings means those drawings prepared by or through the Design-Builder and approved for construction by the Authority consisting of the tangible, graphic manifestations of the technical descriptions of materials, equipment, construction systems, standards, and workmanship as applied to the construction of the Project.
29. Final Design Specifications (Design-Builder Provided): The term Final Design Specifications means those specifications prepared by or through the Design-Builder and approved for construction by the Authority consisting of written technical descriptions of materials, equipment, construction systems, standards, and workmanship as applied to the construction of the Project as well as administrative details related thereto.
30. General Conditions are those contract conditions that are applicable to all Authority construction contracts and mandated by the Authority's funding agency, Federal Transit Administration (FTA) and are not specifically tailored to the requirement.
31. Geotechnical information, logs and borings, water-level readings of existing observation wells, data and drawings of the jurisdictional highway and traffic department, plats of sidewalk vaults, existing building and utility plans and cross sections, street widths and traffic counts, building codes and design standards, environmental information, survey data and existing site conditions as applicable are provided as a part of the Information Documents and have been included for information only as an aid for the proposers' preparation of their proposals. The Geotechnical Information document provided in Section 00321,



GEOTECHNICAL INFORMATION and the environmental information provided in Section 00341, ENVIRONMENTAL REPORT as applicable describes the geologic and environmental conditions anticipated during the work of this Contract and the influence such anticipated geologic and environmental conditions have had upon the preliminary design. The Design-Builder shall conduct its own additional detailed geotechnical and environmental investigations as necessary as a basis for its final design. The survey and site information as applicable is not guaranteed to be complete and the proposers are encouraged to attend the scheduled site visit as specified in Section 00252, SITE INSPECTION.

32. Including/Consisting of:
 - a. Including: Introduces a partial, representative listing of things or actions.
 - b. Consisting of: Introduces a complete listing of things or actions which constitute the whole.
33. Information Documents (Authority-Provided): The term Information Documents means those Contract Documents that are informational and recommended in nature, and which are provided to the Design-Builder for its information and use, but which the Design-Builder is not necessarily required to comply with. Information Documents are listed in Section 00300 of the Proposing Requirements.
34. Issued for Construction: The term Issued for Construction refers to drawings, specifications and other documents that are approved to be issued by the Design-Builder's for the construction, fabrication, or other implementation of its design.
35. Jurisdictional Authorities: The term Jurisdictional Authorities refers to Federal, State and local authorities or agencies having jurisdiction over work to which reference is made.
36. Legal Requirements: The term Legal Requirements means all federal, state and local laws, ordinances, rules, orders, decrees, and regulatory requirements such as building codes, mechanical codes, electrical codes, fire codes, Americans with Disabilities Act Accessibility Guidelines (ADAAG) regulations and other regulations of any government or quasi-government entity that are applicable to the Project as specified in Section 01410, REGULATORY REQUIREMENTS, Section 01420, REFERENCES, Section 00708, RESPONSIBILITY OF THE DESIGN-BUILDER FOR DESIGN-RELATED SERVICES, AND Section 00707, PERMITS AND RESPONSIBILITIES.
37. Authority-Provided Documents: The term Authority-Provided Documents means the Requirements of the Project Manual and Attachments to the Project Manual which the Design-Builder must comply with, and are further described in Section

00300 of the PROPOSING REQUIREMENTS. The following are such Documents:

- a. Project Manual Division 00, Introductory Information, Requirements of the Proposing Requirements, and Contracting Requirements.
 - b. Project Manual Division 01, General Requirements.
 - c. WMATA Design Criteria: Project Manual Program Criteria in Division 01 above, Project Manual WMATA Standard Specifications and WMATA Technical Specifications - Divisions 2 through 16, and Drawings in the Project Drawings Attachments to the Project Manual (See Section 00302).
 - d. The appropriate WMATA Safety Manual, and associated insurance document if applicable, as specified in Section 00371, the Safety and Security Certification Program Plan as specified in Section 00381 and the System Safety Program Plan as specified in Section 00391 Attachments to the Project Manual; and also, the Safety Rules and Procedures Manual and the Metrorail Safety Rules and Procedures Handbook as applicable 12/24/03
 - e. All other documents incorporated by reference in the above.
38. Operations Readiness Date (ORD): Operations Readiness Date is the date upon which WMATA certifies that the system and equipment are complete and capable of supporting revenue rail service.
39. Project: The term Project means the design and construction (Design-Build) of the facility described in the Contract Documents. The Project also involves the integration of new systems into existing Authority systems as applicable.
40. Project Drawings (Authority-Provided):
- a. Project Drawings: The term Project Drawings means the plans, profiles, cross sections, elevations, schedules and details listed or referenced in the Project Manual and which are an Attachment to the Project Manual, and that show the locations, character, dimensions and details of the work to be performed and include the Project Description, Standard and Design Directive Drawings and the Information Drawings.
 - (1) Design Directive Drawings: The term Design Directive Drawings means those drawings that have been prepared by the Authority, and that have been prepared to serve as standard designs for WMATA projects that the Design-Builder shall utilize as applicable in the preparation of the Final Design Drawings.
 - (2) Project Description Drawings: The term Project Description Drawings

means those drawings that have been prepared by the Authority and that have been prepared specifically for this project. The Design-Builder shall utilize these in the preparation of the Final Design Drawings.

- (3) Standard Drawings: The term Standard Drawings means those drawings prepared by the Authority, and that have been prepared to serve as standard for all WMATA projects. The Design-Builder shall include the applicable Standard Drawings in the Final Design Drawings.
 - (4) Information Drawings: The term Information Drawings means those Recommended Layout and Detail Drawings and As-Built Drawings that have been reproduced from similar or previous Authority projects and that have been included for information only.
41. Project Manual (Authority-Provided): Compilation of the Contract Specifications including Introductory Information, Proposing Requirements, Contracting Requirements, General Requirements and the WMATA Standard Specifications and WMATA Technical Specifications as follows:
- a. Introductory Information: Documents related to the Introductory Information for proposers including Project Title Page, Certifications Page, Division 0 Table of Contents, and List of Project Drawings.
 - b. Proposing Requirements: Documents related to the Proposing Requirements including Project Information - Request for Proposal and Proposal Solicitation which includes a statement and scope of work and a solicitation schedule, Instructions to Proposers which includes the procedures with which proposers must comply and conditions affecting award of Contract, Information Available to Proposers which includes information made available to the proposer, and Proposal Forms and Supplements which includes forms and supplements for submitting proposals.
 - c. General Conditions: The term General Conditions means a compilation of contractual and legal requirements that list the rights, responsibilities and relationships of the parties to a contract and defines duties and limits of authority for design professionals and construction management in performance of contract administration.
 - d. Supplementary Conditions: The term Supplementary Conditions means modifications to the General Conditions for requirements unique to a specific project.
 - e. General Requirements: The term General Requirements means a

compilation of the conditions and requirements peculiar to the specific contract that governs the execution of the Design and Construction work including Summary of Work Requirements, Price and Payment Procedures, Administrative Requirements, Quality Requirements, Temporary Facilities and Controls, Product Requirements, Execution Requirements, and Facility Operation Requirements.

- f.. Program Criteria: The term Program Criteria means written design criteria prepared by the Authority that have been created to establish the minimum basis of design for any specific contract. The Design-Builder shall use the WMATA Program Criteria in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA in the preparation of the Contract-specific Design.
 - g. WMATA Standard and Technical Specifications: The term WMATA Standard Specifications means those specifications in Divisions 2 through 16 prepared by the Authority that have been created to serve as standard requirements for materials and construction methods for all WMATA projects and are unedited. The Design-Builder shall use the Standard Specifications and edit accordingly in the preparation of the Contract-specific Final Design Specifications. Some of the Technical Specifications Sections in Divisions 2 through 16 may have already been edited by WMATA to specify Contract-specific project requirements for materials and construction methods. The Design-Builder shall use the WMATA Technical Specifications in the preparation of the Contract-specific Final Design Specifications.
42. Project Representative: The term Project Representative means the individual(s), including but not limited to the Resident Engineer, to whom the Authority Representative has delegated Project responsibilities.
43. Proposer: The prospective Design-Builder who submits Proposals to perform the Work of the Contract. The term Bidder is synonymous with the term Proposer.
44. Related Documents: In specifications in Division 00 (General and Supplementary Conditions), in Division 01 (General Requirements) and in Divisions 02 to 16 (WMATA Standard Specifications and WMATA Technical Specifications), the term "Related Documents" is used to identify documents that directly relate to the Section in question. This is done in order to assist the reader in finding some of the other most relevant Sections of the Contract Documents and the Final Design Specifications and Final Design Drawings. However, this shall not be interpreted as diminishing any other requirement set out in the Contract Documents that are not referred to under "Related Documents". The Contract Documents shall be read and interpreted as a whole.
45. Request for Proposal (RFP): The term RFP means the written document



prepared in anticipation of the negotiation and award of the Design-Build Contract for the design and construction of the Project.

46. Revenue Operations Date (ROD): Revenue Operations Date is the date upon which the new system segment is opened for revenue (passenger) service.
47. Section: An element of the Project Manual bearing its own Alphanumeric designation.
48. Shall/Will/May:
 - a. Shall: Indicates action which is mandatory on the part of the Design-Builder.
 - b. Will: Indicates probable action by the Authority or its representatives.
 - c. May: Indicates permissible action.
49. Shop Drawings (Design-Builder Provided): Fabrication, erection, layout, setting, schematic and installation drawings prepared by the Design-Builder for permanent structures, equipment and systems designed by him to comply with the Requirements of the Contract Documents and the Final Design Specifications and Final Design Drawings including manufacturer's drawings and literature, materials list, product data, product substitution requests, schedules, wiring and control diagrams, catalog cuts or entire catalogs, descriptive literature, performance and test data as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
50. Similar: Generally the same but not necessarily identical; details shall be worked out in relation to location and relation to other parts of the work.
51. Submit: Unless otherwise specified, transmit to the Authority Representative for approval or to the Contracting Officer through the Authority Representative for approval.
52. Submittal: The term Submittal means a written, or graphic or electronic document prepared by the Design-Builder, which the Contract Documents and the Final Design Specifications and Final Design Drawings require be submitted to the Authority. Submittals include, but are not limited to, drawings, specifications, progress schedules, shop drawings, product data, safety and quality control plans, samples, and schedules of value for the Work.
53. WMATA Safety Manual (Authority-Provided): The term WMATA Safety Manual means a compilation of the appropriate safety and reporting requirements for the project as specified in Section 00371.

54. WMATA Safety and Security Certification Program Plan (Authority-Provided): The term WMATA Safety and Security Certification Program Plan means a compilation of the appropriate safety and security certification requirements for the project as specified in Section 00381. 10/01/03
55. WMATA System Safety Program Plan (Authority-Provided): The term means a compilation of the appropriate system safety requirements for the project as specified in Section 00391. 10/24/03
56. Work: The term Work means all of the design and construction services, including supervision, quality control and quality assurance, labor, materials, machinery, equipment, tools, supplies and facilities required to complete the Project, or the various separately identifiable parts thereof, in accordance with the terms of the Contract.
57. Working Drawings (Design-Builder Provided): Plans prepared by the Design-Builder for temporary structures such as decking, temporary bulkheads, support of excavation, support of utilities, groundwater control systems, and forming and falsework; for underpinning; and for such other work as may be required for construction which but do not become an integral part of the completed project as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

00702 ORDER OF PRECEDENCE (10/25/04)

- A. Any inconsistency in this solicitation or Contract shall be resolved by giving precedence in the following order:
 1. Contract Modifications in Division 0, Section 00940, MODIFICATIONS.
 2. The Agreement Form and Attachments in Division 0, Section 00521, DESIGN-BUILD CONTRACT FORM; Section 00541, POWER OF ATTORNEY; and Section 00542, POWER OF EXECUTION, respectively.
 3. Bonds and Certificates in Division 0, Section 00612, PERFORMANCE BOND; Section 00613, PAYMENT BOND; and Section 00621 CERTS.
 4. Representations and Certifications in Division 0, Section 00451, REPS AND CERTS.
 5. Price Proposal and Technical Proposal as Negotiated and Accepted in Division 0, Section 00492, PRICE PROPOSAL AS NEGOTIATED AND ACCEPTED (including the Price Schedule in Division 0, Section 00434, PRICE SCHEDULE).
 6. Approved Final Design Specifications issued for Construction.



7. Approved Final Design Drawings issued for Construction.
 8. Program Criteria in Division 1, Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA and other Division 1 Requirements.
 9. WMATA Standard Specifications and WMATA Technical Specifications in Divisions 2 through 16.
 10. WMATA Project Description, Standard, and Design Directive Drawings Issued as an Attachment to the Project Manual.
 11. General Conditions and Supplementary Conditions in Division 0, Section 00700, GENERAL CONDITIONS and Section 00800, SUPPLEMENTARY CONDITIONS, respectively.
- B. In the event of a conflict within, between or among the above listed order of precedence, the more stringent requirement shall apply.

00703 GENERAL REQUIREMENTS, DRAWINGS AND SPECIFICATIONS (06/01/03)

- A. During the Design Phase of the project, the Design-Builder shall keep at the work site a copy of the Project Manual and Project Drawings and during the Construction Phase of the project shall keep at the jobsite a copy of the Final Design Specifications and Final Design Drawings, and shall at all times give the Authority Representative(s) access thereto.
- B. The Sections of Division 01, General Requirements, procedures shall govern the execution of the Work of the Contract.
- C. Anything mentioned in the Project Manual and not shown on the Project Drawings, or shown on the Project Drawings and not mentioned in the Project Manual, shall be of like effect as if shown or mentioned in both.
- D. In case of discrepancy between the Project Manual and Project Drawings, the Project Manual shall govern. In case of discrepancy in the figures between the Project Drawings, the matter shall be promptly submitted in writing to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTALS who shall promptly make a determination in writing. Notification of conflicts among the requirements and criteria either indicated in the Project Manual and/or Project Drawings or required by local, state or federal jurisdictions or utilities, as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, that affect the scope, cost or quality of this work shall be promptly submitted in writing to the Authority Representative for a written determination in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTALS. Any adjustment by the Design-Builder without such a determination shall be at the Design-Builder's own risk and expense.

- E. Wherever in the Project Manual and in the Final Design Specifications the imperative form is used such as the words "directed," "ordered," "designated," "prescribed," or words of like import are used, it shall be understood that the "direction," "requirement," "order," "designation," or "prescription" of the Authority Representative or Project Representative, as specified, is intended, and similarly the words "approved," "acceptable," "satisfactory," or words of like import, shall mean "approved by," "acceptable to," or "satisfactory to" the Authority Representative or Project Representative, as specified, unless otherwise expressly stated.
- F. Should it appear that the work to be performed is not sufficiently detailed or explained in the Contract Documents and the Final Design Specifications and Final Design Drawings, then the Design-Builder shall promptly apply to the Authority Representative in writing in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTALS for such written explanations as may be necessary and shall conform to the explanation provided. The Design-Builder shall promptly notify the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTALS of all errors, omissions, inconsistencies, or other defects including inaccuracies which it may discover in the Contract Documents and the Final Design Specifications and Final Design Drawings, shall provide options to the Authority Representative to remedy such errors, omissions or other defects, and shall obtain in writing from the Authority Representative specific instruction regarding any such error, omission or defect before proceeding with the design work affected thereby. Omission of details of the work from the Contract Documents or the mis-description of details of work which are necessary to carry out the intent of the Contract Documents, or which are customarily preformed, shall not relieve the Design-Builder from performing such omitted work, no matter how extensive, or mis-described details of the work and they shall be performed as if fully and correctly set forth and described in the Contract Documents, without entitlement to a Change Order hereunder.

00704 INTENT OF CONTRACT

(06/01/03)

- A. The Design-Builder shall, upon execution of this Contract and receipt of Notice to Proceed (NTP), perform all work as defined herein to complete the Project as described in this Contract. The Authority has detailed its requirements in the Contract Documents. The Authority has not specified the precise details of performing the Work, except as the Authority considered such details to be essential for the successful completion of the Work. Therefore, the Design-Builder shall not deviate from the Contract Requirements without the written approval of the Authority.
- B. The Design-Builder shall conduct a pre-design meeting jointly with the Authority, and during the design of the Project, the Design-Builder and the Authority shall meet periodically and confer about the progress of the design as specified in Section 01312, PROJECT MEETINGS. At these design review meetings, the Design-Builder shall identify the evolution of the design and any changes or deviations from the requirements of the Contract Documents, as well any associated potential changes to the Contract Price or Performance Time. The Design-Builder in a timely manner shall



provide minutes of all such meetings for all attendees to review and approve or correct as specified in Section 01312, PROJECT MEETINGS and in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Authority will review and approve subsequent design submittals that are consistent with the Contract Documents and the Final Design Specifications and Final Design Drawings as modified by agreements reached at the design review meetings and documented in meeting minutes approved by the Authority. Any agreement that involves changes to the Contract Documents shall be documented in a fashion consistent with Section 00753, CHANGES. The Authority will perform its design reviews solely for the purposed stated in Section 00719, AUTHORITY REVIEWS.

- C. It is the intent of the Contract Documents to describe a functionally complete Project to be designed and constructed in accordance with the Contract Documents and the Final Design Specifications and Final Design Drawings. Any work, materials or equipment that may reasonably be inferred from the Contract Documents, from prevailing custom, or from trade usage as being required to produce the intended results will be furnished and performed whether or not specifically called for. Unless otherwise defined in the Contract, when words or phrases having a well-known technical, construction industry, or trade meaning are used to describe work, labor, services, materials, tools or equipment, such words or phrases shall be interpreted in accordance with that meaning.
- D. The Design-Builder accepts the relationship of trust and confidence established between it and the Authority by the Agreement. The Design-Builder agrees to furnish the architectural, engineering and construction services set forth herein, and agrees to furnish efficient business administration and superintendence, including quality control and quality assurance, and use its best efforts, to complete the Project in the best and soundest way and in the most expeditious and economical manner consistent with the Contract Documents and the Final Design Specifications and Final Design Drawings. The Design-Builder agrees to perform its design services in accordance with the responsibilities and requirements set forth in Section 00708, RESPONSIBILITY OF THE DESIGN-BUILDER FOR DESIGN RELATED SERVICES, in Section 00709, REQUIREMENTS FOR PROFESSIONAL REGISTRATION, Section 01111, KEY DESIGN-BUILDER FUNCTIONS and in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
- E. The Design-Builder shall be responsible for performing or furnishing construction services and related services in all phases of the Project and require its subcontractors to perform the services in accordance with the best general practice. Only new materials and workmanship of best standard quality shall be used. Unless otherwise specified, the Design-Builder shall furnish all work, services, labor, materials, tools, equipment and incidentals which are necessary to complete the Work in a proper, substantial and workmanlike manner in accordance with the Contract Documents and the Final Design Specifications and Final Design Drawings.
- F. Nothing contained in these Contract Documents shall create a contractual relationship between the Authority and any party other than the Design-Builder. However, it is

understood and agreed that the Authority is an intended third party beneficiary of all contracts for design, engineering or construction services and all such subcontracts, purchase orders, and other agreements between the Design-Builder and third parties related to those services. The Design-Builder shall incorporate the obligations of this Contract into its respective subcontracts, supply agreements, and purchase orders.

00705 LEGAL REQUIREMENTS (06/01/03)

- A. The Design-Builder shall perform the Work in accordance with all Legal Requirements as specified in Section 01410, REGULATORY REQUIREMENTS, in Section 01420, REFERENCES, in Section 00708, RESPONSIBILITY OF THE DESIGN-BUILDER FOR DESIGN RELATED SERVICES, and in Section 00707, PERMITS AND RESPONSIBILITIES. The Contract Price and/or Period of Performance shall be adjusted to compensate the Design-Builder for the effects of any changes in the Legal Requirements enacted after the date of the Agreement affecting the performance of the Work. Such effects may include, without limitation, revisions the Design-Builder is required to make to the Contract Documents and the Final Design Specifications and Final Design Drawings because of changes in Legal Requirements. Notwithstanding the foregoing, any change in Legal Requirements which affects the method and/or manner of performance of the work but not the Final Design of the work incorporated into the Project shall be at the Design-Builder's risk and at no additional cost to the Authority.
- B. The Design-Builder's failure to design or construct the Work in conformance to all applicable Legal Requirements in force as of the Notice to Proceed shall not be the basis for a change to either the Contract Price or Contract Performance Period. The Design-Builder shall remedy all such failures to design or construct the Work in conformance to all such Legal Requirements at its own expense.
- C. The Design-Builder shall be responsible for remaining informed of all changes in the Legal Requirements that may occur after the Notice to Proceed and shall perform the Work in accordance with such changed Legal Requirements.

00706 NOT USED

*00707 PERMITS AND RESPONSIBILITIES (06/01/03)

- A. The Design-Builder shall, without additional expense to the Authority, be responsible for obtaining any necessary licenses, permits, and/or easements and for complying with any applicable International, Federal, State, Local or Municipal laws, codes or regulations, in connection with the prosecution of the Work.
- B. The Design-Builder shall be responsible for all damages to persons or property that occur as a result of its fault or negligence or that of its subcontractors or anyone directly or indirectly employed by the Design-Builder, or anyone for whose acts the Design-Builder may be liable, subject to an allocation or proportion of any such liability, loss,



cost or expense if caused in part by a party indemnified hereunder. The Design-Builder shall take proper safety and health precautions to protect the Work, the workers, the public and the property of others. The Design-Builder shall also be responsible for all materials delivered and Work performed until completion and Acceptance of the entire Work, except for any completed unit of construction thereof which theretofore may have been accepted in writing by the Authority.

00708 RESPONSIBILITY OF THE DESIGN-BUILDER FOR DESIGN-RELATED SERVICES

- A. The Design-Builder shall be responsible for performing or furnishing design professional services and related services in all phases of the Project as specified in Section 01111, KEY DESIGN-BUILDER FUNCTIONS and in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, and require its Design Professional to perform the services in accordance with the specifications and requirements of the Contract and in accordance with professional standards of skill, care, and diligence adhered to by firms recognized for their expertise, experience and knowledge in performing services of a similar nature. The Design-Builder shall be responsible for the professional quality, technical accuracy, completeness, and coordination of the services, it being understood that the Authority will be relying upon such professional quality, technical accuracy, completeness, and coordination in utilizing the services for construction and implementation of the Project.
- B. The Design-Builder shall, without additional compensation, correct or revise any errors or deficiencies in its designs, drawings, specifications, and other services. In addition, the Design-Builder in performing its design services herein shall be responsible for project management, quality control/quality assurance, and other elements of the Work required for the successful completion of the Project.
- C. The Design-Builder shall likewise be liable to the Authority for all costs to the Authority of any kind caused by or resulting from the Design-Builder's failure to perform design services consistent with the terms and conditions of this Contract. Failure to agree to the responsibility for costs, either those incurred by the Design-Builder or by the Authority, for corrective actions required by this Section, shall constitute a dispute concerning a question of fact within the meaning of Section 00732, DISPUTE RESOLUTION.
- D. Neither the Authority's review, approval or acceptance of, nor payment for, the services required under this Contract shall be construed to operate as a waiver of any rights under this Contract or of any cause of action arising out of the performance of this Contract, and the Design-Builder shall be and remain liable to the Authority in accordance with applicable law for all damages to the Authority caused by the Design-Builder's performance of any of the services furnished under this Contract.
- E. The Design-Builder shall be responsible to the Authority for acts, errors and omissions of its Design Professional, subcontractors, suppliers, agents, and employees of those in privity with the Design-Builder, whether employed directly or through subcontracts or

other means.

- F. The rights and remedies of the Authority provided for under this Contract are in addition to any other rights and remedies provided by law.

00709 REQUIREMENTS FOR PROFESSIONAL REGISTRATION (06/01/03)

All architecture, engineering and other design services rendered by or through the Design-Builder under this Contract shall be accomplished and/or reviewed and approved by design professionals licensed to practice in the particular professional field involved in the jurisdiction in which the project being designed will be constructed. The Design-Builder shall comply with local laws regarding the licensing of design firms and personnel providing services for the Project.

*00710 PROJECT MANAGEMENT AND SUPERINTENDENCE AND KEY PERSONNEL(06/01/03)

- A. The Design-Builder shall provide project management and direct superintendence of the Work.
- B. The Design-Builder shall provide personnel for the positions specifically identified by the Authority in this Contract as required key personnel (see Section 00203, TECHNICAL AND PRICE PROPOSAL INSTRUCTIONS AND EVALUATION FACTORS) and in addition, for those and other personnel essential for performance of the work as identified by the Design-Builder (see the Design-Builder's TECHNICAL PROPOSAL AS FINALLY ACCEPTED, Section 00491), and for any other positions the Design-Builder deems necessary for the successful execution during performance of the Contract work. Also see Section 01111, KEY DESIGN-BUILDER FUNCTIONS and Section 01310, PROJECT MANAGEMENT AND COORDINATION for responsibilities of key personnel. All positions shall be filled by competent personnel satisfactory to the Authority. Each position shall be held by a separate full-time employee, unless otherwise specifically approved by the Authority. Individuals holding these, or any key position shall not be changed without permission of the Authority. The Design-Builder shall acquire written Authority approval for substitutions of any key personnel as specified in Section 01111, KEY DESIGN-BUILDER FUNCTIONS. The Design-Builder shall provide the Authority, in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, with any information as may be reasonably requested regarding any substitution and any proposed substitute will share similar or better qualities than the person substituted for. The Design-Builder shall provide the original and six copies and one electronic copy of this qualifications information. The Authority shall be entitled to satisfactory performance of all services described in this Contract and the Design-Builder shall promptly remove from the Project any employee or other person performing services hereunder in an unsatisfactory manner.
- C. The Design-Builder shall present, as specified in Section 00726, COMMENCING THE WORK and Section 01111, KEY DESIGN-BUILDER FUNCTIONS, confirmation of the credentials of the individuals submitted in the TECHNICAL PROPOSAL AS FINALLY

ACCEPTED, Section 00491, to the Authority Representative for review and acceptance in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

00711 WORK BY DESIGN-BUILDER (10/29/04)

- A. The Design-Builder shall perform, with its own organization, work equivalent to at least the percentage specified in Section 00811 of the Supplementary Conditions for the construction work.
- B. The percentage shall be determined by the dollar value of the construction work done by his own organization in comparison to total value of construction work in the Contract. The cost of the work performed by skilled and unskilled labor carried on the Design-Builder's own payroll, together with the cost of materials installed, may be included in the above percentage. The Design-Builder's markup for overhead and profit on work performed by subcontractors shall not be included in determining the percentage.
- C. If, during the progress of the Work, the Design-Builder requests a reduction in such percentage and if the Contracting Officer determines that it would be to the Authority's advantage, the Contracting Officer may approve such a reduction at his/her sole discretion.

*00712 OTHER CONTRACTS (06/01/03)

- A. The Authority may undertake or award other contracts for additional work, and the Design-Builder shall fully cooperate with such other contractors and Authority employees and carefully fit its own work to such additional work as may be directed by the Authority Representative. The Design-Builder shall not commit or permit any act which will interfere with the performance of work by any other contractor or by Authority employees.
- B. The Design-Builder shall conduct all work in a manner that will minimize interference with the operations of other contractors and Authority employees, if any, involved in the performance of related work. All work shall be brought to a stage of completion that will conform to the requirements specified in the Contract Documents and the Final Design Specifications and Final Design Drawings.

00713 CONFIDENTIALITY (06/01/03)

The Design-Builder or its subcontractors shall not divulge any confidential information which is so designated by the Authority to Design-Builder or its subcontractors or acquired in the course of performance of the work under this Contract.

*00714 CONDITIONS AFFECTING THE WORK (06/01/03)

The Design-Builder shall be responsible for having taken steps reasonably necessary to ascertain the nature and location of the Work, and the general and local conditions which can affect the Work or the cost thereof as described in Section 01711, ACCEPTANCE OF CONDITIONS. Any failure by the Design-Builder to do so will not relieve the Design-Builder from responsibility for successfully performing work without additional expense to the Authority. The Authority assumes no responsibility for any understanding or representations concerning conditions made by any of its officers or agents prior to the execution of this Contract, unless such understanding or representations are expressly stated in the Contract.

*00715 SITE INVESTIGATION (06/01/03)

The Design-Builder acknowledges that it has investigated and satisfied itself as to the conditions affecting the work including, but not restricted to, those bearing upon transportation, disposal, handling and storage of materials; availability of labor, water, electric power and roads; and uncertainties of weather, river stages, tides or similar physical conditions at the site, the conformation and conditions of the ground, and the character of equipment and facilities needed preliminary to and during prosecution of the work as described in Section 01711, ACCEPTANCE OF CONDITIONS. The Design-Builder further acknowledges that it has satisfied itself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, including all exploratory work done by the Authority, as well as from information provided by the Authority and made a part of this Contract, the character and extent of existing work within or adjacent thereto, and any other work being performed thereon at the time of the submission of its proposal as described in Section 01711, ACCEPTANCE OF CONDITIONS. Nothing in this requirement shall be construed as being determinative of the character, scope or extent of the work required under this Contract. Any failure by the Design-Builder to acquaint itself with the available information will not relieve it from responsibility for estimating properly the difficulty or cost of successfully performing the work. The Authority assumes no responsibility for any conclusions or interpretations made by the Design-Builder on the basis of the information made available by the Authority.

00716 PRECONSTRUCTION INSPECTION (06/01/03)

- A. Conditional inspection of buildings or structures in the immediate vicinity of the project which may reasonably be expected to be affected by the Work will be performed by and be the responsibility of the Design-Builder.
- B. Prior to beginning excavation or any other work, the Design-Builder shall inform the Authority of buildings or structures on which it intends to perform work or which performance of the project work will affect.
- C. The Authority shall be provided sufficient notice of this inspection and afforded an opportunity to participate in the inspection. The Design-Builder shall submit for



approval, in accordance with Section 01330 DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, the preconstruction inspection records as specified in Section 01711, ACCEPTANCE OF CONDITIONS, to the Authority prior to beginning work.

*00717 DIFFERING SITE CONDITIONS (10/28/04)

- A. The Design-Builder shall promptly, and before such conditions are disturbed, notify in writing as described in Section 01711, ACCEPTANCE OF CONDITIONS and in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, the Contracting Officer, through the Authority Representative, of subsurface or latent physical conditions at the site differing materially from those indicated in this Contract or unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for this Contract .
- B. The Authority will promptly investigate the conditions, and if the Authority finds that such conditions do materially so differ and cause an increase or decrease, in the Design-Builder's cost of, or the time required for, performance of any part of the work under this Contract, whether or not changed as a result of such conditions, an equitable adjustment shall be made and the Contract modified in writing accordingly.
- C. No claim of the Design-Builder under this Section shall be allowed unless the Design-Builder has given the notice required in Paragraph A. above; provided, however, the time prescribed therefor may be extended by the Authority Representative.
- D. No claim by the Design-Builder for an equitable adjustment hereunder shall be allowed if asserted after final payment under this Contract.

00718 ROLE OF THE AUTHORITY (06/01/03)

- A. The character and extent of the Work to be performed by the Design-Builder shall be subject to the general oversight and general approval of the Authority.
- B. The Authority will not supervise, direct or have control over, nor be responsible for, the Design-Builder's means, methods, techniques, sequences, or procedures of design and construction or the safety precautions and programs incident to the Work, or for any failure of the Design-Builder to comply with Legal Requirements. The Authority will not be responsible for the Design-Builder's failure to perform or furnish the Work in accordance with the requirements of the Contract Documents and the Final Design Specifications and Final Design Drawings.

00719 AUTHORITY REVIEWS

(06/01/03)

- A. The Authority shall review information submitted by the Design-Builder, furnish required information and required approvals, and render decisions pertaining thereto, all in a timely manner in order to facilitate the orderly progress of the Work in cooperation with the Design-Builder and in accordance with the planning, scheduling and budgetary requirements and restraints of the Project.
- B. The Authority will review and approve design submittals solely for the purpose of establishing their conformance to the Authority's requirements in the Contract Documents. Such review and approval shall not be deemed to transfer any liability from the Design-Builder to the Authority.
- C. The Authority will review and approve construction submittals solely to determine if the items covered by the submittal will, after installation or incorporation in the construction, conform to the requirements set forth in the Final Design Specifications and Final Design Drawings, be compatible with the design concept of the completed Project as a functioning whole, as indicated by the Contract Requirements. The Authority's review and approval of construction submittals will not extend to means, methods, techniques, sequences or procedures of construction (except where a particular means, method, technique sequence or procedure of construction is specifically and expressly called for by these Contract Requirements) or to safety precautions or programs incident thereto. The Authority's approval will be general and shall not be construed as: (1) permitting any departure from the Contract Requirements; (2) relieving the Design-Builder of the responsibility for any errors including details, dimensions and materials; or, (3) approving departures from details furnished by the Design-Builder and/or the Authority except as otherwise specified.
- D. The Authority reserves the right to review design and construction submittals and to disapprove any submittal when, in its sole judgment, the submittal deviates from the requirements of the Contract Documents or the Final Design Specifications and Final Design Drawings and compromises the integrity of the structure. The Authority's review, approval, or acceptance of any submittal required under this Contract shall not be construed to operate as a waiver of the Design-Builder's responsibility for the professional quality, technical accuracy, and the coordination of all designs, drawings, specifications, construction and other services provided by the Design-Builder under this Contract.
- E. For the Authority's procedures for reviewing and approving design and construction submittals, refer to Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Section 01780, CLOSEOUT SUBMITTALS.



00720 SUBMITTALS

(06/01/03)

- A. The Design-Builder shall submit for review and approval a preliminary Schedule of Required Submittals, as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, that the Authority reserves the right to review and approve, and the times for submitting, reviewing and processing each Submittal.
- B. The Design-Builder shall maintain a Contract Documents submittal log as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, to show the status of all submittals. The submittal log and all approved submittals shall be kept at the Project site and shall at all times be made available for Authority inspection. Approved submittals and certificates are to be turned over to the Authority at the completion of the Project as part of the Project records.
- C. The Authority will timely review and approve those submittals that it deems necessary, and as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Section 01780 CLOSEOUT SUBMITTALS, during the design and construction and closeout of the Project. The Authority's review of design or construction submittals shall be solely for the purposes stated in Section 00719, AUTHORITY REVIEWS. The Authority's review and approval of separate items as such will not indicate approval of the assembly in which the item functions. The Design-Builder shall make corrections to submittals as required and shall return the required number of corrected copies for additional review and approval.
- D. The Authority's review and approval of any submittal that it deems necessary to review and approve shall not relieve the Design-Builder from responsibility for any variations from the requirements of the Contract Documents and the Final Design Specifications and Final Design Drawings unless the Design-Builder has in writing called the Authority's attention to each such variation at the time of submission in the submittal letter of transmittal as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and the Authority has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the submittal.
- E. Where a submittal is required by the Contract Documents or the Final Design Specifications and Final Design Drawings, any related work provided prior to the appropriate review and approval of a submittal shall be at the sole risk, expense, and responsibility of Design-Builder.

00721 VALUE ENGINEERING INCENTIVE

(06/01/03)

- A. This Section applies to those Value Engineering Change Proposals (VECP's) which are initiated and developed by the Design-Builder during the performance of the Contract to modify the Authority's Design Criteria, or other requirements of this Contract including commitments made in the Design-Builder's proposal as finally accepted. In order to be accepted under this Section each VECP shall:

1. Be identified by the Design-Builder at the time of submittal to the Contracting Officer or other delegated Authorized Representative as submitted pursuant to this Section using the prescribed The Authority VECP proposal form;
 2. Require a significant change to this Contract and Contract Requirements;
 3. Decrease the Contract price;
 4. Maintain the Contract requirements such as safety, service life, reliability, economy of operation, ease of maintenance and necessary standardized and architectural features of the facility or system;
 5. Not require an unacceptable extension of original Contract duration; and
 6. Be reviewed and evaluated by way of a two-phase process.
- B. Phase One - Conditional Approval: In addition to the use of the Authority VECP proposal form, any VECP the Design-Builder submits in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES shall be in sufficient detail to clearly define the proposed change including the following items:
1. A description of the difference between the existing and the proposed Contract requirements, and the comparative advantages and disadvantages of each;
 2. Contract requirements recommended by the Design-Builder to be changed;
 3. Separate detailed cost estimates for both the basic Contract requirement and the proposed change, and an estimate of the change in Contract price including an accounting of the costs of development and implementation and Authority review of the VECP and the sharing arrangement as set forth in the following Paragraph E.;
 4. A statement from the Design-Builder predicting any effects the proposed VECP will have on the life-cycle cost of the work to include and identify separately the cost for increased or decreased maintenance and operations;
 5. A statement of the time by which the proposal must be accepted so as to obtain the maximum price reduction effect and not delay the original Contract completion time. The time required for VECP review shall be considered and included in this statement and also in a separate bar chart;
 6. A list of codes and the Authority standards applicable to the work to be carried out by the VECP and a statement that the proposed VECP will be in compliance with the requirements set forth in listed codes and standards;
 7. The identification of a project where the materials, methods of construction and



- special equipment, where required, have been previously and successfully performed on construction similar to that which is being proposed for implementation on this Contract.
8. Preliminary architectural and engineering analysis, including calculations and 11 x 17 inch drawings in sufficient detail for each requirement of the Contract which must be changed if the VECP is accepted, with recommendations for accomplishing each change and its effect on unchanged work.
 9. The Design-Builder shall submit the original and six paper copies and one electronic copy to the Authority for approval.
- C. The Contracting Officer or other delegated Authorized Representative may at any time during the two-phase review and evaluation process reject part or all of the VECP by giving the Design-Builder written notice thereof. Until final approval is issued, the Design-Builder shall remain obligated to perform in accordance with the terms of the original Contract. VECP's will be processed expeditiously; however, the Authority shall not be liable for any delay in acting upon any proposal submitted pursuant to this Section. The decision of the Contracting Officer or other delegated Authorized about acceptance or rejection of any such proposal shall be final and shall not be subject to Section 00732, DISPUTE RESOLUTION.
1. The Design-Builder has the right to withdraw part or all of the VECP at any time prior to acceptance or rejection by the Authority. Such withdrawal shall be made in writing to the Contracting Officer or other delegated Authorized Representative. The Design-Builder shall submit the original and six paper copies and one electronic copy to the Authority for approval. If the Design-Builder desires to withdraw the proposal, it shall be liable for the cost incurred by the Authority in reviewing the proposal.
- D. Upon notice of conditional approval of the concept of the VECP, the Design-Builder shall proceed with final VECP design in accordance with the agreed schedule.
- E. Phase Two - Final Approval: Final approval of the VECP by the Authority will be contingent upon the following items:
1. The Design-Builder shall address, to the Authority's satisfaction, all design issues and review comments and submit the VECP to the Authority for approval in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
 2. An equitable adjustment in the Contract price and appropriate changes in any other affected provisions of the Contract shall be made and the Contract modified in accordance with Section 00753, CHANGES, or other applicable Sections of this Contract.

3. The net savings resulting from the change shall be shared between the Design-Builder and the Authority on the basis of 50 percent for the Design-Builder and 50 percent for the Authority. Net savings shall be determined by deducting from the estimated gross savings, the Design-Builder's costs of developing and implementing the proposal, including any amount attributable to a subcontractor, and the estimated amount of increased costs to the Authority resulting from the change, such as costs for review, implementation, inspection, related items and Authority-furnished property. Estimated gross savings shall include Design-Builder's labor, material, equipment, overhead, profit and bond. The Contract price shall be reduced by the sum of the Authority's costs and share of the net savings.
 4. The Design-Builder is entitled to share in instant Contract savings only, to the full extent provided for in this Section. For purposes of sharing, the term 'instant contract' shall not include any supplemental agreements to or other modifications of this Contract, executed subsequent to acceptance of the particular VECP, by which the Authority increases the quantity of any item or adds any item.
 5. Notwithstanding any review, approval or acceptance of any VECP by the Authority; the Design-Builder agrees to be liable to the Authority for all costs of any kind whatsoever caused by or resulting from any error, omission, deficiency or negligence, or combination thereof, of any kind in the design, drawings or specifications submitted to the Authority in connection with any VECP proposal under this Contract. The rights and remedies of the Authority provided in this Section are in addition to any other rights or remedies provided by law or under this Contract.
 6. The Design-Builder shall submit the original and six paper copies and one electronic copy to the Authority for approval.
- F. The Design-Builder will use its best efforts to include Value Engineering arrangements in any subcontract, which in its judgement, appears to offer sufficient value engineering potential.
- G. A VECP identical to one submitted under any other contract, by this or any other contractor, may also be submitted under this Contract.
- H. The Design-Builder may restrict the Authority's right to use any VECP data by marking it with the following statement:

"This data, furnished pursuant to the VALUE ENGINEERING INCENTIVE Section of this Contract, shall not be duplicated, used or disclosed, in whole or in part, for any purpose except to evaluate the VECP, unless the proposal is accepted by the Authority. This restriction does not limit the Authority's right to use information contained in this data if it is or has been obtained, or is otherwise available, from the Design-Builder or from other source, without limitations. When this proposal is accepted by the Authority,



the Authority shall have the right to duplicate, use and disclose any data in any manner and for any purpose whatsoever, and have others do so whether under this or any other Authority contract."

00722 QUALITY CONTROL / QUALITY ASSURANCE (10/01/03)

- A. The Design-Builder shall be responsible for conducting an ongoing Design/Build Quality System as described in Section 01470, QUALITY SYSTEM during the entire term of the Contract based on the approved detailed Design/Build Quality System. The purpose of the Design-Build Quality System is to effectively and economically assure technical quality in the Final Design, other Contract deliverables, and construction of the Work, thus reducing the potential for:
 - 1. adverse construction schedule and cost impacts;
 - 2. personal and public safety problems and incidents and their attendant costs;
 - 3. those operational and maintenance problems, disruptions, and costs that result from design errors and omissions; and,
 - 4. a poor quality design,
 - 5. poor construction quality,
- B. The Design-Builder shall submit for approval in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES all required quality submittals as specified in Section 01470, QUALITY SYSTEM.
- C. An effective Design-Build Quality Program is fundamental to all work performed by the Design-Builder and will be considered by the Authority in assessing the Design-Builder's progress, performance, and earnings entitlement.

00723 NOT USED

*00724 PROGRESS SCHEDULES AND REQUIREMENTS FOR MAINTAINING PROGRESS RECORDS (10/30/04)

- A. The Design-Builder shall submit a schedule to the Authority Representative for approval, within 15 days after the award of the Contract, showing the order in which the Design-Builder proposes to carry on the work, the dates on which he will start the several major features, including procurement of materials, plant and equipment, and the contemplated dates for completing the same. The schedule shall be in the form of a graphic network diagram or progress chart indicating appropriately the work scheduled for accomplishment at any time in accordance with Section 1330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. Unless otherwise specified, the Design-Builder shall enter on the schedule the

actual progress at monthly intervals and shall immediately deliver to the Authority Representative four copies thereof.

- b. Failure to comply with the terms of this Article may affect the processing of progress payment requests submitted by the Design-Builder as provided in Section 00749, METHOD OF PAYMENT.
- c. If, in the opinion of the Authority Representative, the Design-Builder falls significantly behind the approved progress schedule, the Design-Builder shall take any and all steps necessary to improve his progress. The Authority Representative, in this instance, may require the Design-Builder to increase the number of shifts, initiate or increase overtime operations, increase days of work in the work week, or increase the amount of construction plant, or all of them. The Authority Representative may also require the Design-Builder to submit for approval supplemental progress schedules detailing the specific operational changes to be instituted to regain the approved schedule, all without additional cost to the Authority.
- d. Failure of the Design-Builder to comply with the requirements of the Authority Representative under this provision shall be grounds for determination that the Contractor is not prosecuting the work with such diligence as will ensure completion within the time specified. Upon such determination the Contracting Officer may terminate the Contractor's right to proceed with the work, or any separate part thereof, in accordance with the Section 00728, TERMINATION FOR DEFAULT, DAMAGES FOR DELAY AND TIME EXTENSIONS.

00725 PERIOD OF PERFORMANCE AND PROJECT SCHEDULE (06/01/03)

- A. The Design-Builder shall perform, complete and advance all Work under this Contract in accordance with the schedule set out in Section 00825, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE REQUIREMENTS.
- B. The Authority may modify the Contract, pursuant to Section 00753 CHANGES, to extend the period of performance as often and in time periods as deemed necessary until completion of the Work under this Contract.
- C. Early Completion: If the Design-Builder shall submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, a schedule or express an intention to complete the Work earlier than any required milestone, interim or final completion date, the Authority shall not be liable for any costs incurred because of delay or hindrance should the Design-Builder be unable to complete the Work before such milestone, interim or final completion date. The Design-Builder shall submit the original schedule and six paper copies and one electronic copy. The duties, obligations and warranties of the Authority to the Design-Builder shall be consistent with and applicable only to the completion of the Work and completion dates set forth in this Contract.

00726 COMMENCING THE WORK (10/07/03)

- A. The Design-Builder shall commence the work within ten (10) calendar days after the date of receipt of Notice to Proceed (NTP) and shall prosecute the Work diligently to complete it within the time specified in the Contract to meet all specified interim milestone dates.
- B. A Pre-Design-Build Conference attended by the Authority and the Design-Builder and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the design concepts, schedules, procedures for handling Submittals, processing Applications for Payment, maintaining required records, quality control, and other matters. For a more complete agenda, refer to Section 01312, PROJECT MEETINGS.
- C. The following items require approval prior to commencement of any design activities, construction activities, and/or offsite fabrication associated with the Project. Submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTALS:
 - 1. Executed Contract as specified in Section 00521, DESIGN-BUILD CONTRACT FORM with Power of Attorney as specified in Section 00541, POWER OF ATTORNEY and Power of Execution as specified in Section 00542, POWER OF EXECUTION; Required Performance Bond as specified in Section 00612, PERFORMANCE BOND and Payment Bond, as specified in Section 00613, PAYMENT BOND; and Insurance Certificates as specified in Section 00787, INDEMNIFICATION AND INSURANCE REQUIREMENTS AND SPECIAL PROVISIONS OF INSURANCE FURNISHED BY DESIGN-BUILDER within ten (10) calendar days after the date of receipt of Notice to Proceed (NTP). Submit the original and six paper copies and one electronic copy.
 - 2. Designer, Builder, Major Subcontractors and Key Project Personnel Confirmation as specified in Section 00710, PROJECT MANAGEMENT AND SUPERINTENDENCE AND KEY PERSONNEL and Section 01111, KEY DESIGNER-BUILDER FUNCTIONS within ten (10) calendar days after Award of Contract. Submit the original and six paper copies and one electronic copy.

*00727 SUSPENSION OF WORK (06/01/03)

- A. The Authority may order the Design-Builder in writing to suspend, delay or interrupt all or any part of the work for such period of time as he or she may determine to be appropriate for the convenience of the Authority.
- B. If the performance of all or any part of the work is, for an unreasonable period of time, suspended, delayed or interrupted by an act of the Contracting Officer or other delegated Authority's Representative in the administration of this Contract, or by his or her failure to act within the time specified in this Contract, or if no time is specified, within a reasonable time, an adjustment shall be made for any increase in the cost of

performance of this Contract, excluding profit, necessarily caused by such unreasonable suspension, delay or interruption and the Contract modified in writing accordingly. However, no adjustment shall be made under this Section for any suspension, delay, or interruption to the extent.

1. That performance would have been so suspended, delayed or interrupted by any other cause including the fault or negligence of the Design-Builder or
2. For which an equitable adjustment is provided for or excluded under any other provision of this Contract.

C. No claim under this Section shall be allowed:

1. For any costs incurred more than 20 days before the Design-Builder shall have notified the Contracting Officer or other delegated Authority's Representative in writing in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES of the act or failure to act involved, but this requirement shall not apply as to a claim resulting from a suspension order, and
2. Unless the claim, in an amount stated, is asserted in writing in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES as soon as practicable after the termination of such suspension, delay or interruption, but no later than the date of final payment under this Contract.
3. The Design-Builder shall submit the original and six paper copies and one electronic copy.

D. Failure to agree to any adjustment shall be a dispute concerning a question of fact within the meaning of Section 00732, DISPUTE RESOLUTION.

***00728 TERMINATION FOR DEFAULT, DAMAGES FOR DELAY, AND TIME EXTENSIONS (06/01/03)**

- A. If the Design-Builder refuses or fails to prosecute the Work, or any separable part thereof, with such diligence as will ensure its completion within the time specified in this Contract, or any extension thereof, or fails to complete said Work within such time, the Contracting Officer may, by written notice to the Design-Builder, terminate its right to proceed with the Work or such part of the Work as to which there has been delay. In such event the Contracting Officer may take over the Work and prosecute the same to completion, by contract or otherwise, and may take possession of and utilize in completing the Work such design product, materials, appliances, plant, and other work product as may be on the site of the Work and necessary therefor, all of which shall become the property of the Authority. Whether or not the Design-Builder's right to proceed with the Work is terminated, the Design-Builder and its sureties shall be liable for any damage to the Authority resulting from its refusal or failure to complete the Work in the specified time.



- B. If fixed and agreed liquidated damages are provided in the Contract and if the Contracting Officer so terminates the Design-Builder's right to proceed, the resulting damage will consist of such liquidated damages until such reasonable time as may be required for final completion of the Work together with any increased costs occasioned the Authority in completing the Work.

- C. If fixed and agreed liquidated damages are provided in the Contract and if the Contracting Officer does not so terminate the Design-Builder's right to proceed, the resulting damage will consist of such liquidated damages until the Work is completed or accepted.

- D. The Design-Builder's right to proceed shall not be so terminated nor the Design-Builder charged with resulting damage under the following circumstances:
 - 1. If the delay in the completion of the Work arises from unforeseeable causes beyond the control and without the fault or negligence of the Design-Builder, including, but not restricted to, acts of God, acts of the public enemy, acts of the Authority in its contractual capacity, acts of another contractor in the performance of a contract with the Authority, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, unusually severe weather, or delays of subcontractors or suppliers at any tier arising from causes other than normal weather beyond the control and without the fault or negligence of both the Design-Builder and such subcontractors or suppliers.
 - (a) Unusually severe weather conditions:
 - [1] Pursuant to paragraph D.1. above, the Authority will use the following table as the basis for determining allowable time extensions to the Contract for unusually severe weather conditions and the impact of such weather at the construction site.

 - [2] The column below labeled WORK DAYS represents work-day delays which may be expected in each month named within the Washington Metropolitan Area, based on a five-day work week:

<u>MONTH</u>	<u>WORK DAYS</u>
January	4
February	4
March	4
April	5
May	5
June	2
July	2
August	3
September	2
October	3
November	4
December	4

[3] Time extensions for weather delays during a given month will be allowed only for actual work days in excess of the numbers listed above and only when those excess days of delay affect the current critical path(s) leading to specified Contract completion or milestone dates.

2. If the Design-Builder, within ten (10) calendar days from the beginning of any such delay, unless the Contracting Officer grants a further period of time before the date of final payment under the Contract, notifies the Contracting Officer in writing of the causes of delay in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Design-Builder shall submit the original and six paper copies and one electronic copy of the notification. The Contracting Officer shall ascertain the facts and the extent of the delay and extend the time for completing the Work when, in the Contracting Officer's judgment, the findings of fact justify such an extension. The Contracting Officer's findings of fact shall be final and conclusive on the parties, subject only to appeal as provided Section 00732, DISPUTE RESOLUTION.
3. If, after notice of termination of the Design-Builder's right to proceed under the provisions of this Section, it is determined for any reason that the Design-Builder was not in default under the provisions of this Section, or that the delay was excusable under the provisions of this Section, the rights and obligations of the parties shall be the same as if the notice of termination had been issued pursuant to the Section 00730, TERMINATION FOR CONVENIENCE OF THE AUTHORITY of these General Conditions.
4. The rights and remedies of the Authority provided in this Section are in addition to any other rights and remedies provided by law or under this Contract.

00729 NOT USED



*00730 TERMINATION FOR THE CONVENIENCE OF THE AUTHORITY (06/01/03)

- A. The Authority may terminate this Contract in whole or, from time to time, in part, for the convenience of the Authority, the performance of Work under this Contract may be terminated by the Authority in accordance with this subsection, in whole, or from time to time in part, whenever the Contracting Officer shall determine that such termination is in the best interest of the Authority. Any such termination shall be effected by delivery to the Design-Builder of a Notice of Termination specifying the nature, extent to which performance of work under the Contract is terminated, and the date upon which such termination becomes effective.
- B. After receipt of a Notice of Termination, and except as otherwise directed by the Contracting Officer, the Design-Builder shall:
1. Immediately discontinue all services and stop work under the Contract on the date and to the extent specified in the Notice of Termination;
 2. Place no further orders or subcontracts for materials, services or facilities, except as may be necessary for completion of such portion of the Work under the Contract as is not terminated;
 3. Terminate all orders and subcontracts to the extent that they relate to the performance of work terminated by the Notice of Termination;
 4. Assign to the Authority, in the manner, at the times, and to the extent directed by the Contracting Officer, all of the right, title, and interest of the Design-Builder under the orders and subcontracts so terminated, in which case the Contracting Officer shall have the right to settle or authorize payments on any or all claims arising out of the termination of such orders and subcontracts;
 5. Settle all outstanding liabilities and all claims arising out of such termination of orders and subcontracts, with the approval or ratification of the Contracting Officer, to the extent he or she may require, which approval or ratification shall be final for all the purposes of this Section;
 6. Transfer title and deliver the following to the Authority in the manner, at the times, and to the extent, if any, directed by the Contracting Officer:
 - a. The fabricated or unfabricated parts, work in process, completed work, supplies, and other material procured as a part of, or acquired in connection with the performance of, the work terminated by the Notice of Termination.
 - b. All data, Design Specifications and Design Drawings, reports, estimates, summaries, and other information and materials accumulated in performing this Contract, whether completed or in process, shall become the property

of the Authority.

- c. All data, drawings, specifications, reports, estimates, summaries, and other information and materials accumulated in performing this Contract, whether completed or in process.
 7. Use its best efforts to sell, in the manner, at the times, to the extent, and at the price or prices directed or authorized by the Contracting Officer, any property of the types referred to in (6) above, provided, however, that the Design-Builder:
 - a. Shall not be required to extend credit to any purchaser, and
 - b. May acquire any such property under the conditions prescribed by and at a price or prices approved by the Contracting Officer; and provided further that the proceeds of any such transfer or disposition shall be applied in reduction of any payments to be made by the Authority to the Design-Builder under this Contract or shall otherwise be credited to the price or cost of the Work covered by this Contract or paid in such other manner as the Contracting Officer may direct.
 8. Complete performance of such part of the Work as shall not have been terminated by the Notice of Termination; and
 9. Take such action as may be necessary, or as the Contracting Officer may direct, for the protection and preservation of the property related to this Contract which is in the possession of the Design-Builder and in which the Authority has or may acquire an interest.
- C. After receipt of a Notice of Termination, the Design-Builder shall submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES to the Contracting Officer the original and six paper copies and one electronic copy of its termination claim, in the form and with certification prescribed by the Contracting Officer. Such claim shall be submitted promptly but in no event later than one year from the effective date of termination, unless one or more extensions in writing are granted by the Contracting Officer, upon request of the Design-Builder made in writing within such one year period or authorized extension thereof. However, if the Contracting Officer determines that the facts justify such action, the Contracting Officer may receive and act upon any such termination claim at any time after such one year period or any extension thereof. Upon failure of the Design-Builder to submit its termination claim within the time allowed, the Contracting Officer may determine, on the basis of information available to the Contracting Officer, the amount, if any, due to the Design-Builder by reason of the termination and shall thereupon authorize payment to the Design-Builder the amount so determined.
- D. Subject to the provisions of Paragraph C. the Design-Builder and the Contracting Officer may agree upon the whole or any part of the amount or amounts to be paid to



the Design-Builder by reason of the total or partial termination of work pursuant to this Section, which amount or amounts may include a reasonable allowance for profit on work done; provided, that such agreed amount or amounts, exclusive of settlement costs, shall not exceed the total Contract price as reduced by the amount of payments otherwise made and as further reduced by the Contract price of work not terminated. The foregoing notwithstanding, the Contracting Officer shall allow no anticipated profit on services not performed by the Design-Builder.

- E. The Contract shall be amended accordingly, and the Design-Builder shall be paid the agreed amount. Nothing in Paragraph F. of this Section, prescribing the amount to be paid to the Design-Builder in the event of failure of the Design-Builder and the Contracting Officer to agree upon the whole amount to be paid to the Design-Builder by reason of the termination of work pursuant to this Section shall be deemed to limit, restrict, or otherwise determine or affect the amount or amounts which may be agreed upon to be paid to the Design-Builder pursuant to Paragraph D. above.
- F. In the event of the failure of the Design-Builder and the Contracting Officer to agree, as provided in Paragraph D. upon the whole amount to be paid to the Design-Builder by reason of the termination of work pursuant to this Section, the Contracting Officer shall authorize payment to the Design-Builder the amounts determined by the Contracting Officer as follows, but without duplication of any amounts agreed upon in accordance with Paragraph D.:
 - 1. With respect to all Contract Work performed prior to the effective date of the Notice of Termination, the total, without duplication of any items, of the following:
 - a. The cost of such work;
 - b. The cost of settling and paying claims arising out of the termination of work under subcontracts or orders as provided in Paragraph B.5. above, exclusive of the amount paid or payable on account of supplies or materials delivered or services furnished by the subcontractors or suppliers prior to the effective date of Notice of Termination of work under this Contract, which amounts shall be included in the cost on account of which payment is made under Paragraph D. above; and
 - c. A sum, as profit on Paragraph D. above, determined by the Contracting Officer to be fair and reasonable, provided, however, that the Contracting Officer shall allow no anticipated profit on design services not performed by the Design-Builder, and, further, if it appears that the Design-Builder would have sustained a loss on the entire Contract had it been completed, no profit shall be included or allowed and an appropriate adjustment shall be made reducing the amount of the settlements to reflect the indicated rate of loss; and
 - 2. The reasonable cost of the preservation and protection of property incurred

pursuant to Paragraph B.9.; and any other reasonable cost incidental to termination of work under this Contract, including expense incidental to the determination of the amount due to the Design-Builder as the result of the termination of work under this Contract.

- G. The total sum to be paid to the Design-Builder under Paragraph F. above shall not exceed the total Contract price as reduced by the amount of payments made and as further reduced by the Contract price of work not terminated. Except for normal spoilage, and except to the extent that the Contracting Officer shall have otherwise expressly assumed the risk of loss, there shall be excluded from the amounts payable to the Design-Builder under this Section 00793, the fair value, as determined by the Contracting Officer, of property which is destroyed, lost, stolen, or damaged so as to become undeliverable to the Authority, or to a buyer pursuant to subparagraph B.7.
- H. The Design-Builder shall have the right of appeal, under Section 00732, DISPUTE RESOLUTION, from any determination made by the Contracting Officer under Paragraphs C. or E. above, except that if the Design-Builder has failed to submit its claim within the time provided in Paragraph C. above and has failed to request extension of such time, he shall have no such right of appeal. In any case where the Contracting Officer has made a determination of the amount due under Paragraphs C. or E. above, the Authority shall pay to the Design-Builder the following:
1. If there is no right of appeal hereunder or if no timely appeal has been taken, the amount so determined by the Contracting Officer; or
 2. If an appeal has been taken, the amount finally determined on such appeal.
- I. In arriving at the amount due the Design-Builder under this Section, the following shall be deducted:
1. All unliquidated advance or other payments on account theretofore made to the Design-Builder, applicable to the terminated portion of this Contract.
 2. Any claim which the Authority may have against the Design-Builder in connection with this Contract.
 3. The agreed price for, or the proceeds of sale of any materials, supplies, or other things acquired by the Design-Builder or sold, pursuant to the provisions of this Section, and not otherwise recovered by or credited to the Authority.
- J. If the termination hereunder be partial, prior to the settlement of the terminated portion of this Contract, the Design-Builder may file with the Contracting Officer in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, the original and six paper copies and one electronic copy of a request for an equitable adjustment of the price or prices specified in the Contract relating to the continued portion of the Contract, i.e., the portion not terminated by the Notice of Termination, and

such equitable adjustment as may be agreed upon shall be made in such price or prices.

- K. The Authority may from time to time, under such terms and conditions as it may prescribe, make partial payments and payments on account against costs incurred by the Design-Builder in connection with the terminated portion of this Contract whenever in the opinion of the Contracting Officer the aggregate of such payments shall be within the amount to which the Design-Builder will be entitled hereunder. If the total of such payments is in excess of the amount finally agreed or determined to be due under this Section, such excess shall be payable by the Design-Builder to the Authority upon demand for the period from the date such excess payment is received by the Design-Builder to the date on which such excess payment is repaid to the Authority upon demand, together with interest computed at the rate of six percent per annum, for the period from the date such excess payment is received by the Design-Builder to the date on which such excess payment is repaid to the Authority; provided, however, that no interest shall be charged with respect to any such excess, payment attributable to a reduction or other disposition of termination inventory until ten days after date of such retention or disposition, or such later date as determined by the Contracting Officer by reason of the circumstances.
- L. Unless otherwise provided for in this Contract, or by applicable statute, the Design-Builder, from the effective date of termination and for a period of three years after final settlement under this Contract, shall preserve and make available to the Authority at all reasonable times at the office of the Design-Builder but without direct charge to the Authority, all its books, records, documents and other evidence bearing on the costs and expenses of the Design-Builder under this Contract and relating to the work terminated hereunder, or to the extent determined by the Contracting Officer, photographs, microphotographs or other authentic reproduction thereof.

*00731 ASSIGNMENT

(06/01/03)

- A. The Design-Builder shall not transfer or assign this Agreement or any portion thereof or any of the rights and/or obligations of the Contract to any other party. The Contracting Officer may recognize a third party as successor in interest to the Contract where the third party's interest is incidental to the transfer of all the assets of the Design-Builder, i.e., sales of assets, transfer of assets pursuant to merger or consolidation, or incorporation of a proprietorship or partnership. Such recognition of the transfer shall be within the sole discretion of the Authority after review of the facts and circumstances surrounding each request submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, but the assignment shall not be approved unless the surety, in writing, agrees to that assignment and accepts the assignee as the Design-Builder and principal on the payment and/or performance bonds. The Design-Builder shall submit the original and six paper copies and an electronic copy of request.
- B. If this Contract provides for payments aggregating \$1,000 or more, claims for moneys

due or to become due the Design-Builder from the Authority under this Contract may be assigned to a bank, trust company or other financing institution, including any Federal lending agency, and may thereafter be further assigned and reassigned to any such institution. Notice of such assignment shall be made to the Contracting Officer and submitted through the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, but the assignment shall not be approved unless the surety, in writing, agrees to that assignment and accepts the assignee as the Design-Builder and principal on the payment and/or performance bonds. The Design-Builder shall submit the original and six paper copies and an electronic copy of notice. Any such assignment or reassignment shall cover all amounts payable under this Contract and not already paid, and shall not be made to more than one party, except that any such assignment or reassignment may be made one party as agent or trustee for two or more parties participating in such financing. It is the Authority's intent to recognize assignments only to bona fide lending institutions, therefore, assignment to any private corporation, business or individual which does not qualify as such is specifically prohibited.

- C. Any attempt to transfer by assignment not authorized by this Section shall constitute a breach of the Contract and the Contracting Officer may for such cause terminate the right of the Design-Builder to proceed as provided in Section 00728, TERMINATION FOR DEFAULT, DAMAGES FOR DELAY AND TIME EXTENSIONS, and the Design-Builder and its sureties shall be liable to the Authority for any excess costs incurred by the Authority.

*00732 DISPUTE RESOLUTION

(06/01/03)

- A. Except as otherwise provided in this Contract, any dispute arising under or related to this Contract including allegations of breach of contract or similar allegations which are not disposed of by agreement shall be decided by the Contracting Officer, who shall reduce a decision to writing and mail or otherwise furnish a copy thereof to the Design-Builder. The decision of the Contracting Officer is final and conclusive unless, within thirty (30) calendar days from the date of receipt of such copy, the Design-Builder mails or otherwise furnishes to the Contracting Officer a written notice of appeal accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES addressed to the Authority Board of Directors. The Design-Builder shall submit the original and six paper copies and an electronic copy of notice. Such notice should indicate that an appeal is intended and should reference the decision and Contract number. The decision of the Board of Directors or its duly authorized representative for the determination of such appeals shall be final and conclusive unless in proceedings initiated by either party for review of such decision in a court of competent jurisdiction, the court determines the decision to have been fraudulent, or capricious, or arbitrary, or so grossly erroneous as necessarily to imply bad faith, or is not supported by substantial evidence. In connection with any appeal proceeding under this Section, the Design-Builder shall be afforded an opportunity to be heard and to offer evidence in support of its appeal. Pending final decision of a dispute hereunder, the Design-Builder shall proceed diligently with the performance of the Contract and in accordance with the



Contracting Officer's decision. The Armed Services Board of Contract Appeals is the authorized representative of the Board of Directors for finally deciding appeals to the same extent as could the Board of Directors.

- B. This Section does not preclude consideration of questions of law in connection with decisions provided for in Paragraph A above. Nothing in this Contract, however, shall be construed as making final the decisions of the Board of Directors or its representative on a question of law.

*00733 USE AND POSSESSION PRIOR TO COMPLETION (06/01/03)

The Authority shall have the right to take possession of or use any completed or partially completed part of the work. Such possession or use shall not be deemed an acceptance of any work not completed in accordance with the Contract. While the Authority is in such possession, the Design-Builder, notwithstanding the provisions of Section 00707, PERMITS AND RESPONSIBILITIES, shall be relieved of the responsibility for loss or damage to the work other than that resulting from the Design-Builder's fault or negligence or that of its subcontractors or agents. If such prior possession or use by the Authority delays the progress of the work or causes additional expense to the Design-Builder, an equitable adjustment in the Contract price or the time of completion will be made and the Contract shall be modified in writing accordingly.

00734 NOT USED

*00735 ACCEPTANCE AND INSPECTION OF WORK (10/24/03)

- A. "Acceptance," as used in this Section, means the act of the Authority Representative, or the Project Representative, by which the Authority approves specific services as partial or complete performance of the Contract. As used in this Section, "Correction" means the elimination of a defect.
- B. Unless otherwise provided in this Contract, acceptance by the Authority shall be made as promptly as practicable after completion and inspection of all Work required by this Contract. Acceptance shall be final and conclusive except as regards latent defects, fraud or such gross mistakes as may amount to fraud, or as regards to the Authority's right under any warranty or guarantee. All punch list items identified during final inspections and noted at the time of Acceptance shall be corrected by the Design-Builder as soon as is practically possible as specified in Section 01770, CLOSEOUT PROCEDURES.
- C. The Authority Representative shall give written notice of any defect or nonconformance to the Design-Builder if and when discovered, but no later than final acceptance of the construction work designed under this Contract as specified in Section 01770, CLOSEOUT PROCEDURES, except for latent defects which may be discovered following such acceptance. This notice shall state either:

1. that the Design-Builder shall correct or re-perform any defective or nonconforming services; or,
 2. that the Authority does not require correction or re-performance. The Design-Builder shall be liable to the Authority for all costs incurred of any kind caused by or resulting from the Design-Builder's defective workmanship or noncompliance with the requirements of the Contract Documents and the Final Design Specifications and Final Design Drawings.
- D. Should it be considered necessary or advisable by the Design-Builder or Authority at any time before acceptance of the entire Work to make an examination of work already completed, by removing or tearing out same, the Design-Builder shall, on request, promptly furnish all necessary facilities, labor and material. If such work is found to be defective or nonconforming in any material respect, the Design-Builder shall defray all the expenses of such examination and of satisfactory reconstruction and pay all delay damages. If, however, such work is found to meet the requirements of the Contract Documents and the Final Design Specifications and Final Design Drawings, an equitable adjustment shall be made in the Contract price to compensate the Design-Builder for the additional services involved in such examination and reconstruction and, if completion of the Work has been delayed thereby, the Design-Builder shall in addition be granted a suitable extension of time.
- E. All Work, which term includes but is not restricted to materials, workmanship, and manufacture and fabrication of components, shall be subject to inspection and test by the Authority, if it so deems, at all reasonable times prior to acceptance as specified in Section 01113, SYSTEMS INTEGRATION, Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS, Section 01470, QUALITY SYSTEM, Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING. Any such inspection and test is for the sole benefit of the Authority and shall not relieve the Design-Builder of the responsibility of providing quality control measures to assure that the Work strictly complies with the requirements of the Contract Documents and the Final Design Specifications and Final Design Drawings. No inspection or test by the Authority shall be construed as constituting or implying acceptance. Inspection or test shall not relieve the Design-Builder of responsibility for damage to or loss of the material prior to acceptance, nor in any way affect the continuing rights of the Authority after acceptance of the completed Work.
- F. The Design-Builder shall furnish promptly, without additional charge, all services, work, labor, materials, tools, equipment and facilities reasonably needed for performing such safe and convenient inspections and tests as may be required. All inspections and tests shall be performed in such manner as not to unnecessarily delay the Work. The Authority shall receive adequate advance notice submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES to witness all tests and inspections as part of its overall quality oversight of the Project as specified in Section 01113, SYSTEMS INTEGRATION, Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS, Section 01470, QUALITY SYSTEM, Section



01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING. Tests performed that the Authority does not witness, due to the Design-Builder's failure to provide timely notice to the Authority of such tests, shall have no effect. Special, full size and performance tests shall be performed as described in the Contract Documents and the Final Design Specifications and Final Design Drawings.

- G. If the Design-Builder is required to correct or re-perform, it shall be without additional cost or fee to the Authority, and any services corrected or re-performed by the Design-Builder shall be subject to this Section to the same extent as work initially performed. If the Design-Builder fails or refuses to correct or revise any errors or deficiencies in its performance within 30 days of the Authority's request, the Authority may, by contract or otherwise, correct or replace with similar services and charge to the Design-Builder the cost incurred by the Authority thereby, or make an equitable adjustment to the Contract price.
- H. Failure to agree to responsibility for costs, either those incurred by the Design-Builder or by the Authority, for corrective actions required by this Section, shall constitute a dispute and shall be subject to the provisions of Section 00732, DISPUTE RESOLUTION.
- J. The rights and remedies of the Authority provided in this Section are in addition to any other Rights or remedies provided by law or under this Contract.
- K. The Design-Builder shall give the Authority Representative at least 14 calendar days advance notice of the date the Work, or separate portion thereof, will be fully completed and ready for final inspection, test and acceptance as specified in Section 01113, SYSTEMS INTEGRATION, Section 01470, Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS, QUALITY SYSTEM, Section 01770, CLOSEOUT PROCEDURES, Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING

*00736 AUTHORITY-FURNISHED PROPERTY (06/01/03)

- A. The Authority will make available to the Design-Builder, for use only in connection with this Contract, the property, if any, described in the Section 00836, hereinafter referred to as Authority-furnished property, at the times and locations stated therein. If the Authority-furnished property, suitable for its intended use, is not made available to the Design-Builder, the Contracting Officer shall, upon timely written request from the Design-Builder, if the facts warrant such action, equitably adjust any affected provision of this Contract pursuant to any procedures of Section 00753, CHANGES.
- B. Title to Authority-furnished property shall remain in the Authority. The Design-Builder shall maintain adequate property control records of Authority-furnished property in accordance with sound industrial practice.
- C. Unless otherwise provided in this Design-Build Contract, the Design-Builder, upon

acceptance of Authority-furnished property, assumes the risk of and shall be responsible for loss thereof or damage thereto except for reasonable wear and tear and except to the extent that such property is consumed in the performance of this Design-Build Contract.

- D. The Design-Builder shall, upon completion of this Design-Build Contract, prepare for shipment, deliver FOB origin or dispose of all Authority-furnished property not consumed in the performance of this Design-Build Contract or not theretofore delivered to the Authority as directed. The net proceeds of such disposal shall be credited to the Design-Builder price or paid in such other manner as may be directed.

*00737 MATERIAL, WORKMANSHIP AND EQUIPMENT

(06/01/03)

- A. Unless otherwise specifically provided in this Contract, all equipment, material and articles incorporated in the Project covered by this Contract are to be new and of the most suitable grade for the purpose intended. Notwithstanding the Authority's review and approval of any substitution, nothing herein relieves the Design-Builder of its obligations to satisfy its requirements under the Contract.
- B. Unless otherwise specifically provided in this Contract, reference to any equipment, material, or article to be incorporated in the Project and any patented process, by trade name, make or catalog number in the Contract Documents and Final Design Specifications and Final Design Drawings shall be regarded as establishing a standard of quality and shall not be construed as limiting competition, and the Design-Builder may, at its option, use any equipment, material, article, or process which, in the judgment of the Authority, is equal to that named. When required by this Contract or when called for by the Authority, the Design-Builder shall furnish to the Authority for approval the name of the manufacturer, the model number and other identifying data and information respecting the performance, capacity, nature and rating of the machinery and mechanical and other equipment which the Design-Builder contemplates incorporating in the Work. The Design-Builder shall furnish the Authority for approval full information concerning the material or articles which are contemplated to be incorporated into the Work. When required by the Contract or when so directed by the Authority, samples shall be submitted for approval at the Design-Builder's expense, with all shipping charges prepaid. Machinery, equipment, material and articles installed or used without required approval shall be at the risk of subsequent rejection.
- C. The Design-Builder shall provide construction equipment, in first class working order and safe condition, of sufficient quantities and sizes to complete the Work as specified and detailed in the Contract Documents and the Final Design Specifications and Final Design Drawings within the Contract Performance Time, and shall provide adequate maintenance of this equipment throughout the length of the Project.
- D. Any item of equipment that, at any time, proves ineffectual, or hazardous to personnel and/or property, shall be promptly brought to acceptable condition, or shall be removed



from the site as directed by the Authority or by any jurisdictional agencies.

*00738 HAZARDOUS MATERIALS (06/01/03)

The Authority shall be responsible for the presence of and any associated consequences of asbestos, PCB's, petroleum, or other hazardous waste or like materials and radioactive materials (Hazardous Materials) on the Project if such presence is unknown, unexpected, or not identified in information provided by the Authority, or not otherwise known to the Design-Builder prior to the preparation of his proposal. The Design-Builder shall, upon encountering or recognizing such Hazardous Materials, immediately stop work in the affected area and report the condition to the Authority Representative in writing. The Design-Builder shall submit the original and six copies and one electronic copy of the hazardous material report in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Authority shall have no responsibility or liability for any Hazardous Material that is brought to the Project or handled by the Design-Builder or any subcontractor.

*00739 PROTECTION OF EXISTING VEGETATION, STRUCTURES, UTILITIES AND IMPROVEMENTS (10/29/04)

- A. The Design-Builder shall preserve and protect all existing vegetation such as trees, shrubs, and grass on or adjacent to the site of work which is not to be removed and which does not unreasonably interfere with the work. Care shall be taken in removing trees authorized for removal to avoid damage to vegetation to remain in place. The Design-Builder shall be obligated to replace or restore all existing vegetation that is destroyed, removed or damaged in the performance of the Work to the condition that existed before work commenced.
- B. The Design-Builder shall protect from damage all adjacent property including, but not limited to, land, existing structures, improvements and/or utilities at or near the site of the Work and shall repair or restore any damage to such facilities resulting from failure to comply with the requirements of this Contract or the failure to exercise reasonable care in the performance of the Work. If the Design-Builder fails or refuses to repair any such damage promptly, the Authority may have the necessary work performed and charge the cost thereof to the Design-Builder.

00740 OPERATIONS AND STORAGE AREAS (10/29/04)

- A. All operations of the Design-Builder, including storage of materials, shall be confined to areas authorized or approved by the Authority Representative. Temporary buildings such as storage sheds, shops and offices, may be erected by the Design-Builder only with the approval of the Authority Representative, and shall be built with labor and materials furnished by the Design-Builder without expense to the Authority. Such temporary buildings and utilities shall remain the property of the Design-Builder and shall be removed by the Design-Builder at its expense upon the completion of the work. With the written consent of the Authority Representative, such buildings and utilities

may be abandoned and need not be removed.

- B. The Design-Builder shall, under regulations prescribed by the Authority, use only established roadways or construct and use such temporary roadways as may be authorized by the Authority Representative. Where materials are transported in the prosecution of the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any Federal, State or Local law or regulation. When it is necessary to cross curbs or sidewalks, protection against damage shall be provided by the Design-Builder and any damaged roads, curbs, or sidewalks shall be repaired by or at the expense of the Design-Builder.

00741 CLEANING UP (06/01/03)

- A. The Design-Builder shall at all times keep the construction area, including storage areas used by the Design-Builder, free from accumulations of waste material or rubbish and prior to completion of the work remove any rubbish from the premises and all tools, scaffolding, equipment and materials not the property of the Authority.
- B. Upon completion of construction, the Design-Builder shall leave the work and premises in a clean, neat and workmanlike condition satisfactory to the Authority Representative.

*00742 ACCIDENT PREVENTION (10/29/04)

- A. In order to provide safety controls for protection to the life and health of employees and other persons, for prevention of damage to property, materials, supplies and equipment, and for avoidance of work interruptions in the performance of this Contract, the Design-Builder shall comply with all pertinent provisions of Authority safety requirements as specified in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS and shall also take or cause to be taken such additional measures as the Authority Representative may determine to be reasonably necessary for that purpose.
- B. All construction work under this Contract shall be performed in a skillful and workmanlike manner. The Authority Representative may, in writing, require the Design-Builder to remove from the Project any employee the Authority Representative deems to be incompetent, careless or objectionable on other reasonable grounds related to the advancement of the project.
- C. The Design-Builder shall maintain an accurate record of, and shall report to the Authority Representative in the manner and on the forms prescribed by the Authority Representative exposure data and all accidents resulting in death, traumatic injury, occupational disease and damage to property, materials, supplies and equipment incidental to work performed under this Contract immediately after of such incident. Submittal shall include the original and six copies and an electronic copy of the form.
- D. The Authority Representative will notify the Design-Builder of any noncompliance with

the foregoing provisions and the action to be taken. The Design-Builder shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Design-Builder or its representative at the site of the work, shall be deemed sufficient for the purpose. If the Design-Builder fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Design-Builder.

- E. Compliance with the provisions of this Section by subcontractors shall be the responsibility of the Design-Builder.
- F. Prior to commencement of the work, the Design-Builder shall:
 - 1. Submit in writing the original and six copies and an electronic copy of its proposals for effectuating this provision for accident prevention;
 - 2. Meet in conference with the Authority to discuss and develop mutual understanding relative to administration of the overall safety program.

00743 FIRE PROTECTION EQUIPMENT AND LIFE SAFETY AGREEMENT (06/01/03)

The Design-Builder shall submit a plan for a temporary fire protection system with provisions for fire protection systems and equipment as specified in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS for use during the term of the Contract.

00744 PROTECTION OF PERSONS AND PROPERTY (06/01/03)

- A. The Design-Builder shall be responsible for ensuring compliance with the most stringent provisions of the applicable occupational safety and health statutes and regulations of the District of Columbia, State of Maryland, Commonwealth of Virginia or political subdivision in which the work is being performed and the Department of Labor OSHA standards. The Design-Builder shall comply with the Interim Organizational Health and Safety Program submitted with the Technical Proposal and the approved Organizational Health and Safety Program as specified in Section 01114 that is to be submitted by the Design-Builder prior to commencement of construction work. In addition, the Design-Builder must comply with the following documents: The appropriate WMATA Safety Manual, and associated insurance document if applicable, as specified in Section 00371; the WMATA System Safety Program Plan; the Metrorail Safety Rules and Procedures Handbook (for contracts in which work is performed on, or interfaces with the Metrorail System); the Department Bus Service Employee Handbook (for contracts in which work is performed on, or interfaces with the Metrobus System or facilities); Consolidated Plan prepared by WMATA for each Bus Division and Rail Yard in order to minimize the potential for pollutant discharge to the environment; the National Institute for Occupational Safety and Health (NIOSH) guidelines provisions pertaining to the safe performance of the Work; the American Conference of

Governmental Industrial Hygienists (ACGIH) guidelines; the American National Standards Institute (ANSI) guidelines; and the U.S. Army Corps of Engineers Safety and Health Requirements Manual. The Design-Builder shall also be responsible for compliance with applicable National Fire Protection Association (NFPA) Standards 13, 14, 24, 25 and 130. Further, the Design-Builder shall ensure that all methods of performing the work do not involve danger to the personnel employed thereon, the public, or private property, whether or not these methods are cited or indicated in the Contract Documents. Should charges of violation of any of the above be issued to the Design-Builder in the course of the work, a copy of each charge shall be immediately forwarded to the Authority Representative. The Design-Builder shall promptly notify the Authority of all damage to property of the Authority or others and of injuries sustained by any persons, of which the Design-Builder becomes aware, including but not limited to, employees of the Design-Builder, in any manner relating directly or indirectly to the Work or otherwise to this Contract.

- B. See Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS of the General Requirements for further safety, health and environmental safety requirements and procedures.
- C. See Section 00844 of the Supplementary Conditions for safety superintendence requirements.

00745 CONSIDERATION AND BASIS OF PAYMENT (06/01/03)

In consideration of its undertaking under this Contract, the Design-Builder shall be paid the sums set forth in this Contract, which shall constitute complete payment for all work and services required to be performed under this Contract and for all expenditures which may be made and expenses incurred. The basis of payment will be the Contract Price, as shown on the DESIGN-BUILD CONTRACT FORM, Section 00521, and which shall constitute complete compensation for performance of all work required by the Contract.

00746 CONTRACT PRICES AND PRICE SCHEDULE (06/01/03)

Payment for the various proposal items listed in the Price Schedule shall constitute full compensation for furnishing all plant, labor, equipment, appliances and material and for performing all operations required to complete the Work in conformity with the Authority's Contract requirements and the Final Design Specifications and Final Design Drawings developed by the Design-Builder. All costs for work not specifically mentioned in the Price Schedule shall be included in the Contract prices for the items listed.

00747 NOT USED



*00748 VARIATION IN ESTIMATED QUANTITIES

(06/01/03)

Where the quantity of a pay item in this Contract is an estimated quantity provided by the Authority and where the actual quantity of such pay item varies more than 15 percent above or below the estimated quantity stated in this Contract, an equitable adjustment in the Contract price shall be made upon demand of either party. The equitable adjustment shall be based upon any increase or decrease in costs due solely to the variation above 115 percent or below 85 percent of the estimated quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the Authority Representative shall, upon receipt of a written request for an extension of time within ten (10) calendar days from the beginning of such delay, or within such further period of time which may be granted by the Authority Representative prior to the date of final settlement of the Contract, ascertain the facts and make such adjustment for extending the completion date as in the Authority Representative's judgment the findings justify.

00749 METHOD OF PAYMENT

(10/29/04)

- A. The Authority will make progress payments monthly as the Work proceeds on estimates approved by the Authority Representative for design related work and by estimates reviewed and approved by the Authority Representative for construction related work in accordance with Section 01290 PAYMENT PROCEDURES. At least ten (10) calendar days before submission of any Application for Payment, a Preliminary Progress and Quality Status Report Review meeting as specified in Section 01312, PROJECT MEETINGS, attended by Design-Builder, Authority Representative and others as appropriate will be held to review for acceptability of the schedules as specified in Section 01322, CONTRACT PROGRESS REPORTING and the Quality System as specified in Section 01470, QUALITY SYSTEM submitted in accordance with Section 01290, PAYMENT PROCEDURES. The Design-Builder shall have an additional ten (10) calendar days to make corrections and adjustments and to complete and resubmit the schedules a Formal Progress and Quality Status Report Review meeting as specified in Section 01312, PROJECT MEETINGS, attended by Design-Builder, Authority Representative and others as appropriate will be held to approve the schedules as specified in Section 01322, CONTRACT PROGRESS REPORTING and the QA/QC Manager's Statement of Compliance Quality Certification for Payment Verification as specified in Section 01470, QUALITY SYSTEM and Section 01111, KEY DESIGN-BUILDER FUNCTIONS, and shall be submitted in accordance with Section 01290, PAYMENT PROCEDURES and Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. No progress payment shall be made to Design-Builder until the schedules are provided and accepted by the Authority Representative, whose acceptance shall not be unreasonably withheld. The progress schedule shall be acceptable to Authority as providing an orderly progression of the Work to completion within any specified Milestones and the Contract Performance Time, but acceptance of the progress schedule will neither impose on Authority responsibility for the sequencing, scheduling or work progress nor interfere with or relieve the Design-Builder from Design-Builder's full responsibility for the Work. The format and structure of the progress schedule will be as set forth in the Contract

Documents. The Authority's acceptance shall not be deemed to confirm that the schedule is a reasonable plan for performing the Work.

- B. The Design-Builder's progress payment requests shall be reviewed based on the scheduled and actual progress of the Work as reflected on the design schedule, cost loaded progress schedule, and monthly updates. The Design-Builder shall not be entitled to progress payments and the Authority shall have no obligation to review or approve progress payment requests if the Design-Builder has failed to submit or update the schedules, or if the applicable schedule or update submitted by the Design-Builder fails to accurately reflect the actual progress of the Work, or if the Authority Representative declines to approve the submitted schedules for any of the reasons stated in this Contract. A decision not to approve a request for progress payments based upon the Design-Builder's failure to comply with the schedule and update submission requirements is committed under this Contract shall be at the sole and absolute discretion of the Authority Representative.
- C. The Design-Builder shall furnish a breakdown of the total Contract price showing the amount included therein for each principal category of the Work, in such detail as requested, to provide a basis for determining progress payments. In the preparation of estimates the Authority Representative may authorize material delivered on the site and preparatory work done to be taken into consideration. Material delivered to the Design-Builder at locations other than the site may also be taken into consideration if the Design-Builder furnishes satisfactory evidence that the Design-Builder has acquired title to such material and that it will be utilized on the Work covered by this Contract.
- D. If the Contract price is more than \$50,000, material delivered that will be incorporated into the Project will be taken into consideration in computing progress payments, provided the materials is delivered on the site, or is delivered to the Design-Builder and properly stored in a warehouse, storage yard, or similar suitable place within 25 miles of the site or such reasonable distance in excess of 25 miles as may be approved by the Authority Representative, provided, however, that the Designer-Builder has the proper storage facilities, security, and insurance for the stored material as approved by the Authority Representative. Before each such payment is made for delivered material on the site, the Design-Builder shall furnish to the Authority Representative such evidence as may be required as proof of the ownership, quantity and value of such materials. Before each such payment is made for delivered materials off the site, the Design-Builder shall furnish the Authority Representative evidence of ownership, properly executed bills of sale to the Authority for the delivered material upon which payment is being made.
- E. In determining progress accomplished, the Authority will allow as an element of work accomplished, i.e., progress toward completion, only 50 percent of the invoiced cost of materials or equipment delivered to the site, or suitable location as described in paragraph D above, but not incorporated in the construction up to the time the materials or equipment are actually incorporated in the work.



- F. In making such progress payments, five percent of the estimated amount of work completed shall be retained until final completion and acceptance of the Contract Work. Also, whenever the Work is substantially complete, and the Design-Builder is in compliance with all provisions of the Contract, if the Authority Representative considers the amount retained to be in excess of the amount adequate for the protection of the Authority, the Authority Representative may request that the Contracting Officer reduce the level of retainage to an amount sufficient to protect the Authority's interests and release all or any portion of excess retainage to the Design-Builder.
- G. Where the time originally specified for completion of this Contract exceeds one year, the Authority Representative, at any time after 50 percent of the Work has been completed, if the Authority Representative finds that satisfactory progress (satisfactory progress includes prosecution of physical work, adherence to DBE if applicable, quality assurance and all other provisions of the Contract) is being made, may request that the Contracting Officer reduce the total amount retained from progress payments to the minimum level necessary to protect the interest of the Authority.
- H. All material and work covered by progress payments made shall thereupon become the sole property of the Authority but this provision shall not be construed as relieving the Design-Builder from the sole responsibility for all material and work upon which payments have been made or the restoration of any damaged work, or as waiving the right of the Authority to require the fulfillment of all of the terms of the Contract.
- I. Upon completion and acceptance of all work, the amount due the Design-Builder under this Contract shall be paid upon the presentation of a properly executed voucher as specified in Section 1290, PAYMENT PROCEDURES and Section 01770, CLOSEOUT PROCEDURES, and after the Design-Builder shall have furnished the Authority with a release of all claims against the Authority arising by virtue of this Contract as specified in Section 01780, CLOSEOUT SUBMITTALS, other than claims in stated amounts as may be specifically excepted by the Design-Builder from the operation of the release. If the Design-Builder's claim to amounts payable under the Contract has been assigned, a release may also be required of the assignee.
- J. The Authority may, at its sole discretion, withhold payment from the Design-Builder at the appropriate percentage for work, or portions thereof, that it deems to be defective or in nonconformance with the requirements of the Contract Documents.
- K. Satisfactory records for design, inspection, testing or other quality elements required under the approved Design-Build Quality System must be presented in order to receive payment for the completed work.
- L. See Section 01770, CLOSEOUT PROCEDURES for Final Inspection requirements.

*00750 PROGRESS PAYMENTS FOR LUMP SUM ITEMS (06/01/03)

If requested, the Design-Builder shall furnish to the Authority Representative a breakdown of the total Contract price for every lump sum item on the Price Schedule, showing the amount included therein for each principal category of the Work, in such detail as to provide a basis for determining progress payments. The breakdown shall be supported by such data to substantiate its correctness as the Authority Representative may require.

*00751 GARNISHMENT OF PAYMENTS (06/01/03)

Payment under this Contract shall be subject to any garnishment and attachment orders issued pursuant to the laws of Maryland, Virginia, and the District of Columbia, and to levies issued under the laws of the United States.

*00752 SUBCONTRACT PAYMENTS (06/01/03)

- A. The Design-Builder shall, under this Contract, establish procedures to ensure timely payment of amounts due pursuant to the terms of their subcontracts. The Design-Builder shall pay each subcontractor for satisfactory performance of its contract, no later than ten (10) days from the date of the Design-Builder's receipt of payment from the Authority for work by that subcontractor. The Design-Builder shall also release, within ten (10) days of satisfactory completion of all work required by the subcontractor, any retention withheld from the subcontractor.
- B. The Design-Builder shall certify on each payment request to the Authority that payment has been or will be made to all subcontractors in accordance with Paragraph A. above. The Design-Builder shall notify the Contracting Officer or other delegated Authority Representative with each payment request, of any situation in which scheduled subcontractor payments have not been made.
- C. If a subcontractor alleges that the Design-Builder has failed to comply with this Section, the Design-Builder agrees to support any Authority investigation, and, if deemed appropriate by the Authority, to consent to remedial measures to ensure subcontractor payment that is due.
- D. The Design-Builder agrees that the Authority may provide appropriate information to interested subcontractors who want to determine the status of Authority payments to the Design-Builder.
- E. Nothing in this Section is intended to create a contractual obligation between the Authority and any subcontractor or to alter or affect traditional concepts of privity of contract between all parties.



*00753 CHANGES

(06/01/03)

- A. The Authority Representative (or Contracting Officer, depending on the level of authority required) may, at any time, and without notice to the sureties, by written order designated or indicated to be a change order, make any change in the Work within the general scope of the Contract including, but not limited to, changes:
1. In the Scope of the Work or other Contract Requirements;
 2. In the Project Manual, the Project Drawing Attachments to the Project Manual, the Final Design Specifications and the Final Design Drawings;
 3. In the method or manner of performance of the work;
 4. In the Authority-furnished facilities, equipment, materials, services, or site; or
 5. Directing acceleration in the performance of work.
- B. Any other written order or an oral order, which terms as used in this Paragraph B. shall include direction, instruction, interpretation or determination from the Authority Representative or Contracting Officer, which causes any such change, shall be treated as a change order under this Section, provided that the Design-Builder gives the Authority Representative written notice stating the date, circumstances and source of the order and that the Design-Builder regards the order as a change order.
- C. Except as herein provided, no order, statement or conduct of the Authority Representative or Contracting Officer shall be treated as a change under this Section or entitle the Design-Builder to an equitable adjustment hereunder.
- D. If any change under this Section causes an increase or decrease in the Design-Builder's cost of, or the time required for, the performance of any part of the work under this Contract, whether or not changed by any order, an equitable adjustment shall be made and the Contract modified in writing accordingly: Provided, however, that no claim for any change under Paragraph B. above shall be allowed for any costs incurred more than 20 days before the Design-Builder gives written notice as therein required. This 20-day limitation shall be strictly applied regardless of whether the Authority is prejudiced by any lack of notice.
- E. If the Design-Builder intends to request an equitable adjustment under this Section, it must, within 30 days after receipt of a written change order under Paragraph A. above or furnishing of a written notice under Paragraph B. above, submit to the Authority Representative a written proposal in accordance with this CHANGES Section, unless this period is extended by the Authority Representative. The proposal hereunder may be included in the notice under Paragraph B. above.
- F. No claim by the Design-Builder for an equitable adjustment hereunder shall be allowed

if asserted after final payment under this Contract.

*00754 PRICING OF ADJUSTMENTS (06/01/03)

- A. When costs are a factor in any determination of a Contract price adjustment pursuant to Section 00753, CHANGES or any other Section of this Contract, such costs shall be in accordance with the contract cost principles and procedures in Subpart 31.1 of the Federal Acquisition Regulations (48 CFR 31.1). Where general and administrative expense is recoverable as part of any pricing adjustment under this Contract, the adjustment shall be based on the relationship between the entity's total general and administrative expenses allowable under FAR cost principles for all construction-type operations during the fiscal or calendar year covering the actual performance period of the work included in this pricing adjustment, and the entity's total cost input (excluding General and Administrative costs) for construction-type operations during the same period, expressed as a percentage, applied to the direct and overhead Contract costs included in the pricing adjustment; i.e., general and administration expenses will be paid on a percentage of cost basis, not on a daily rate type basis.
- B. Notwithstanding any interpretation of the aforementioned contract cost principles and procedures to the contrary, the Authority shall not be liable for interest, however represented, on or as a part of any claim, request, proposal or adjustment (including equitable adjustments) whether said claim, request, proposal or adjustment (including equitable adjustments) arises under the Contract or otherwise.

*00755 ACCOUNTING AND RECORD KEEPING (10/29/04)

- A. Applicability. This Section shall become effective for and shall apply to any adjustment in the price of this Contract initiated by the Design-Builder or the Authority. However, where the original amount of this Contract is less than \$1,000,000, Paragraph C. of this Section does not apply unless the adjustment is expected to exceed \$50,000.
- B. Forward Priced Adjustments. Unless expressly waived in writing in advance by the Authority Representative, the Design-Builder shall furnish to the Authority Representative a cost proposal in advance of performance of any work for which a price adjustment is requested under this Contract. The proposal format shall be as detailed in Section 01250, CONTRACT MODIFICATION PROCEDURES. The Design-Builder shall initiate such records as are necessary to substantiate all elements of the pricing proposal. Such records supporting the costs of each pricing adjustment request shall be specifically segregated and identified in the Design-Builder's accounting system as being applicable to the pricing adjustment request.
- C. Post Pricing Adjustments. In addition to the records required to be originated under Paragraph B. above, in the event pricing of an adjustment under this Contract is not agreed upon between the Design-Builder and the Authority Representative prior to the commencement of work for which the pricing adjustment is requested, the Design-Builder and any subcontractor engaged in work for which the pricing adjustment is



requested, shall maintain accounts and original cost records specifically segregated and identified by job order or other appropriate accounting procedures approved by the Authority of all incurred separated costs related to the work for which the pricing adjustment is requested. The Design-Builder shall maintain accounts and records which segregate and account for the costs of all work associated with that part of the project for which the pricing adjustment is requested and shall allocate between:

1. work required under the base Contract or under any Option if applicable;
2. work requested to be reimbursed under the pricing adjustment; and
3. other claim, including but not limited to, changes, differing site conditions, and the like.

In addition to the accounting system established to segregate and account for contract price adjustments, which shall accumulate such costs by work activity under logical cost groups, such as material, labor, equipment, subcontracts, field overhead and the like, the Design-Builder shall maintain field records associated with these costs on a form approved by the Authority Representative. Subject to agreement between the Design-Builder and the Authority Representative, or upon direction of the Authority Representative for work under Section 01250, CONTRACT MODIFICATION PROCEDURES, the Design-Builder shall use Authority Forms (Daily Report - Labor, Materials and Equipment), to be supplied by the Authority at the request of the Design-Builder. The terms of Section 01250, CONTRACT MODIFICATION PROCEDURES shall apply regardless of the form used. The use of Authority Forms to segregate change order costs does not, in and of itself, invoke the provisions of Section 01250, CONTRACT MODIFICATION PROCEDURES.

D. Availability. The accounts, records and costs information required to be originated under Paragraphs B. and C. above together with all other accounts, records and costs information related to this Contract shall be maintained and made available by the Design-Builder or subcontractor(s):

1. At the office of the Design-Builder or subcontractor(s) at all reasonable times for inspection, audit, reproduction or such other purposes as may be required by the Authority, or pursuant to any other Sections of this Contract;
2. Until the expiration of three years from the date of payment of the final \$100 (final payment) under this Contract or such lesser time as is specified in Contractor Records Retention, Subpart 4.7 of the Federal Acquisition Regulations (48 C.F.R. 4.7) and for such longer period, if any, as is required by applicable statute, or by any other Sections of this Contract, or by subparagraphs a. and b. below:
 - a. If the Contract is completely or partially terminated, for a period of three years from either the date of any resulting final settlement or the date of final payment, whichever is the greater period; and

- b. If a pricing adjustment is involved in any appeal under Section 00732, DISPUTE RESOLUTION, or in any litigation related to this Contract, for a period of one (1) year following the final disposition of the appeal or litigation.

- E. When asserting a claim under the various Sections of this Contract, the Design-Builder shall grant the Authority access to review and ascertain the validity of the accounting records being maintained for segregation of costs, including base cost records, and to audit such costs as are deemed appropriate by the Authority Representative. No payment shall be made to the Design-Builder on its claim until such records are made available and access is permitted.

- F. Limitation on Pricing Adjustment. In the event the Design-Builder or any subcontractor fails to originate or to maintain, or to make available any accounts or records as required under this or any other Section of the Contract, any pricing adjustment or portion thereof previously granted by the Authority Representative for which records are not available shall be rescinded and re-computed, or if a pricing adjustment has not yet been granted shall be computed, in an amount not to exceed the direct costs for which accounts or records are not available, plus a single markup for indirect expenses not to exceed 10 percent of the direct costs so determined by the Authority Representative. The adjustment will be established by the Authority Representative based upon, at his or her election, either:
 - 1. An audit of any existing books and records of the Design-Builder or subcontractor; or
 - 2. An Authority estimate adopted by the Authority Representative; or
 - 3. A combination of 1 and 2.

The Design-Builder and subcontractors shall not be allowed any profit for the work for which the Design-Builder or subcontractor fails to originate, or to maintain, or to make available any accounts or records as required under this Contract.

- G. The Design-Builder shall insert a clause containing all the provisions of this Section in all subcontracts issued under this Contract, modified as necessary, for proper identification of the contracting parties and the Authority Representative under this Contract.

***00756 AUDIT - PRICE ADJUSTMENTS (06/01/03)**

- A. General: The Authority shall have the audit and inspection rights described in the applicable Paragraphs B., C., and D. below.

- B. Examination of costs: If this is a cost-reimbursement type, incentive, time and materials, labor hour or price re-determinable contract, or any combination thereof, the



Design-Builder shall maintain, and the Authority shall have the right to examine books, records, documents and other evidence and accounting procedures and practices, sufficient to reflect properly all direct and indirect costs of whatever nature claimed to have been incurred for the performance of this Contract. Such right of examination shall include inspection at all reasonable times of the Design-Builder's plant, or such parts thereof, as may be engaged in the performance of this Contract.

- C. Cost or pricing data: If the Design-Builder submitted cost or pricing data in connection with the pricing of this Contract or any change or modification thereto, unless such pricing was based on adequate price competition, established catalog or market prices of commercial items sold in substantial quantities to the general public, or prices of commercial items sold in substantial quantities to the general public, or prices set by law or regulation, the Authority shall have the right to examine all books, records, documents and other data of the Design-Builder related to the negotiation, pricing or performance or such Contract, change or modification, for the purpose of evaluating the accuracy, completeness and currency of the cost or pricing data submitted. The right of examination shall extend to all documents necessary to permit adequate evaluation of the cost or pricing data submitted along with the computations and projections used therein.
- D. The Design-Builder shall insert a clause containing all the provisions of this Section, including this Paragraph D. in all subcontracts hereunder except altered as necessary for proper identification of the contracting parties and the Authority Representative under this Contract.

*00757 CERTIFICATE OF CURRENT COST OR PRICING DATA (06/01/03)

The Design-Builder shall provide a Certificate of Current Cost or Pricing Data to the Authority on a form suitable to the Contracting Officer as required in Subpart 15.403 of the Federal Acquisition Regulations (48 CFR 15.403) in support of any negotiated contract expected to exceed \$100,000 or any modification to a formally advertised or negotiated contract on which the aggregate of the increases and decreases in cost are expected to exceed \$100,000. The Authority Representative at his/her discretion may request cost or pricing data for modifications on which costs are less than \$100,000 and an attendant certificate of current cost or pricing data. Cost or Pricing data submittal procedures are specified in Section 00201, GENERAL INSTRUCTIONS and Section 01250, CONTRACT MODIFICATION PROCEDURES.

*00758 PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA - PRICE ADJUSTMENTS (06/01/03)

- A. This Section shall become operative only with respect to any modification of this Contract which involves aggregate increases and/or decreases in cost plus applicable profits in excess of \$100,000 unless the modification is priced on the basis of adequate competition, established catalog or market prices of commercial items sold in substantial quantities to the general public, or prices set by law or regulation. The right

to price reduction under this Section is limited to defects in data relating to such modification.

- B. If any price, including profit or fee, negotiated in connection with any price adjustment under this Contract was increased by any significant sums because:
1. The Design-Builder furnished cost or pricing data which was not complete, accurate and current as certified in the Design-Builder's Certificate of Current Cost or Pricing Data;
 2. A subcontractor, pursuant to the Section 00760, SUBCONTRACTOR COST OR PRICING DATA, or any subcontract provision therein required, furnished cost or pricing data which was not complete, accurate and current as certified in the subcontractor's Certificate of Current Cost or Pricing Data;
 3. A subcontractor or prospective subcontractor furnished cost or pricing data which was required to be complete, accurate and current and to be submitted to support a subcontract cost estimate furnished by the Design-Builder but which was not complete, accurate and current as of the date certified in the Design-Builder's Certificate of Current Cost or Pricing Data; or
 4. The Design-Builder or a subcontractor or prospective subcontractor furnished any data, not within Paragraphs (1), (2) or (3) above, which was not accurate, as submitted; then the price shall be reduced accordingly and the Contract shall be modified in writing as may be necessary to reflect such reduction. However, any reduction in the Contract price due to defective subcontract data of a prospective subcontractor, when the subcontract was not subsequently awarded to such subcontractor, will be limited to the amount, plus applicable overhead and profit markup, by which the actual subcontract, or actual cost to the Design-Builder if there was not a subcontract, was less than the prospective subcontract cost estimate submitted by the Design-Builder, provided the actual subcontract price was not affected by defective cost or pricing data. (Note: Since the Contract is subject to reduction under this Section by reason of defective cost or pricing data submitted in connection with certain subcontracts, it is expected that the Design-Builder may wish to include an article in each such subcontract requiring the subcontractor to appropriately indemnify the Design-Builder. However, the inclusion of such an article and the terms thereof are matters of negotiation and agreement between the Design-Builder and the subcontractor, provided that they are consistent with disputes provisions in subcontracts. It is also expected that any subcontractor subject to such indemnification will generally require substantially similar indemnification for defective cost or pricing data required to be submitted by its lower tier subcontractors.)



00759 CONTRACT MODIFICATIONS: REQUIREMENTS FOR PROPOSALS, PRICE BREAKDOWN AND NEGOTIATION OF PROFIT (10/30/04)

- A. The Design-Builder, in connection with any proposal he makes for a Contract modification, shall furnish a price breakdown, itemized as required by the Authority Representative. Unless otherwise directed, the breakdown shall be in sufficient detail to permit an analysis of all material, labor, equipment, subcontract and overhead costs, as well as profit, and shall cover all work involved in the modification, whether such work was deleted, added or changed. Any amount claimed for subcontracts shall be supported by a similar price breakdown. In addition, if the proposal includes a time extension, a justification therefor shall also be furnished. The proposal, together with the price breakdown and time extension justification shall be furnished by the date specified by the Authority Representative.
- B. Where profit is negotiated as an element of price, with either the Design-Builder or subcontractor, a reasonable profit will be negotiated for each modification by using the following procedure as a guide:

(1) Breakdown:

FACTOR	RATE	WEIGHT	VALUE
Degree of Risk	20		
Relative difficulty of Work	15		
Size of Job	15		
Period of Performance	15		
Design-Builder's Investment	5		
Assistance by Authority	5		
Subcontracting	25		
	100		%

(2) Based on the circumstances of each modification, each of the above factors shall be weighted from .03 to .12 as indicated below. The value shall be obtained by multiplying the rate by the weight. From the value column when totaled the fair and reasonable profit can be determined under the circumstances of the particular modification.

[a] **Degree of risk:** Where the modified work involves no risk or the degree of risk is very small the weighting should be .03; as the degree of risk

increases the weighting should be increased up to a maximum of .12. Lump sum items will generally have a higher weighted value than unit price items for which quantities are provided. Things to consider: The portion of the work to be done by subcontractors, nature of work, where work is to be performed, reasonableness of negotiated costs, amount of labor included in cost and whether the negotiation is before or after performance of work.

- [b] **Relative difficulty of work:** If the modified work is most difficult and complex the weighting should be .12 and should be proportionately reduced to .03 on the simplest of jobs. This factor is tied in, to some extent, with the degree of risk. Things to consider: The nature of the work, by whom it is to be done, the location and the time schedule.
 - [c] **Size of job:** All modified work not in excess of \$100,000 shall be weighted at .12. Work estimated between \$100,000 and \$5,000,000 shall be proportionately weighted from .12 to .05. Work from \$5,000,000 to \$10,000,000 shall be weighted at .04 and work in excess of \$10,000,000 at .03.
 - [d] **Period of performance:** Modifications providing for an extension of time in excess of 30 days are to be weighted at .12. Jobs of lesser duration are to be proportionately weighted to a minimum of .03 for jobs not to exceed one day. No weight is to be granted for this factor where there is no extension of the Contract performance period of interim dates due to work under this modification.
 - [e] **Design-Builder's investment:** To be weighted from .03 to .12 on the basis of below average, average and above average. Things to consider: Amount of subcontracting, mobilization payment item, Authority-furnished property and method of making progress payments.
 - [f] **Assistance by Authority:** To be weighted from .12 to .03 on the basis of average to above average. Things to consider: Use of Authority-owned property, equipment and facilities, and expediting assistance.
 - [g] **Subcontracting:** To be weighted inversely proportional to the amount of subcontracting. Where 80 percent or more of the work is to be subcontracted the weighting is to be .03 and such weighting proportionately increased to .12 where all the work is performed by the Design-Builder's own forces.
- (3) When considered necessary because of very unusual circumstances or local conditions, the range of weight may be increased to an upper limit of .15 if supported by adequate justification and if approved by the Contracting



Officer.

- (4) When negotiations between the Authority and the Design-Builder are joined to determine an equitable adjustment for a modification of this Contract, the Design-Builder shall encourage involved subcontractor(s) to be present to present their cost data and to participate in the resolution of a fair and equitable adjustment. In any event, if after reasonable effort a negotiated settlement cannot be reached between the Authority and the Design-Builder and subcontractor(s) involved, then at the request of the subcontractor(s) concerned, the Contracting Officer may process Part 1 of a two-part modification to cover the direct costs only, as agreed upon or, if not agreed upon, as determined unilaterally by the Contracting Officer. Subcontractor(s) requests for a Part 1 modification shall be submitted to the Design-Builder and the Design-Builder shall forward such requests promptly to the Contracting Officer. Any payments received by the Design-Builder under this procedure shall be passed along within 10 days thereafter to the subcontractor(s) concerned.
- C. Change orders: When the Authority Representative directs a change in accordance with Section 00724, PROGRESS SCHEDULES AND REQUIREMENTS FOR MAINTAINING PROGRESS RECORDS and Section 01322, CONTRACT PROGRESS REPORTING, the Design-Builder shall identify in his proposal for equitable adjustment the network activities that precede and follow the change order work activities. If the change order work activities are performed concurrently with existing network activities, those concurrent network activities shall be identified. If the change order work activities restrain network activities, those restraints shall be identified.

*00760 SUBCONTRACTOR COST OR PRICING DATA

(06/01/03)

- A. The Design-Builder shall require subcontractors hereunder to submit cost or pricing data prior to award of any negotiated lump sum or cost-reimbursement type, incentive, or price re-determinable subcontract over \$100,000. The Design-Builder shall require subcontractors to certify that to the best of their knowledge and belief, the cost and pricing data submitted under this Paragraph is accurate, complete, and current as of the date of execution, which date shall be as close as possible to the date of agreement on the negotiated price of the subcontract. The Design-Builder shall insert the substance of this Section in each of its negotiated lump sum or cost reimbursement type, price re-determinable, or incentive subcontracts over \$100,000 hereunder. The Design-Builder also shall insert the substance of this Section in each subcontract with respect to any change or other modification made pursuant to one or more Sections of this Contract which involves a price adjustment greater than \$100,000. The Design-Builder shall conduct a cost analysis of all negotiated subcontracts.
- B. The requirements that follow shall become operative only with respect to any change or other modification made pursuant to one or more Sections of this Contract which

involves a price adjustment in excess of \$100,000. The requirements of this Section shall be limited to such price adjustments:

1. The Design-Builder shall require subcontractors hereunder to submit cost or pricing data:
 - a. prior to award of any cost-reimbursement type, incentive, or price re-determinable subcontract;
 - b. prior to the award of any subcontract the price of which is expected to exceed \$100,000; or,
 - c. prior to the pricing of any subcontract change or other modification for which the price adjustment is expected to exceed \$100,000; except where the price is based on adequate price competition, established catalog or market prices of commercial items sold in substantial quantities to the general public or prices set by law or regulation.
2. The Design-Builder shall require subcontractors to certify that to the best of their knowledge and belief the cost and pricing data submitted under this Paragraph B. is accurate, complete and current as of the date of execution, which date shall be as close as possible to the date of agreement on the negotiated price of the Contract modification.
- C. The Design-Builder shall insert the substance of this Section in each subcontract hereunder which exceeds \$100,000.

*00761 EXAMINATION OF RECORDS (06/01/03)

- A. The Design-Builder agrees that the Contracting Officer, and the Comptroller General of the United States and the United States Secretary of Transportation if applicable, or their duly authorized representatives, shall, until the expiration of three years after final payment under this Contract, have access to and the right to examine any directly pertinent books, documents, papers, and records of the Design-Builder involving transactions related to this Contract, for the purpose of making audit, examination, excerpts and transcription.
- B. The Design-Builder further agrees to include in all its subcontracts hereunder, a provision to the effect that the subcontractor agrees that the Contracting Officer, and the Comptroller General of the United States and the United States Secretary of Transportation if applicable, or their duly authorized representatives, shall until the expiration of three years after final payment under this Contract, have access to and the right to examine any directly pertinent books, documents, papers, and records of the subcontractor involving transactions related to the subcontract, for the purpose of making audit, examination, excerpts and transcription. The term "subcontract," as used in this Section, excludes:



1. purchase orders not exceeding \$2,500 and,
2. subcontracts or purchase orders for public utility services at rates established from standard costs applicable to the general public.

***00762 WARRANTY/GUARANTEE OF CONSTRUCTION (07/15/03)**

- A. Unless otherwise specifically provided for in the Contract, the Design-Builder, notwithstanding any final inspection, acceptance or payment, guarantees that all work performed and materials and equipment furnished under this Contract are in accordance with the Contract requirements. The Design-Builder also guarantees that when installed all materials and equipment were free from defects and will remain so for a period of at least two years from the date of acceptance by the Authority.
- B. If defects of any kind should develop during the period such guarantees are in force, the Contracting Officer shall immediately notify the Design-Builder in writing of such defects. The Authority thereupon shall have the right, by a written notice to that effect, to require the Design-Builder to repair or replace all inferior or defective work, material, or equipment or permit it to remain in place and assess the Design-Builder the costs it (the Design-Builder) would have incurred had the Design-Builder been required to effect repair or replacement.
- C. Any correction or replacement of parts, materials, equipment, supplies or construction made pursuant to the provisions of this Section shall also be subject to the provisions of the Contract including this clause to the same extent as parts, material, equipment, supplies or construction originally installed. The warranty with respect to such new or corrected parts, materials, equipment, supplies or construction shall be equal in duration as that set forth in A. above and shall run from the date that such parts, materials, equipment, supplies or construction are replaced or corrected and accepted by the Authority.
- D. The Design-Builder guarantees to reimburse the Authority for, or to repair or replace, any damages to the site, buildings, or contents thereof that is caused by inferior or defective workmanship, or the use of inferior or defective materials or equipment in the performance of this Contract. The Contracting Officer shall immediately notify the Design-Builder in writing when such damage occurs. The Authority shall have the right to require the Design-Builder to repair or replace such damaged areas or equipment, or elect to permit such damage to remain as is and assess the Design-Builder the costs it would have incurred had it been required to effect repair or replacement.
- E. Should the Design-Builder fail to proceed promptly, after notification by the Contracting Officer, to repair or replace any inferior or defective work, material, or equipment, or damage to the site, buildings, or contents, thereof, caused by inferior or defective work, or the use of inferior or defective materials, or equipment, the Authority may have such work, material, equipment, or damage repaired or replaced and charge all costs incident thereto to the Design-Builder.

- F. Any special guarantees that may be required under the Contract, shall be subject to the elections set forth above unless otherwise provided in such special guarantees.
- G. Should the Design-Builder fail to prosecute the work or fail to proceed promptly to provide guarantee period services after notification by the Contracting Officer, the Authority may, subject to Section 00728, TERMINATION FOR DEFAULT, DAMAGES FOR DELAY AND TIME EXTENSIONS contained in this Contract, and after allowing the Design-Builder 10 calendar days to correct and comply with the Contract, terminate the right to proceed with the work (or the separable part of the work) that has been delayed or unsatisfactorily performed. In this event, the Authority may take over the work and complete it by contract or otherwise, and may take possession of and use any materials, appliance, and plant on the work site necessary for completing the work. The Design-Builder and its sureties shall be liable for any damages to the Authority resulting from the Design-Builder's refusal or failure to complete the work within this specified time, whether or not the Design-Builder's right to proceed with the work is terminated. This liability includes any increased costs incurred by the Authority in completing the work.
- H. The decision of the Contracting Officer as to liability of the Design-Builder under this Section is subject to the appeal procedure provided for in Section 00732, DISPUTE RESOLUTION of this Contract.
- I. All subcontractor's, manufacturers' and suppliers' warranties and guarantees, expressed or implied, respecting any part of the Work and any material used therein shall be deemed obtained in accordance with Section 01780, CLOSEOUT SUBMITTALS, and shall be enforced, by the Design-Builder for the benefit of the Authority without the necessity of separate transfer or assignment thereof, provided that, if directed by the Authority, the Design-Builder shall require such subcontractor's, manufacturers and suppliers to execute such warranties and guarantees in writing to the Authority in accordance with Section 01780, CLOSEOUT SUBMITTALS. In connection therewith, the Design-Builder further agrees to perform the Work in such a manner or consistent with and so as to preserve all such warranties and guarantees.
- J. Certain Standard and Technical Specifications Sections provide for a warranty longer than the general warranty provided in this Contract, or commence from dates other than Final Completion and Acceptance of the Work. Where such warranties are specified as both in addition to the general warranty and in total years, the total years shall govern, and the warranty period shall commence from Final Completion and Acceptance of the Work.

00763 CORRECTION OF DEFICIENCIES

(07/07/03)

- A. This Section shall apply only to those deficiencies discovered by either the Authority or the Design-Builder within two years after acceptance. Materials or equipment will be regarded as having a deficiency if a type of material or equipment in like service accumulates a failure rate greater than five percent within a period of two years



following final acceptance by the Authority. Systems or subsystems will be regarded as having a deficiency if they exhibit any condition or characteristics which are not in compliance with the Contract Documents and the Design-Builder's Final Design Specifications and Final Design Drawings, and intent of this Contract anytime during a period extending for two years following their final acceptance by the Authority.

- B. Notice of deficiency to Design-Builder: If the Authority determines that a deficiency exists in any of the materials, equipment, systems or subsystems provided the Authority under this Contract, it shall promptly notify the Design-Builder of the deficiency, in writing, within 30 days.
- C. Recommendation for correction: Upon timely notification of the existence of such a deficiency, or if the Design-Builder independently discovers a deficiency in accepted materials, equipment, systems or subsystems, the Design-Builder shall promptly submit to the Authority its recommendation for corrective actions, together with supporting information in sufficient detail for the Authority to determine what corrective action, if any, shall be undertaken in accordance with Section 01780, CLOSEOUT SUBMITTALS. The recommendation shall be submitted to the Authority within 15 working days of discovery or receipt of notice of the deficiency.
- D. Direction to Design-Builder concerning correction of deficiencies: Within 30 days after receipt of the Design-Builder's recommendations for corrective action and adequate supporting information, the Contracting Officer, at his sole discretion, shall give the Design-Builder written notice not to correct any deficiency, or to correct or partially correct any deficiency within a reasonable time and at a specified location.
- E. Schedule of deficiency corrections: The Design-Builder shall prepare Schedule of Deficiency Corrections and deliver it to the Authority for approval in accordance with Section 01780, CLOSEOUT SUBMITTALS within 15 working days of discovery of deficiency by the Design-Builder or receipt of notice of discovery of a deficiency by the Authority.
- F. Correction of deficiencies by Design-Builder: The Design-Builder shall promptly comply with any timely written direction by the Contracting Officer to correct or partially correct a deficiency, at no increase in the Contract price. The Design-Builder shall also prepare and furnish to the Authority in accordance with Section 01780, CLOSEOUT SUBMITTALS data and reports applicable to any correction required under this Section (including revision and updating of all other affected data called for under this Contract) at no increase in the Contract price.
- G. Modification of Contract with respect to uncorrected deficiencies: In the event of timely notice of a decision not to correct or only to partially correct a deficiency, the Design-Builder shall submit to the Authority within 15 working days, a technical and cost proposal to amend the Contract in accordance with Section 01780, CLOSEOUT SUBMITTALS to permit acceptance of the affected materials, equipment, systems or subsystems in accordance with the revised requirements, and an equitable reduction

in Contract price shall promptly be negotiated by the parties and stated in a modification to this Contract.

- H. Failure to correct: If the Design-Builder fails or refuses to present a detailed recommendation for corrective action and to prepare and furnish data and reports as required in Paragraph G., then the Contracting Officer shall give the Design-Builder written notice specifying the failure or refusal and setting a period after receipt of the notice within which it must be corrected. If the failure or refusal is not corrected within the specified period, the Contracting Officer may, by contract or otherwise, as required:
1. Obtain detailed recommendations for corrective action;
 2.
 - a. Correct the materials, equipment, systems or subsystems, or
 - b. Replace the materials, equipment, systems or subsystems; and if the Design-Builder fails to furnish timely disposition instructions, the Contracting Officer may dispose of non-conforming materials, equipment, systems or subsystems for the Design-Builder's account in a reasonable manner, in which case the Authority is entitled to reimbursement from the Design-Builder or from the proceeds for the reasonable expense of care and disposition, as well as for excess costs incurred or to be incurred; and
 - c. Obtain applicable data and reports.
 3. Charge to the Design-Builder the cost occasioned to the Authority thereby.
- I. Correction of deficient replacements and re-performances: Any materials or equipment corrected or furnished in replacement and any systems or subsystems revised pursuant to this Section shall also be subject to all the provisions of the Contract to the same extent as materials, equipment, systems or subsystems initially accepted.
- J. The correction of materials or equipment exhibiting a failure rate greater than five percent means taking of any and all actions necessary to correct the deficiencies, including removal and replacement of all pieces of material or equipment in like service in a manner satisfactory to the Authority Representative. The correction of systems or subsystems exhibiting one or more deficiencies means taking any and all actions necessary to eliminate any and all deficiencies in a manner satisfactory to the Authority.
1. Disassembly/reassembly expense: The Design-Builder shall be liable for reasonable cost of disassembly/reassembly of larger items necessary to remove the materials or equipment to be inspected and/or returned for correction or replacement.
 2. Transportation charges:
 - a. When the Authority returns supplies to the Design-Builder for correction or



replacement pursuant to this Section, the Design-Builder shall be liable for transportation charges up to an amount equal to the cost of transportation by the usual commercial method of shipment from the designated destination point under this Contract to the Design-Builder's plant, in addition to any charges provided for in subparagraph 2.b. below. The Design-Builder shall also bear the responsibility for the supplies while in transit.

- b. When compliance with the terms of this Section by the Design-Builder involves shipment of corrected or replacement supplies from the Design-Builder to the Authority, the Design-Builder shall be liable for transportation charges up to an amount equal to the cost of transportation by the usual commercial method of shipment from the Design-Builder's plant to the designated destination point under this Contract, in addition to any charges provided for subparagraph 2.a. above. The Design-Builder shall also bear the responsibility for the supplies while in transit.
- K. No extension in time for performance; no increase in Contract price: In no event shall the Authority be responsible for extension or delays in the scheduled deliveries or periods of performance under this Contract as a result of the Design-Builder's obligations to correct deficiencies, nor shall there be any adjustment of the delivery schedule or period of performance as a result of such correction of deficiencies, except as may be agreed to by the Authority in a supplemental agreement with adequate consideration.
- L. The Design-Builder shall not be responsible under this Section for the correction of deficiencies in Authority-furnished property, except for deficiencies in installation, unless the Design-Builder performs or is obligated to perform any modifications or other work on such property. In that event, the Design-Builder shall be responsible for correction of deficiencies to the extent of such modifications or other work.
- M. The Design-Builder shall not be responsible under this Section for the correction of deficiencies caused by the Authority.

00764 COVENANT AGAINST CONTINGENT FEES

(06/01/03)

The Design-Builder warrants that no person or selling agency has been employed or retained to solicit or secure this Contract upon an agreement or understanding for a commission, percentage, brokerage or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies utilized by the Design-Builder for the purpose of securing business. For breach or violation of this warranty the Contracting Officer shall have the right to annul this Contract without liability or in his or her discretion to deduct from the Contract price or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage or contingent fee.

***00765 OFFICIALS NOT TO BENEFIT (06/01/03)**

- A. No member of Congress or resident commissioner shall be admitted to any share or part of this Contract, or to any benefit that may arise therefrom; but this Paragraph shall not be construed to extend to this Contract if made with a corporation for its general benefit.
- B. No member, officer or employee of the Authority or of a local public body during tenure with the Authority or with another local public body and one year thereafter shall have any interest, direct or indirect, in this Contract or the proceeds thereof.

***00766 GRATUITIES (06/01/03)**

In connection with performance of work required under this Contract, or any changes or modifications relative thereto, the giving of or offering to give gratuities (in the form of entertainment, gifts or otherwise) by the Design-Builder, or any agent, representative or other person deemed to be acting on behalf of the Design-Builder, or any supplier or subcontractor furnishing material to or performing work under this Contract, or any agent, representative or other person deemed to be acting on behalf of such supplier or subcontractor, to any Director, Officer or employee of the Authority; or to any Director, Officer, employee or agent of any of the Authority's agents, consultants, representatives or other persons deemed to be acting for or on behalf of the Authority, with a view toward securing a contract or securing favorable treatment with respect to the awarding or amending, or the making of any determinations with respect to the performing of such contract is expressly forbidden. The terms of this GRATUITIES Section shall be strictly construed and enforced in the event of violations hereto.

***00767 CONFLICT OF INTEREST (06/01/03)**

- A. Neither the Design-Builder nor any person affiliated with it shall have, during the term of this Contract and any extension thereof, any contractual or other financial relationship with the Authority, with any Authority prime contractor, or with any subcontractor or supplier to any Authority prime contractor other than the contractual relationship established under this Contract, unless an exception is granted as described below. Such exceptions will not unreasonably be withheld.
- B. Upon request of the Design-Builder and upon full disclosure and for good cause the Contracting Officer may, at his/her sole discretion, grant an exception to the requirement of this Section 00767, when in his/her judgment the exception will not create a conflict between the Design-Builder's duties and obligations under this Contract and the duties and obligations imposed on the Design-Builder under the contractual or other relationship for which an exception is requested.
- C. If, during the performance of this Contract and any extension thereof, the Design-Builder becomes aware of any relationship, financial interest, or other activity in which it or an affiliated person or company is involved which is not in compliance with the

provisions of this Section 00767, it shall promptly notify the Contracting Officer in writing and fully disclose all circumstances thereof. Should the Contracting Officer not grant an exception to the requirements of this Section 00767, the Design-Builder shall, within ten days of written notice from the Contracting Officer to do so, take all action necessary to comply with the terms of this Section.

- D. If the Design-Builder fails to comply with the terms of this Section 00767, the Contracting Officer may withhold payments due under the Contract until such time as the Design-Builder is in compliance or, should the non-compliance remain uncorrected at the expiration of ten days from written notice from the Contracting Officer as provided in this Section, terminate the Contract for default pursuant to Section 00728, TERMINATION FOR DEFAULT, DAMAGES FOR DELAY, AND TIME EXTENSIONS of this Contract.
- E. The Design-Builder in performing this Contract shall avoid any conduct which might result in or give the appearance of creating for Directors, Officers or employees of the Authority in their relationship with the Design-Builder any conflicts of interest or favoritism and/or the appearance thereof and shall avoid any conduct which might result in a Director, Officer or employee failing to adhere to the Standards of Conduct adopted by the Authority's Board of Directors.
- F. The Design-Builder shall not, during the period of performance of the Contract, engage in any other contracts where its customary role would or might:
 - 1. Impair the actual or potential ability of the Design-Builder to render impartial assistance or advice to the Authority;
 - 2. Impair the Design-Builder's objectivity in performing this Contract or any other Authority contract,
 - 3. Give the Design-Builder an unfair competitive advantage with respect to the work under another proposed Authority contract.
- G. Any determination by the Contracting Officer under this Section shall be final and shall be subject to Section 00732, DISPUTE RESOLUTION.

00768 EMPLOYMENT RESTRICTION WARRANTY

(06/01/03)

- A. The Design-Builder warrants that it will not offer employment to any officer or employee of the Washington Metropolitan Area Transit Authority (WMATA) who has been involved, directly or indirectly, in any matter of financial interest to the Design-Builder until at least one year after the officer or employee has ceased involvement in or responsibility for the matter.
- B. The Design-Builder further warrants that it will not employ any WMATA officer or employee who has had direct responsibility for any matter of financial interest to the

Design-Builder within the year prior to the retirement or termination of the officer or employee until at least one full year after such officer or employee has left the employment of the Authority.

- C. The one-year restriction described in Paragraphs A. and B. above may be waived at the discretion of the Authority if the WMATA employee or former employee has been subject to a Reduction in Force; in such case, the Authority will provide the Design-Builder with a letter to that effect.
- D. If a waiver is granted, or if a former employee of WMATA is eventually hired, the Design-Builder shall be responsible for ensuring that the former employee is not directly involved in negotiating or otherwise dealing with WMATA on any particular matter over which such employee had responsibility during his or her period of employment at WMATA.
- E. Should the Design-Builder fail to comply with Paragraphs A., B. or D. above, the Authority shall have the right to withhold payment under this Contract in an amount not to exceed two percent of the total Contract amount as liquidated damages to the Authority, such withholding to be in addition to any other withholding or damages available for other matters under this Contract. Further, the Authority shall consider such violation in evaluating the Design-Builder's responsibility in connection with award of any other Authority contract.

00769 NOT USED

00770 CIVIL RIGHTS (06/01/03)

- A. Nondiscrimination: In accordance with Title VI of the Civil Rights Act, as amended, 42 U.S.C. §2000d, section 303 of the Age Discrimination Act of 1975, as amended, 42 U.S.C. §6102, section 202 of the American with Disabilities Act of 1990, 42 U.S.C. §12132, and Federal transit law at 49 U.S.C. §5332, the Design-Builder agrees that it will not discriminate against any employee or applicant for employment because of race, color, creed, national origin, sex, age, or disability. In addition, the Design-Builder agrees to comply with applicable Federal implementing regulations and other implementing regulations that the Authority, and the FTA if applicable, may issue.
- B. Equal Employment Opportunity: The following equal employment opportunity requirements apply to this Contract.
 - 1. Race, Color, Creed, National Origin, Sex: In accordance with Title VII of the Civil Rights Act, as amended, 42 U.S.C. §2000e, and Federal transit laws at 49 U.S.C. §5332, the Design-Builder agrees to comply with all applicable equal opportunity requirements of the U. S. Department of Labor (U.S. DOL) regulations, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor, " 41 C.F.R. Parts 60 *et seq.*, (which implement Executive Order No. 11246, "Equal Employment Opportunity,"



as amended by Executive Order No. 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," 42 U.S.C. 2000e note), and with any applicable Federal statutes, executive orders, regulations, and Federal policies that may in the future affect construction activities undertaken in the course of the Contract. The Design-Builder agrees to take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, creed, national origin, sex or age. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. In addition, the Design-Builder agrees to comply with any implementing requirements the Authority, and the FTA if applicable, may issue.

2. Age: In accordance with Section 4 of the Age Discrimination in Employment Act of 1967, as amended, 29 U.S.C. §§ 623 and Federal transit law at 49 U.S.C. §5332, the Design-Builder agrees to refrain from discrimination against present and prospective employees for reason of age. In addition, the Design-Builder agrees to comply with any implementing requirements the Authority, and the FTA if applicable, may issue.
3. Disabilities: In accordance with Section 102 of the Americans with Disabilities Act, as amended, 42 U.S.C. §12112, the Design-Builder agrees that it will comply with the requirements of U. S. Equal Employment Opportunity Commission, "Regulations to Implement the Equal Employment Provisions of the Americans with Disabilities Act," 29 C.F.R. Part 1630, pertaining to employment of persons with disabilities. In addition, the Design-Builder agrees to comply with any implementing requirements the Authority, and the FTA if applicable may issue.

C. The Design-Builder also agrees to include these requirements in each subcontract, modified only if necessary to identify the affected parties.

00771 NOT USED

00772 DISADVANTAGED BUSINESS ENTERPRISE (Not Used) (10/25/04)

*00773 UTILIZATION OF SMALL BUSINESS CONCERNS (06/01/03)

- A. It is the policy of the Authority that a fair proportion of the purchases and contracts for supplies and services for the Authority be placed with small business concerns.
- B. The Design-Builder agrees to accomplish the maximum amount of subcontracting to small business concerns that the Design-Builder finds to be consistent with the efficient performance of this Contract.

*00774 LABOR PROVISIONS

(10/01/03)

The following Paragraphs B. TO M. apply only to the Construction portion of the Design-Build Contract.

A. Minimum Wages:

1. All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing-Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act, 29 C.F.R. Part 3), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at the time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof as specified in APPENDIX D to Section 00800, regardless of any contractual relationship which may be alleged-to exist between the Design-Builder and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b) (2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of 29 C.F.R. §5.5(a)(1)(iv); also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs that cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided at 29 C.F.R. §5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein, provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under 29 C.F.R. §5.5(a)(1)(ii) And the Davis-Bacon poster (WH-1321) shall be posted at all times by the Design-Builder and its subcontractor at the site of the work in a prominent and accessible place where it can be easily seen by the workers.
 - a. The Authority shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The Authority shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:
 - (1) The work to be performed by the classification requested is not



- performed by a classification in the wage determination; and
- (2) The classification is utilized in the area by the construction industry; and
 - (3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.
- b. If the Design-Builder and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the Authority agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the Authority Representative to the Administrator of the Wage and Hour Division, Employment Standards Administration, Washington, D.C. 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the Authority or will notify the Authority within the 30-day period that additional time is necessary.
 - c. In the event the Design-Builder, the laborers or mechanics to be employed in the classification or their representatives, and the Authority do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the Authority shall refer the questions, including the views of all interested parties and the recommendation of the Authority to the administrator for determination. The Administrator, or an authorized representative, will issue a determination with 30 days of receipt and so advise the Authority or will notify the Authority within the 30-day period that additional time is necessary.
 - d. The wage rate (including fringe benefits where appropriate) determined pursuant to A.1.b. and c. above, shall be paid to all workers including helpers performing work in the classification under this contract from the first day on which work is performed in the classification.
2. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the Design-Builder shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.
 3. If the Design-Builder does not make payments to a trustee or other third person, the Design-Builder may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, provided, that the secretary of labor has found,

upon the written request of the Design-Builder, that the applicable standards of the Davis-Bacon act have been met. The Secretary of Labor may require the Design-Builder to set aside in a separate account assets for the meeting of obligations under the plan or program.

B. Withholding

1. The Authority shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the Design-Builder, under this agreement or any other Authority contract with the same recipient, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Design-Builder or any subcontractor the full amount of wages required by the Contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), all or part of the wages required by the Contract, the Authority may, after written notice to the Design-Builder, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee or funds until such violations have ceased.

C. Payrolls and Basic Records

1. Payrolls and basic records relating thereto shall be maintained by the Design-Builder during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in Section 1(b)(2)(b) of the Davis-Bacon act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 C.F.R. § 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in Section 1(b)(2)(b) of the Davis-Bacon Act, the Design-Builder shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual costs incurred in providing such benefits. Design-Builders employing apprenticeship or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the



applicable programs.

2. The Design-Builder shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Authority. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 C.F.R. §5.5(a)(3)(i). This information may be submitted in any form desired. Optional form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal Stock no. 029-005-00014-1), U.S. Government Printing Office, Washington, D.C. 20402. The Design-Builder is responsible for the submission of copies of payrolls by all subcontractors.
 - a. Each payroll submitted shall be accompanied by a "Statement of Compliance" signed by the Design-Builder or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the Contract and shall certify the following:
 - (1) That the payroll for the payroll period contains the information required to be maintained under 29 C.F.R. §5.5(a)(3)(i) And that such information is correct and complete;
 - (2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth at 29 C.F.R. Part 3;
 - (3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.
 - b. The weekly submission of a properly executed certification set forth on the reverse side of optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by 29 C.F.R. §5.5(a)(3)(ii)(B).
 - c. The falsification of any of the above certifications may subject the Design-Builder or subcontractor to civil or criminal prosecution under 18 U.S.C. §1001 and 31 U.S.C. §3729.

D. Apprentices and Trainees

1. The Design-Builder or subcontractor shall make the records required under 29 C.F.R. §5.5(a)(3)(i) available for inspection, copying, or transcription by authorized

representatives of the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the Design-Builder or subcontractor fails to submit the required records or make them available, the Authority may, after written notice to the Design-Builder, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or make such records available may be grounds for debarment action pursuant to 29 C.F.R. §5.12.

- a. Apprentices: Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship, Training and Employer Labor Services, or with a State apprenticeship agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship, Training and Employer Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the Design-Builder as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage on the wage, determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a Design-Builder is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Design-Builder's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringe benefits shall be paid in accordance with that determination. In the event the Office of Apprenticeship, Training and Employer Labor Services, or a



state apprenticeship agency recognized by the Office, withdraws approval of an apprenticeship program, the Design-Builder will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

2. Trainees: Except as provided in 29 C.F.R. §5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination that provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the employment and training administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the employment and training administration withdraws approval of a training program, the Design-Builder will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.
3. Equal employment opportunity. The utilization of apprentices, trainees, and journeymen under 29 C.F.R. Part 5 shall be in conformity with the equal employment opportunity requirements of Executive Order No. 11246, as amended 29 C.F.R. Part 30.
4. Helpers: Helpers will be permitted to work on a project if the helper classification is specified on an applicable wage determination or is approved pursuant to the conformance procedure set forth in 29 C.F.R. §5.5(a)(1)(ii). The allowable ratio of helpers to journeyman employed by the Design-Builder or subcontractor on the job site shall not be greater than two helpers for every three journeymen (in other words, not more than 40 percent of the total number of journeymen and helpers in each Design-Builder's or in each subcontractor's own work force employed on the job site.) Any worker listed on a payroll at a helper wage rate, who is not a

helper as defined in 29 C.F.R. §5.2(n)(4), shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any helper performing work on the job site in excess of the ratio permitted shall be paid not less than the applicable journeyman's (or laborer's, where appropriate) wage rate on the wage determination for the work actually performed.

- E. Compliance with Copeland Act Requirements. The Design-Builder shall comply with the requirements of 29 C.F.R. Part 3, which are incorporated herein by reference.
- F. Contract Termination: Debarment. A breach of the contract clauses in 29 C.F.R. §5.5 may be grounds for termination of the Contract, and for debarment as a Design-Builder and/or a subcontractor as provided in 29 C.F.R. §5.12.
- G. Compliance with Davis-Bacon and Related Act Requirements. All rulings and interpretations of the Davis-Bacon and related Acts contained in 29 C.F.R. Parts 1, 3 and 5 are incorporated herein by reference.
- H. Disputes Concerning Labor Standards: Disputes arising out of the Labor Standards provisions of this Contract shall not be subject to Section 00732, DISPUTE RESOLUTION of this Contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 C.F.R. Parts 5, 6, and 7. Disputes within the meaning of this Section include disputes between the Design-Builder (or any of its subcontractors) and the Contracting Agency, the U.S. Department of Labor, or the employees or their representatives.
- I. Certification of Eligibility:
 - 1. By entering into this agreement or a third party contract financed under this agreement the Design-Builder certifies that neither it (nor he nor she) nor any person or firm that has an interest in the Design-Builder's firm is a person or firm ineligible to be awarded government contracts by virtue of Section 3(a) of the Davis-Bacon Act or 29 C.F.R. §5.12(a)(1).
 - 2. No part of this Contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of Section 3(a) of the Davis-Bacon Act or 29 C.F.R. §5.12(a)(1).
 - 3. The penalty for making false statement is prescribed in the U.S. Criminal code, 18 U.S.C.1001.
- J. Overtime Requirements: Neither the Design-Builder nor any subcontractor contracting for any part of the Contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanics in any work week in which he or she is employed on such work to work in excess of forty hours in such work week unless such laborer or mechanics receives compensation at



a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such work week.

- K. Violation: Liability for Unpaid Wages: Liquidated Damages: In the event of any violation of the requirements of 29 C.F.R. §5.5(b)(1), the Design-Builder and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such Design-Builder and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such district or to such territory) if the Contract is funded by the FTA, and if not, to the Authority for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of 29 C.F.R. §5.5(b)(1) in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard work week of forty hours without payment of the overtime wages required by 29 C.F.R. §5.5(b)(1).
- L. Withholding for Unpaid Wages and Liquidated Damages: The FTA or the recipient shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the Design-Builder or subcontractor under any such contract, or any other Authority contract with the same Design-Builder or any federally-assisted contract subject to the Contract Work Hours and Safety Standards Act if FTA funding is provided for the Contract, which is held by the same Design-Builder, such sums as may be determined to be necessary to satisfy any liabilities of such Design-Builder or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth at 29 C.F.R. §5.5(b)(2).
- M. Subcontracts: The Design-Builder or subcontractor shall insert in any subcontracts, the clauses set forth in Paragraphs A. through L. of this LABOR PROVISIONS Section, and also a clause requiring the subcontractor to include these clauses in any lower tier subcontracts. The Design-Builder shall be responsible for compliance by any subcontractor with Paragraphs A. through M. of this LABOR PROVISIONS Section.

*00775 WALSH-HEALEY PUBLIC CONTRACTS ACT

(06/01/03)

If this Contract is for the manufacture or furnishing of materials, supplies, articles, or equipment in an amount which exceeds or may exceed \$10,000 and is subject to the Walsh-Healey Public Contracts Act, as amended (41 U.S.C. 35-45), the following terms and conditions apply:

- A. All stipulations required by the Act and regulations issued by the Secretary of Labor (41 CFR Chapter 50) are incorporated by reference. These stipulations are subject to all applicable rulings and interpretations of the Secretary of Labor that are now, or may be hereafter, be in effect.
- B. All employees whose work relates to this Contract shall be paid not less than the minimum wage prescribed by regulations issued by the Secretary of Labor (41 CFR 50-

202.2). Learners, student learners, apprentices, and handicapped worker may be employed at less than the prescribed minimum wage (see 41 CFR 50-202.3) to the same extent that such employment is permitted under Section 14 of the Fair Labor Standards Act (41 U.S.C. 40).

***00776 WAGE RATES (06/01/03)**

- A. The minimum wages, which in addition to basic hourly rate of pay include fringe benefit payments to be paid laborers and mechanics on this project pursuant to Section 00774, LABOR PROVISIONS of this Contract, as determined by, the Secretary of Labor to prevail for corresponding classes of laborers and mechanics employed on projects similar in character to the Contract work in the pertinent locality, are set forth as an attachment to this Contract.
- B. Any class of laborers and mechanics not listed but employed on this Contract shall be classified or reclassified conformably to the schedule set out therein by mutual agreement between the Design-Builder and class of labor concerned, subject to prior approval of the Authority Representative. In the event the interested parties cannot agree on the proper classification or reclassification of a particular class of laborer and mechanics to be used, the question, accompanied by the recommendation of the Authority Representative, shall be referred to the Secretary of Labor for final determination.
- C. For Current Wage Mods, Refer to Appendix D - WAGE DETERMINATION RATES, included as an Appendix to the Proposal Forms and Supplements in Section 00400.

00777 NOTICE TO THE AUTHORITY OF LABOR DISPUTES (06/01/03)

- A. Whenever the Design-Builder has knowledge that any actual or potential labor dispute is delaying or threatens to delay the timely performance of this Contract, the Design-Builder shall immediately give notice thereof, including all relevant information with respect thereto, to the Authority Representative.
- B. The Design-Builder agrees to insert the substance of this Section 00777 in any subcontract hereunder as to which a labor dispute may delay the timely performance of this Contract; except that each such subcontract shall provide that in the event its timely performance is delayed or threatened by delay by any actual or potential labor dispute, the subcontractor shall immediately notify its next higher tier subcontractor, or the Design-Builder, as the case may be, of all relevant information with respect to such dispute.

***00778 CONVICT LABOR (06/01/03)**

In connection with the performance of work under this Contract, the Design-Builder agrees not to employ any person undergoing sentence of imprisonment at hard labor.



*00779 FEDERAL, STATE AND LOCAL TAXES

(06/01/03)

- A. The Contract price includes all applicable Federal, State and local taxes and duties.
- B. Nevertheless, with respect to any Federal excise tax or duty on the transactions or property covered by this Contract, if a statute, court decision, written ruling, or regulation takes effect after the Contract date and results in the following:
 - 1. The Designer-Builder being required to pay or bear the burden of any such Federal excise tax or duty or increase in the rate thereof which would not otherwise have been payable on such transactions or property, the Contract price shall be increased by the amount of such tax or duty or rate increase, provided the Designer-Builder warrants in writing that no amount for such newly imposed Federal excise tax or duty or rate increase was included in the Contract price as a contingency reserve or otherwise; or
 - 2. The Designer-Builder not being required to pay or bear the burden of, or in its obtaining a refund or drawback of, any such Federal excise tax or duty which would otherwise have been payable on such transactions or property or which was the basis of an increase in the Contract price, the Contract price shall be decreased by the amount of the relief, refund, or drawback, or that amount of the relief, refund, or drawback, or that amount that shall be paid to the Authority, as directed by the Authority Representative. The Contract price shall be similarly decreased if the Designer-Builder, through its fault or negligence or its failure to follow instructions of the Authority Representative, is required to pay or bear the burden of, or does not obtain a refund or drawback or, any such Federal excise tax or duty.
- C. Paragraph B. above shall not be applicable to Social Security taxes or to any other employment tax.
- D. No adjustment of less than \$100 shall be made in the Contract price pursuant to Paragraph B. above.
- E. As used in Paragraph B. above, the term Contract date means the dates set for proposal opening, except if this is a negotiated Contract, the date that the Designer-Builder submits its Best and Final Offer. As to additional supplies or services procured by modification to this Contract, the term Contract date means the date of such modification.
- F. Unless there does not exist any reasonable basis to sustain an exemption, the Authority Representative upon the request of the Designer-Builder shall, without further liability, furnish evidence appropriate to establish exemption from any Federal, State, or Local tax; provided that, evidence appropriate to establish exemption from any Federal excise tax or duty which may give rise to either increase or decrease in the Contract price will be furnished only at the discretion of the Authority Representative.

- G. The Designer-Builder shall promptly notify the Authority Representative of matters which will result in either an increase or decrease in the Contract price, and shall take action with respect thereto as directed by the Authority Representative.

*00780 ADDITIONAL BOND SECURITY (06/01/03)

For information on Additional Bond Security, see Section 00614.

00781 NOT USED

00782 NOT USED

*00783 PATENT AND COPYRIGHT INDEMNITY (06/01/03)

In addition to any other indemnification provided in this Contract, the Design-Builder agrees to defend, hold harmless and indemnify the Authority, and its officers, representatives, agents and employees acting within the scope of their official duties, from and against any and all claims, demands, liabilities, damages, losses, costs and expenses (including, but not limited to, court costs, reasonable attorney's fees and expenses) of any nature whatsoever in any way arising out of infringement upon any Letters of Patent of the United States arising out of the performance of this Contract or out of the use or disposal by or for the account of the Authority of supplies furnished or work performed hereunder. Similarly, the Design-Builder indemnifies the Authority from any claim of copyright infringement resultant from actions of the Design-Builder or any of its subcontractors or suppliers. Nothing in this Section shall be construed to require any indemnification which would make said this Section void or unenforceable or to eliminate or reduce any indemnification or rights which the Authority or Design-Builder has by law.

*00784 NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT (06/01/03)

- A. The Design-Builder shall report to the Authority Representative, promptly and in reasonable written detail, each notice or claim of patent or copyright infringement based on the performance of this Contract of which the Design-Builder has knowledge.
- B. In the event of any action, claim or suit against the Authority on account of any alleged patent or copyright infringement arising out of or related to the performance of this Contract or out of the use of any supplies furnished or work or services performed hereunder, the Design-Builder shall furnish to the Authority, when requested by the Authority Representative, all evidence and information in possession of the Design-Builder pertaining to such action, suit or claim. Such evidence and information shall be furnished at the expense of the Authority except where the Design-Builder has agreed to defend, indemnify, or hold harmless the Authority. This Section shall be included in all subcontracts.



*00785 TECHNICAL DATA - WITHHOLDING OF PAYMENT

(06/01/03)

- A. If technical data, as defined in this Contract, specified to be delivered under this Contract is not delivered within the time specified by this Contract or is deficient upon delivery (including having restrictive markings not specifically authorized by this Contract), the Authority may until such data is accepted by the Authority, withhold payment to the Design-Builder of ten percent of the total Contract price or amount unless a lesser withholding is specified in the Contract. Payments shall not be withheld nor any other action taken pursuant to this Paragraph when the Design-Builder's failure to make timely delivery or to deliver such data without deficiencies arises out of or is beyond the control and without the fault or negligence of the Design-Builder.
- B. After payments total 90 percent of the total Contract price or amount and if all technical data specified to be delivered under this Contract has not been accepted, the Authority may withhold from further payment, in addition to other withholdings specified elsewhere, such sum as he considers appropriate, not exceeding ten percent of the total Contract price or amount unless a lesser withholding limit is specified in the Contract.
- C. The withholding of any amount or subsequent payment to the Design-Builder shall not be construed as a waiver of any rights accruing to the Authority under this Contract.

*00786 AUTHORITY RIGHTS IN TECHNICAL DATA

(06/01/03)

- A. All drawings, designs, specifications, architectural design of structures and buildings, samples, processes (including computer software), laboratory testing analyses and reports, notes, as-built drawings produced after completion of design tasks and other work produced in the performance of this Contract, or in the contemplation or implementation thereof shall be and remain the sole property of the Authority and may be used on any other work without additional cost to the Authority. Any re-use of design services shall be at the Authority's sole risk and with respect thereto the Design-Builder agrees not to assert any rights or to establish any claim under the design patent or copyright laws and not to publish or reproduce such matter in whole or in part or in any manner or form, or authorize others so to do, without the written consent of the Authority until such time as the Authority may have released such matter to the public. Further, with respect to any design or process which the Authority desires to protect by applying for and prosecuting a design patent application, or otherwise, the Design-Builder agrees to furnish the Authority such duly executed instruments and other papers (prepared by the Authority) as are deemed necessary to vest in the Authority the rights granted it pursuant to this Section. The Design-Builder for a period of three (3) years after completion of the project or task agrees to furnish and to provide access to the originals or copies of all such materials on the request of the Authority.
- B. Rights in Technical Data
 - 1. The Authority shall have the right to use, duplicate or disclose technical data,

which includes, without limitation, computer software and other items listed below, in whole or in part, in any manner and for any purpose whatsoever, and to have or permit others to do so:

- a. Any manuals, instructional materials prepared for installation, operation, maintenance or training purposes;
 - b. Technical data pertaining to end items, components or processes which were prepared for the purpose of identifying sources, size, configuration, mating and attachment characteristics, functional characteristics and performance requirements ("form, fit and function" data; e.g., specification control drawings, catalog sheets, outline drawing; except that for computer software it means data identifying source, functional characteristics, and performance requirements but specifically excludes the source code, algorithm, process, formulae, and flow charts of the software);
 - c. Other technical data which has been, or is normally furnished without restriction by the Design-Builder or subcontractor;
 - d. Other specifically described technical data which the parties have agreed will be furnished without restriction.
- C. The Authority shall have the right to use, duplicate, or disclose technical data other than that defined in Paragraph B.1.a. in whole or in part, with the express limitation that such technical data shall not, without the written permission of the party furnishing such technical data, be:
1. Released or disclosed in whole or in part outside the Authority;
 2. Used in whole or in part by the Authority for manufacture; or
 3. Used by a party other than the Authority except for emergency repair or overhaul work only, by or for the Authority where the item or process concerned is not otherwise reasonably available to enable timely performance of the work; provided, that the release or disclosure thereof outside the Authority shall be made subject to a prohibition against further use, release or disclosure.
 4. Technical data provided in accordance with the provisions of Paragraph B.1.b. shall be identified by a legend which suitably recites the aforesaid limitation. Nothing herein shall impair the right of the Authority to use similar or identical data acquired from other sources.
 5. The term technical data as used in this Section means technical writing, computer software, sound recordings, pictorial reproductions, drawings, or other graphic representations and works of a technical nature, whether or not copyrighted, which are specified to be delivered pursuant to this Contract. The term does not



include financial reports, cost analyses, and other information incidental to Contract administration. Computer software as used in this Section means computer programs, computer data bases, and documentation thereof.

6. Material covered by copyright:
 - a. The Design-Builder agrees to and does hereby grant to the Authority, and to its officers, agents and employees acting within the scope of their official duties, a royalty-free, nonexclusive and irrevocable license throughout the world for Authority purposes to publish, translate, reproduce, deliver, perform, dispose of, and to authorize others so to do, all technical data now or hereafter covered by copyright.
 - b. No such copyrighted matter shall be included in technical data furnished hereunder without the written permission of the copyright owner for the Authority to use such copyrighted matter in the manner above described.
 - c. The Design-Builder shall report to the Authority promptly and in reasonable written detail each notice or claim of copyright infringement received by the Design-Builder with respect to any technical data delivered hereunder.
 - d. Relation to patents: Nothing contained in this Section shall imply a license to the Authority under any patent, or be construed as affecting the scope of any license or other right otherwise granted to the Authority under any patent.
 - e. Any dispute under this Section shall be subject to Section 00732, DISPUTE RESOLUTION.
 - f. Notwithstanding any other payment provision in this Contract, the Authority may retain from payment up to 10 percent of the Contract price until final delivery and acceptance of the Technical Data defined in this Section and as required to be furnished by the Project Manual.

00787 INDEMNIFICATION AND INSURANCE REQUIREMENTS AND SPECIAL PROVISIONS OF INSURANCE FURNISHED BY DESIGN-BUILDER (10/01/03)

A. Indemnification:

1. The Design-Builder shall indemnify, hold harmless and defend the Authority and its officers, representatives, agents, consultants and employees as well as the Government, its officers, representatives and agents acting within the scope of their official duties (hereinafter, the "Indemnitees") from and against any and all claims, demands, liabilities, damages, losses, costs and expenses (including, but not limited to, court costs, reasonable attorney's fees and expenses) and for injuries, including personal injury to or death of person or persons, and for any

acts in connection with activities to be performed under this Contract of any nature whatsoever in any way arising out of or relating to the performance by the Design-Builder of the Work required under this Contract, in all its phases, which are caused in whole or in part by any negligent or willful act, error or omission, or breach of Contract by the Design-Builder, the Design-Builder's subcontractors or anyone directly or indirectly employed by the Design-Builder, or anyone for whose acts the Design-Builder may be liable, subject to an allocation or proportion of any such liability, loss, cost or expense to the extent caused by a party indemnified hereunder. Nothing in this Section shall be construed to require any indemnification which would make said Section void or unenforceable or to eliminate or reduce any indemnification or rights which the Authority or Design-Builder has by law.

2. The Design-Builder further expressly undertakes to, upon request of the Authority, indemnify, hold harmless and defend the Indemnitees, at the Design-Builder's sole expense, against any actions, lawsuits or proceedings brought against Indemnitees as a result of claims filed against the Authority, the Work, the Project site, the site of any of the Work, payments due the Design-Builder or any portion of the property of any of the Indemnitees (referred to collectively as "claims" in this Section) by any subcontractor, provided such claims arise out of, are related to, or are connected with the Work or any activities of the Design-Builder in connection with the Project or the Contract and are not due solely to a failure by the Authority to pay the Design-Builder amounts properly due and owing. The Design-Builder hereby agrees to defend, indemnify and hold the Indemnitees harmless against any damages, costs, expenses (including, without limitation, reasonable attorneys' fees, consultant fees, court costs and related expenses), losses, claims and liabilities arising out of, relating to, or in connection with the claims, unless such claim is due solely to a failure by the Authority to pay the Design-Builder amounts properly due and owing under the Contract. The Design-Builder hereby agrees that amounts which are subject to a good faith dispute shall not be deemed due and owing under the Contract.
 3. The Design-Builder shall, during the entire period of performance under this Contract, be responsible for and make good at no additional cost to the Authority, all damage to the Authority property caused by its acts and those of its employees, subcontractors, and subcontractors' employees in carrying out the work required by this Contract.
- B. The Design-Builder will provide WMATA with evidence of its Design-Builder's insurance coverages for the exposures listed in Section 00887 of the Supplementary Conditions.
1. The Design-Builder shall forward to the Washington Metropolitan Area Transit Authority's Office of Insurance, Room 8D-01, through the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, a certificate or certificates,



issued by the insurer(s) of the insurance indicating the insurance and any special provisions required under the foregoing provisions. Such certificate(s) shall be in a form satisfactory to WMATA and shall list the various coverages and limits. Insurance companies providing the coverage must be acceptable to WMATA, rated by A.M. Best and carry at least an "A" Rating. In addition to the aforementioned provisions; such insurance policies shall not be changed or canceled and they will be automatically renewed upon expiration and continued in full force and effect until completion and acceptance of all work covered by the Contract between WMATA and the Design-Builder, unless WMATA's Office of Insurance is given thirty (30) days written notice before any change or cancellation is made effective. The Design-Builder shall furnish WMATA's Office of Insurance with a certified copy of each insurance policy upon request.

2. The initial and subsequent certificates of insurance shall include a description of the Contract work and the assigned Contract number. Prior to beginning any project work, the insurance requirements as outlined by WMATA's Office of Insurance must be approved in writing.
3. All insurance shall be procured from insurance or indemnity companies acceptable to WMATA and licensed and authorized to conduct business in the District of Columbia, State of Maryland and Commonwealth of Virginia. WMATA approval or failure to disapprove insurance furnished by the Design-Builder shall not release the Design-Builder of full responsibility for liability for damage and accidents.
4. If at any time the above required insurance policies should be canceled, terminated or modified so that the insurance is not in full-force and effect as required herein, WMATA reserves the right to terminate this Contract between WMATA and the Design-Builder.
5. The Design-Builder shall require each subcontractor, at all tiers, to provide evidence of insurance coverage specified herein and such evidence of coverage shall be provided to WMATA's Office of Insurance through the Authority Representative prior to commencement of work in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. Such coverage shall remain in full force and effect during the performance of activities under this Contract between WMATA and the Design-Builder.
6. Any contract of insurance or indemnification naming WMATA, the United States of America, its officers, representatives and agents as an additional insured shall be endorsed to provide that the insurer will not contend in the event of any occurrence, accident, or claim that WMATA or the United States of America, et al, are not liable in tort by virtue of being governmental instrumentalities or public or quasi-public bodies.
7. In the event the required certificates of insurance as specified herein are not

furnished within ten calendar days after the date of receipt of Notice to Proceed (NTP), the Design-Builder shall not be permitted to enter upon the property to perform the duties outlined in the Contract until all required insurance certificates or evidence of self-insurance has been received.

8. The Design-Builder will not be paid for providing insurance for this Project Work as prescribed in this Contract, but the insurance cost thereof shall be included in the prices for the various items as set forth in the Price Proposal.

*00788 LIQUIDATED DAMAGES (06/01/03)

- A. The Design-Builder understands that if it fails to complete portions of and/or all of the Work as described in Section 00725, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE of these General Conditions, the Authority will suffer damages which have been estimated and are specified in Section 00888, LIQUIDATED DAMAGES REQUIREMENTS of the Supplementary Conditions.
- B. The Design-Builder agrees that if it does not complete the Work within the specified Period of Performance, then the Design-Builder shall pay to the Authority as liquidated damages, pursuant to Section 00728, TERMINATION FOR DEFAULT, DAMAGES FOR DELAY, AND TIME EXTENSIONS of these General Conditions, the sums per calendar day as separate damages for each specified completion requirement. Milestones are as defined in Section 00725, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE of these General Conditions.

*00789 COMPLIANCE WITH COPELAND ACT REQUIREMENTS (08/20/03)

The Design-Builder shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this Contract.

*00790 CONTRACT WORK HOURS AND SAFETY STANDARDS ACT (08/20/03)

- A. Overtime requirements: Neither the Design-Builder nor any subcontractor contracting for any part of the Contract work which may require or involve the employment of laborers, mechanics, apprentices, trainees, watchmen, and guards shall require or permit any laborer, mechanic apprentice, trainee, watchman or guard in any workweek in which he is employed on such work to work in excess of 40 hours in such work week on work subject to the provisions of the Contract Work Hours and Safety Standards Act, unless such laborer, mechanic, apprentice, trainee, watchman, or guard receives compensation at a rate not less than one and one-half times his or her basic rate of pay for all such hours worked in excess of 40 hours in such work week.
- B. Violation, liability for unpaid wages, and liquidated damages. In the event of any violation of the provisions of Paragraph A. above, the Design-Builder and any subcontractor responsible therefor shall be liable to any affected employee for unpaid wages. In addition, such Design-Builder and subcontractor shall be liable to the



Authority for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer, mechanic, apprentice, trainee, watchman, or guard employed in violation of the provisions of Paragraph A. in the sum of ten dollars for each calendar day on which such employee was required or permitted to be employed on such work in excess of his or her standard work week of 40 hours without payment of the overtime wages required by Paragraph A.

- C. Withholding for unpaid wages and liquidated damages: The Authority Representative may withhold from the Design-Builder, from any monies payable on account of work performed by the Design-Builder or subcontractor, such sums as may be administratively determined to be necessary to satisfy any liabilities of such Design-Builder or subcontractor for unpaid wages and liquidated damages as provided in the provisions of Paragraph B.
- D. Subcontracts: The Design-Builder shall insert Paragraphs A. through E. of this Section in all subcontracts and shall require their inclusion in all subcontracts of any tier.
- E. Records: The Design-Builder shall maintain payroll records containing the information specified in 29 CFR 516.2(a). Such records shall be preserved for three years from completion of this Contract.

00791 EQUITABLE ADJUSTMENT FOR MINOR CONTRACT MODIFICATIONS: (11/22/04)

- A. When the Contracting Officer and Contractor agree to an additive or deductive amount for a modification to this Contract made pursuant to Section 00753, CHANGES, Section 00707, DIFFERING SITE CONDITIONS, or Section 00721, VALUE ENGINEERING INCENTIVE, when the fair and reasonable price in aggregate amount does not exceed \$50,000 and further agree to an adjustment in the time for Contract performance resulting from said modification which increases or decreases the completion date 10 or less calendar days, the equitable adjustment in Contract amount shall consist of the sum of the following:
 - (1) Direct costs as agreed to by the Contracting Officer and Contractor.
 - (2) Job Office Overhead costs, the sum of which shall be limited to a maximum of 10 percent of direct labor costs, including fringe benefits, but excluding FICA, FUTA, and State Unemployment Insurance (SUI); a maximum of 10 percent of direct material costs; a maximum of five percent of direct equipment costs (small tools, defined as equipment less than \$2,000 in acquisition costs, are included and computed at a maximum of five percent of direct base labor wages); and a maximum of five percent of subcontract costs.
 - (3) Home Office General and Administrative (G&A) costs, the sum of which shall be limited to a maximum of three percent or the audited rate of the direct costs plus job office overhead costs computed as above.

- (4) Profit will be determined in accordance with the guidelines specified in Section 00759 CONTRACT MODIFICATIONS-REQUIREMENTS FOR PROPOSALS, PRICE BREAKDOWN AND NEGOTIATION OF PROFIT.
- B. In using the above rates, the following shall apply:
- (1) Payroll Tax (FICA, FUTA & SUI) amounts are added immediately after direct and indirect costs are totaled.
 - (2) Subcontractors' indirect costs and profit shall be computed in the same manner as above.
 - (3) Indirect costs shall not be duplicated in direct costs.
 - (4) When the Contract time is increased, the change in Contract amount for direct and indirect costs computed by application of the above rates includes costs of impact and extended performance due to the time extension and no further consideration of costs arising from the specific modification and cited pending change orders (PCO's) will be given. The Contractor shall not receive both a percentage and a daily rate markup for job office overhead costs when a time extension to the Contract Performance Period is recognized.
 - (5) Bond will be allowed at actual cost without markup.
- C. Equipment Rates shall be determined from prior Authority audits. In the absence of audited rates for equipment owned or controlled by the Contractor, hourly rates shall be computed from the current Contractor's Equipment Cost Guide (monthly rate divided by 176).

END OF SECTION



CONTRACTING REQUIREMENTS

00800 SUPPLEMENTARY CONDITIONS

This Section includes Modifications to the Section 00700 General Conditions for requirements unique to a specific project and are hereby incorporated into the General Conditions by reference to. This Section 00800, which specifies any modifications to the General Conditions, shall be read in conjunction with Section 00700 and which will be cited in the 00700 Section using the same last 2 digits of the Section number; i.e., a mod to Section 00724 is indicated as Section 00824.

00811 WORK BY DESIGN-BUILDER PERCENTAGE REQUIREMENTS

Modify General Conditions Section 00711, WORK BY DESIGN-BUILDER to delete Paragraph A. and substitute the following Paragraph:

- A. The Design-Builder shall perform, with its own organization, work equivalent to at least **15%** for the construction work.

00825 PERIOD OF PERFORMANCE AND PROJECT SCHEDULE REQUIREMENTS

Modify General Conditions Section 00725, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE to delete Paragraph A. and substitute the following Paragraph and subparagraphs:

- A. The Design-Builder shall perform, complete and advance all Work under this Contract in accordance with the following:
1. Interim Completion(s)
 - a. Greenbelt Yard NTP+ **765** calendar days
 2. Final Completion
 - a. Greenbelt/Shady Grove Yards Project NTP+ **825** calendar days
 - b. Brentwood Yard Project NTP+ **910** calendar days
 3. See Section 00888 LIQUIDATED DAMAGES for Liquidated Damages associated with the Milestone(s) listed above.

00832 DISPUTES REVIEW BOARD REQUIREMENTS

Modify General Conditions Section 00732, DISPUTE RESOLUTION to add the following Paragraph and subparagraphs:

- C. Disputes Review Board: WMATA is interested in undertaking any type of alternative disputes resolution procedure which is thought by the parties to have a likelihood of



successfully resolving disputes. Either party may propose and the parties may agree to any type of dispute resolution procedure including but not limited to mediation, arbitration, mini trial, etc. WMATA has available a list of retired federal judges who have indicated a willingness to mediate WMATA contract disputes and, upon agreement of the parties that such mediation is appropriate for a specific dispute, WMATA is willing to bear one half of the cost of such mediation.

1. A written demand by any party requesting an equitable adjustment under this Contract, that is not disposed of by agreement within a reasonable time, is a dispute governed by this Section and shall be submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES to the Contracting Officer for a written final decision. The Contracting Officer shall either call for a hearing before the Disputes Review Board or issue a Contracting Officer's Final Decision if the dispute is of a policy nature already decided under other contracts or there are no facts in dispute. However, all parties to the Contract agree that the dispute will not be heard by the Disputes Review Board until such time as the Authority's Project Manager, or if the Authority Representative is the Project Manager, a level of supervision within the Authority higher than the Authority Representative and the Design-Builder's Representative (Officer, Area Manager or Vice President) have met and attempted to resolve the dispute or 60 calendar days have passed, whichever occurs first. If the Contracting Officer convenes the Disputes Review Board, completion of this dispute resolution process is a condition precedent to commencement of any other administrative proceeding or commencement of a court action. Either party may request in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES that a specific dispute not be subject to the Disputes Review Board proceeding and be immediately addressed by the Contracting Officer's final decision. The Authority may do so in cases involving Authority policy or contract interpretation issues which have broad application to other Authority contracts. The Design-Builder may do so for any good reason. If the Contracting Officer denies the Design-Builder's request to forego the DRB procedure or decides on the Authority's behalf to forego the DRB procedure at the Authority's request, he shall so advise the Design-Builder who shall have five days to request a review of this decision by the Assistant General Manager for Capital Projects Management in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Assistant General Manager for Capital Projects Management shall make his/her decision in coordination with WMATA's Offices of Procurement and Materials, Auditor General, and General Counsel. This decision regarding whether to proceed with DRB proceedings or directly to a Contracting Officer's final decision shall be final and not subject to further review.
2. At all times during this disputes resolution process or any subsequent administrative or court proceeding, the Design-Builder shall proceed with the work diligently, without delay, in accordance with the Contract, and as directed by the Contracting Officer or his/her Authorized Representative. The Design-Builder

shall continue to comply with all provisions of the Contract and shall be entitled to timely payment of all proper payment requests to the extent that payments are not affected by the dispute. The following notice requirements and procedures set forth elsewhere in the Contract shall all take precedence over any provision of this article including Sections: 00717, DIFFERING SITE CONDITIONS; 00728, TERMINATION FOR DEFAULT, DAMAGES FOR DELAY, AND TIME EXTENSIONS; 00732, DISPUTE RESOLUTION; and 00753, CHANGES for submitting and processing claims.

3. Within 60 calendar days following receipt of the final DRB recommendations, the Contracting Officer shall indicate acceptance or rejection of the DRB findings and recommendations. The acceptance, rejection or modification of the Final Recommendation is the Contracting Officer's final decision. The Contracting Officer's final decision shall cite the DRB findings and recommendations and, in the case of rejection in whole or in part, or modifications thereto, stipulate specific reasons for rejection of the DRB recommendation(s).
4. If the Design-Builder disagrees with the decision of the Contracting Officer, written appeal may be filed as specified in this Section in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. Admission of all or part of the data presented to the DRB shall be left to the rules of evidence used by the appeals process.
5. Processes to be used for the Disputes Review Board are set out in Section 01260, DISPUTES REVIEW BOARD PROCEDURES.
6. An allowance is listed in Section 00434, PRICE SCHEDULE Notes to Proposers to provide funds for the Authority's share of all Disputes Review Board costs. The Design-Builder will be reimbursed for the Authority's share on an invoice basis from the established allowance in accordance with the Contract payment provisions.

00836 AUTHORITY-FURNISHED PROPERTY REQUIREMENTS

- A. The Authority intends to provide a fully functional Underfloor Wheel-Truing Machine as manufactured by Hegenscheidt-MFD, Model U2000 modified to WMATA's requirements and as described in the Architectural Program Criteria, Section 1.04.B.46. The Design-Builder is required to provide equipment and manpower as required to assist the equipment manufacturer with the installation of the Wheel-Truing Machine at Brentwood Shop. It shall be the responsibility of the Design-Builder to: construct the equipment pit and foundation; provide the main power input supply, grounding rods, hand rails, and pit stairs. Alignment, calibration, testing, and training will be the responsibility of the equipment manufacturer.



00844 SAFETY SUPERINTENDENCE REQUIREMENTS

Modify General Conditions Section 00744, PROTECTION OF PERSONS AND PROPERTY Paragraph C. as follows:

- C. The Design-Builder shall assign to the work Safety Superintendent(s) who has (have) specialized training and experience in construction safety supervision and has (have) a thorough knowledge of all OSHA regulations. He (They) shall have the ability to develop and conduct safety training courses. He (They) shall be familiar with industrial hygiene equipment and testing as required for the protection of all employees. The contractor shall employ and assign full-time dedicated Safety Superintendent(s) and First Aid Attendant for on-site work activities at all times. The Safety Superintendent shall have no duty other than safety supervision of persons, equipment, and property affected by contract work. Due to the distance between the project sites, separate full-time dedicated Safety Superintendents are to be employed and assigned for each project site. He (They) shall also be responsible for providing first aid at the site and must have current First Aid and CPR certifications. Employees expected to render First Aid or CPR must be trained in Bloodborne Pathogens in accordance with 29 CFR §1910.1030. Copies of required certifications and evidence of required training shall be provided to WMATA prior to the start of work, along with a resume in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Safety Superintendent(s) must be acceptable to the Contracting Officer and no work at the site shall be performed until this approval has been received. Once employed, the Safety Superintendent(s) shall not be changed without permission of the Contracting Officer and he (they) must be onsite anytime work is being performed by the Contractor or any subcontractors.

00887 INSURANCE REQUIREMENTS

Modify General Conditions Section 00787, INDEMNIFICATION AND INSURANCE REQUIREMENTS AND SPECIAL PROVISIONS OF INSURANCE FURNISHED BY DESIGN-BUILDER to add Paragraph C. as follows:

- C. Insurance Requirements:
1. The Design-Builder will provide WMATA with evidence of it's Design-Builder's commercial insurance coverages in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES for the following exposures:
 - a. Workers Compensation: An insurance policy complying with the requirements of the statutes of the jurisdiction(s) in which the work will be performed, and if there is any exposure to any of the Design-Builder or Design-Builder's personnel due to the U. S. Longshoremen's and Harbor Workers' Act, Jones Act, Admiralty Laws or the Federal Employers' Liability Act, the Design-Builder shall provide coverage for these exposures on an

"if any" basis. The coverage under such an insurance policy or policies shall have limits not less than:

Worker's Compensation:	STATUTORY LIMIT
Employer's Liability: Each Accident	<u>\$1,000,000</u>
Disease Policy Limits	<u>\$1,000,000</u>
Disease - Each Employee	<u>\$1,000,000</u>

- b. Commercial General Liability Insurance (CGL): An insurance policy covering the liability of the Design-Builder for all work or operations under or in connection with this Project; and all obligations assumed by the Design-Builder under this Contract. Products, Completed Operations and Contractual Liability insurance must be included in addition to coverage for explosion, underground hazards and collapse, wherever required. Liability for Project work within 50 feet of owned / operating railroad property is excluded and Railroad Protective Liability Insurance must be provided.

The coverage under such an insurance policy or policies shall have limits not less than:

BODILY INJURY AND PROPERTY DAMAGE LIABILITY
\$1,000,000 per occurrence/\$2,000,000 aggregate
or Combined Single Limit not less than \$2,000,000

PREMISES MEDICAL PAYMENTS
\$5,000

FIRE LEGAL LIABILITY
\$1,000,000

PERSONAL INJURY / ADVERTISING
\$1,000,000

WMATA must be included as an additional insured under the general liability insurance coverage with respect to activities related to this Contract.

- c. Automobile Liability Insurance: A commercial auto insurance policy covering the use of all owned, non-owned, hired, rented or leased vehicles bearing license plates appropriate for the circumstances for which they are being used. These vehicles should bear license plates applicable to the state laws for which the vehicle(s) are registered. Liability for Design-Builder's mobile equipment is not subject to this coverage and therefore the aforementioned general liability insurance is required. Contract employees are not permitted to operate any vehicle owned by WMATA whether in

commission of the contract or outside the same.

The coverage under such an insurance policy or policies shall include Uninsured Motorist Coverage and include Form MCS-90 as required by the Motor Carrier Act of 1980.

The coverage under such an insurance policy or policies shall have limits not less than:

BODILY INJURY AND PROPERTY DAMAGE LIABILITY
\$2,000,000 Combined Single Limit

WMATA must be included as an additional insured under the automobile liability insurance coverage with respect to activities related to this Contract.

- d. Professional Errors and Omissions Liability Insurance: A separate insurance policy to pay on behalf of the Design-Builder all costs the Design-Builder shall become legally obligated to pay as damages due to any claim caused by any negligent act, error or omission of the Design-Builder or any other person for whose acts the Design-Builder is legally liable arising out of the performance under this Project work.

Such insurance shall be maintained for five (5) years after the final acceptance of the work by either continuation of the policy every year or if coverage is moved to another carrier, the same prior acts retro date should be continued. If coverage is not renewed, an extended reporting period of five (5) years should be purchased and such coverage should be evidenced on the certificate of insurance.

The coverage under such an insurance policy shall have a limit of liability not less than:

BODILY INJURY AND PROPERTY DAMAGE LIABILITY
\$3,000,000 per occurrence / \$3,000,000 aggregate

- e. Railroad Protective Liability Insurance: An insurance policy issued to WMATA for bodily injury and property damage liability of the Design-Builder resulting from the Design-Builder's performance of project work within 50 feet of WMATA's railroad property. Project work within 50 feet is defined as: work performed on, adjacent to (North, South, East, West), above, or beneath WMATA's owned /operating railroad property.

Such insurance shall be written on the ISO form. The coverage under such an insurance policy shall have a limit of liability not less than:

BODILY INJURY AND PROTECTIVE DAMAGE LIABILITY
\$5,000,000 per occurrence / \$10,000,000 Aggregate

No waivers will be issued for the Railroad Protective Liability Insurance requirement under this Contract.

- f. Builder's Risk Insurance: An insurance policy covering all risk of physical damage to property under construction. Damage to building materials being installed may be written separately or by endorsement to this policy. Insurance shall be on an all-risks policy form including the perils of fire, extended coverage, theft, vandalism, certified acts of terrorism, malicious mischief, collapse, and earthquake. Coverage limits shall be equal to the initial Contract construction amount and any amendments to the Contract which affect the project cost on a replacement cost basis.

Such insurance shall be written on the ISO Form. The coverage under such an insurance policy shall have a limit of liability not less than:

The estimated completed value of building under construction.

If additional options are exercised after award of Contract, the coverage shall be increased to include the estimated cost of materials for the options awarded.

00888 LIQUIDATED DAMAGES REQUIREMENTS

Modify General Conditions Section 00788, LIQUIDATED DAMAGES Paragraph A. as follows:

- A. The Design-Builder understands that if it fails to complete portions of and/or all of the Work as described in Section 00825, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE of these General Conditions, the Authority will suffer damages which have been estimated and are as specified below:
1. The following are the Contract Milestone(s) and the associated Interim and Final Liquidated Damages amounts:
 - a. Interim Completion(s)
 1. Greenbelt Yard \$2,940 per calendar day
 - b. Final Completion - \$5,650 per calendar day
 2. Total Liquidated Damages shall not exceed \$5,650 per calendar day combined.
 3. See Section 00825, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE



for Project Milestone(s).

00891 PARTNERING REQUIREMENTS

Modify Section 00700 General Conditions to add the following Section:

00791 PARTNERING

A. Authority Partnering Policy: The Authority intends to encourage development of a cohesive partnership with the Design-Builder, the Design Professional, principal subcontractors and suppliers for effective and efficient completion of this Contract. This partnership will strive to draw on the strengths of each organization in an effort to achieve a quality project done right the first time, and completed on-schedule, within the budget. This partnership will be bilateral in make-up and participation of the parties is required. The partnering workshop(s) will be conducted by a professional facilitator at an off-site location convenient to the project within 45 days of Contract award. Follow-up workshops will be conducted on a quarterly basis during the course of the Contract as agreed to between the Design-Builder and the Authority.

1. The establishment of a partnership charter on this project will not change the legal relationship of the parties to the Contract nor relieve either party from any terms of the Contract.
2. All costs associated with initiating and maintaining this partnership, outside of participant's salaries and travel and travel-related costs, will be agreed to by both parties and will be shared. The Authority will reimburse the Design Builder 50% of the incurred cost up to the allowance specified on the Notes to Proposers in Section 00434, PRICE SCHEDULE. If the agreed cost exceeds the allowance specified on the Notes to Proposers in Section 00434, PRICE SCHEDULE, the Authority will reimburse the Design Builder 100% of the cost over that amount.
3. Partnership Goals:
 - a. For the Design-Builder and the Authority to work together probatively through a cohesive partnership with the objective to build a quality product on time, at a satisfactory cost to the Authority, with a satisfactory profit to the Design-Builder (fostering a win-win relationship);
 - b. To establish and maintain an atmosphere of trust with timely, positive and ongoing communications;
 - c. To reach a mutual understanding on how the construction project will be managed;
 - d. To resolve disputes at the lowest working level possible; and,

e. To avoid confrontation and disputes among the parties.

B. Measurement and Payment:

1. Allowance for Partnering Costs:

- a. An allowance is identified in Section 00434, PRICE SCHEDULE to provide funds for the Design Builder's share of services for a Professional Facilitator and for the expenses of the partnering workshop(s).
- b. The Design-Builder will be reimbursed for the Design Builder's share of hiring a Professional Facilitator (and for conducting the workshops) on an invoice basis from the allowance in accordance with the Contract payment provisions.

00892 FTA REQUIREMENTS:

Modify Section 00700 General Conditions to add the following Section:

00792 FTA CLAUSES:

A. Buy America Requirements

The Design-Builder agrees to comply with 49 U.S.C. §5323(j), and its implementing regulations at 49 C.F.R. Part 661, any amendments thereto, and any implementing guidance issued by FTA.

B. Rights in Data and Copyrights - FTA

1. The term "subject data" used in this Paragraph and subparagraphs means recorded information, whether or not copyrighted, that is delivered or specified to be delivered under this Contract in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The term includes graphic or pictorial delineation in media such as drawings or photographs; text in specifications or related performance or design-type documents; machine forms such as punched cards, magnetic tape, or computer memory printouts; and information retained in computer memory. Examples include, but are not limited to: computer software, engineering drawings and associated lists; specifications, standards, process sheets, manuals, technical reports, catalog item identifications, and related information. The term "subject data" does not include financial reports, cost analyses, and similar information incidental to project administration.
2. The following restrictions apply to all "subject data" first produced in the performance of this Contract:



- a. Except for its or the Authority's own internal use, the Design-Builder may not publish or reproduce "subject data" in whole or in part, or in any other manner or form, nor may the Design-Builder authorize others to do so, without the written consent of the U.S. Government, until such time as the Government may have either released or approved the release of such data to the public; this restriction on publication, however does not apply to Agreements with academic institutions.
- b. In accordance with 49 C.F.R. §18.34 and 49 C.F.R. §19.36, the Government reserves a royalty-free, non-exclusive and irrevocable license to reproduce, publish, or otherwise use, and to authorize others to use, the following "subject Data" for Federal Government purposes:
 - (1) Any "subject data" developed under this Contract whether or not a copyright has been obtained; and
 - (2) Any rights of copyright to which the Design-Builder purchases ownership with Federal assistance.
3. When the Federal Transit Administration (FTA) provides financial assistance for a planning, research, development, or a demonstration project, it is FTA's general intention to increase mass transportation knowledge, rather than limit the benefits of the Project to participants in the Project. Therefore, unless FTA determines otherwise, the Design-Builder agrees that, in addition to the rights set forth in subparagraph 2.b. above, FTA may make available to any FTA recipient, subrecipient, third party contractor, or third party subcontractor, either FTA's license in the copyright to the "subject data" derived under this Contract or a copy of the "subject data" first produced under this Contract. If this Contract is not completed for any reason whatsoever, all data developed under this Contract shall become "subject data" as defined in subparagraph 1. and shall be delivered as the Government may direct.
4. Unless prohibited by state law, the Design-Builder agrees to indemnify, save, and hold harmless the Authority and the Government, their Officers, agents, and employees acting within the scope of their official duties against any liability, including costs and expenses, resulting from any willful or intentional violation by the Design-Builder of proprietary rights, copyrights, or right of privacy, arising out of the publication, translation, reproduction, delivery, use or disposition of any data furnished under this Contract. The Design-Builder shall not be required to indemnify the Authority and the Government for any such liability arising out of the wrongful acts of employees or agents of the Authority and the Government.
5. Nothing contained in this Section on rights in data shall imply a license to the Authority or the Government under any patent or be construed as affecting the scope of any license or other right otherwise granted to the Authority or the Government under any patent.

6. The requirements of subparagraphs 2. and 3. do not apply to material furnished by the Authority to the Design-Builder and incorporated into the work carried out under the Contract provided that the Design-Builder identifies the incorporated material at the time of delivery of the work.
7. Any dispute under this Section shall be subject to the Section 00732, DISPUTE RESOLUTION.
8. Notwithstanding any other payment provision in this Contract, the Authority may retain from payment up to 10 percent of the Contract price until final delivery and acceptance of the technical data defined in this Section and as required to be furnished by the Price Schedule or the Project Manual.

C. Cargo Preference - Use of United States Flag Vessels

Pursuant to Pub. L 664 (46 U.S.C. 1241 (b)):
"Cargo Preference — Use of United States-Flag Vessels

The Design-Builder agrees:

1. To utilize privately owned United States-flag commercial vessels to ship at least 50 percent of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, materials, or commodities pursuant to this Contract, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels.
2. To furnish in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES within 20 days following the date of loading for shipments originating within the United States, or within 30 working days following the date of loading for shipments originating outside the United States, a legible copy of a rated, "on-board" commercial ocean bill-of-lading in English for each shipment of cargo described in subparagraph 1. above to the Grantee (through the prime Design-Builder in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, D.C. 20230, marked with appropriate identification of the Project.
3. To insert the substance of the provisions of this Paragraph and subparagraphs in all subcontracts issued pursuant to this Contract.

D. Incorporation of Federal Transit Administration (FTA) Terms

1. The contract provisions include, in part, certain Standard Terms and Conditions required by DOT, whether or not expressly set forth in the Contract provisions. All Contractual provisions required by DOT, as set forth in FTA Circular 4220.1E, dated June 19, 2003, as amended or revised by FTA, are hereby incorporated by



reference. Anything to the contrary herein notwithstanding, all FTA mandated terms shall be deemed to control in the event of a conflict with other provisions contained in this Agreement. The Design-Builder shall not perform any act, fail to perform any act, or refuse to comply with any WMATA requests which would cause WMATA to be in violation of the FTA terms and conditions.

2. The Design-Builder agrees to include this Section in each subcontract financed in whole or in part with Federal assistance provided by FTA. It is further agreed that the following subparagraphs shall not be modified, except to identify the subcontractor who will be subject to the provisions.

E. Federal Changes

1. The Design-Builder shall at all times comply with all applicable FTA regulations, policies, procedures and directives, including without limitation those listed directly or by reference in the Agreement (Form FTA MA (9) dated October, 2002) between the Authority and FTA, as they may be amended or promulgated from time to time during the term of this Contract. Design-Builder's failure to so comply shall constitute a material breach of this Contract.
2. The Design-Builder agrees to include this clause in each subcontract financed in whole or in part with Federal assistance provided by FTA. It is further agreed that the clause shall not be modified, except to identify the subcontractor who will be subject to its provisions.

F. No Obligation by the Federal Government

1. The Authority and the Design-Builder acknowledge and agree that, notwithstanding any concurrence by the Federal Government in or approval of the solicitation or award of this contract, absent the express written consent by the Federal Government, the Federal Government is not a party to this contract and shall not be subject to any obligations or liabilities to the Authority, Design-Builder, or any other party (whether or not a party to that contract) pertaining to any matter resulting from the underlying contract.
2. The Design-Builder agrees to include the above clause in each subcontract financed in whole or in part with Federal assistance provided by FTA. It is further agreed that the clause shall not be modified, except to identify the subcontractor who will be subject to its provisions.

G. Program Fraud and False or Fraudulent Statements and Related Acts

1. The Design-Builder acknowledges that the provisions of the Program Fraud Civil Remedies Act of 1986, as amended, 31 U.S.C. § § 3801 et seq . and U.S. DOT regulations, "Program Fraud Civil Remedies," 49 C.F.R. Part 31, apply to its actions pertaining to this Project. Upon execution of the underlying Contract, the

Design-Builder certifies or affirms the truthfulness and accuracy of any statement it has made, it makes, it may make, or causes to be made, pertaining to the underlying Contract or the FTA assisted project for which this Contract work is being performed. In addition to other penalties that may be applicable, the Design-Builder further acknowledges that if it makes, or causes to be made, a false, fictitious, or fraudulent claim, statement, submission, or certification, the Federal Government reserves the right to impose the penalties of the Program Fraud Civil Remedies Act of 1986 on the Design-Builder to the extent the Federal Government deems appropriate.

2. The Design-Builder also acknowledges that if it makes, or causes to be made, a false, fictitious, or fraudulent claim, statement, submission, or certification to the Federal Government under a contract connected with a project that is financed in whole or in part with Federal assistance originally awarded by FTA under the authority of 49 U.S.C. § 5307, the Government reserves the right to impose the penalties of 18 U.S.C. § 1001 and 49 U.S.C. § 5307(n)(1) on the Design-Builder, to the extent the Federal Government deems appropriate.
3. The Design-Builder agrees to include the above two clauses in each subcontract financed in whole or in part with Federal assistance provided by FTA. It is further agreed that the clauses shall not be modified, except to identify the subcontractor who will be subject to the provisions.

H. Seat Belt Use Policy:

The Design-Builder agrees to comply with terms of Executive Order No. 13043 "Increasing Seat Belt Use in the United States" and is encouraged to include those requirements in each subcontract awarded for work relating to this Contract.

I. Access to Records:

1. The Design-Builder shall maintain records and the Authority Representative, the FTA Administrator or his authorized representatives, including any Project Management Oversight (PMO) Design-Builder, the U.S. Department of Transportation, and the Comptroller General of the United States or any of their duly authorized representatives shall have access to and the right to examine any books, documents, papers and records of the Design-Builder, involving transactions related to this Contract.
2. The Design-Builder agrees to permit any of the foregoing parties to reproduce by any means whatsoever or to copy excerpts and transcriptions as reasonably needed.
3. The Design-Builder agrees to maintain all books, records, accounts and reports required under this Contract for a period of not less than three years after the date of termination or expiration of this Contract, except in the event of litigation



or settlement of claims arising from the performance of this contract, in which case Design-Builder agrees to maintain same until the Authority, the FTA Administrator, the Comptroller General, or any of their duly authorized representatives, have disposed of all such litigation, appeals, claims or exceptions related thereto. Reference 49 CFR 18.39(i)(11).

4. The Design-Builder agrees to include this Paragraph and subparagraphs in each subcontract awarded for work performed under this Contract. It is further agreed that the Section shall not be modified, except to identify the subcontractor who will be subject to its provisions.

J. Contracts Involving Federal Privacy Act Requirements:

The following requirements apply to the Design-Builder and its employees that administer any system of records on behalf of the Federal Government under any contract:

1. The Design-Builder agrees to comply with, and assures the compliance of its employees with, the information restrictions and other applicable requirements of the Privacy Act of 1974, 5 U.S.C. §§ 552a. Among other things, the Design-Builder agrees to obtain the express consent of the Federal Government before the Design-Builder or its employees operate a system of records on behalf of the Federal Government. The Design-Builder understands that the requirements of the Privacy Act, including the civil and criminal penalties for violation of that Act, apply to those individuals involved, and that failure to comply with the terms of the Privacy Act may result in termination of the underlying contract.
2. The Design-Builder also agrees to include these requirements in each subcontract to administer any system of records on behalf of the Federal Government financed in whole or in part with Federal assistance provided by FTA.

K. Fly America Requirements:

The Design-Builder agrees to comply with 49 U.S.C. 40118 (the "Fly America" Act) in accordance with the General Services Administration's regulations at 41 CFR Part 301-10, which provide that recipients and subrecipients of Federal funds and their contractors are required to use U.S. Flag air carriers for U.S Government-financed international air travel and transportation of their personal effects or property, to the extent such service is available, unless travel by foreign air carrier is a matter of necessity, as defined by the Fly America Act. The Design-Builder shall submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, if a foreign air carrier was used, an appropriate certification or memorandum adequately explaining why service by a U.S. flag air carrier was not available or why it was necessary to use a foreign air carrier and shall, in any event, provide in accordance with Section 01330, DESIGN AND CONSTRUCTION

SUBMITTAL PROCEDURES a certificate of compliance with the Fly America requirements. The Design-Builder agrees to include the requirements of this Paragraph in all subcontracts that may involve international air transportation.

L. Seismic Safety:

The Design-Builder agrees that any new building or addition to an existing building will be designed and constructed in accordance with the standards for Seismic Safety required in Department of Transportation Seismic Safety Regulations 49 CFR Part 41 and will certify to compliance to the extent required by the regulation. The Design-Builder also agrees to ensure that all work performed under this Contract including work performed by a subcontractor is in compliance with the standards required by the Seismic Safety Regulations and the certification of compliance issued on the project.

M. Energy Conservation:

The Design-Builder agrees to comply with standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act.

N. Recovered Materials:

The Design-Builder agrees to comply with all the requirements of Section 6002 of the Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 6962), including but not limited to the regulatory provisions of 40 CFR Part 247, and Executive Order 12873, as they apply to the procurement of the items designated in Subpart B of 40 CFR Part 247.

END OF SECTION



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APPENDIX D TO SECTION 00800 WAGE DETERMINATION RATES

APPENDIX D

WAGE RATES

CONTRACT NUMBER FN5008

All on-site work to be performed at the **HEAVY** Rates.

NOTICE: In accordance with 29 CFR, Part 1, the contractor will be required to pay wages which are not less than those established by the final Wage Determination Decision contained in the solicitation.



THIS PAGE NOT USED

General Decision Number: DC030001 09/24/2004 DC1

Superseded General Decision Number: DC020001

State: District of Columbia

Construction Types: Heavy (Heavy, and Sewer and Water Line)
and Highway

County: District of Columbia Statewide.

HEAVY CONSTRUCTION PROJECTS (Including Sewer and Water Lines);
HIGHWAY CONSTRUCTION PROJECTS

Modification Number	Publication Date
0	06/13/2003
1	10/03/2003
2	10/31/2003
3	01/02/2004
4	03/19/2004
5	04/02/2004
6	05/14/2004
7	06/11/2004
8	06/18/2004
9	06/25/2004
10	07/02/2004
11	07/09/2004
12	07/16/2004
13	08/13/2004
14	08/20/2004
15	09/17/2004
16	09/24/2004

ASBE0024-001 03/01/2004

Rates Fringes

Asbestos Worker/Heat and
Frost Insulator

Includes application of
all insulating materials,
protective coverings,
coatings and finishes to
all types of mechanical
systems. Also the



application of firestopping material for wall openings and penetrations in walls, floors, ceilings and curtain walls.....	\$ 24.17	11.09
--	----------	-------

ASBE0024-002 03/01/2004

	Rates	Fringes
Hazardous Material Handler Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials, whether they contain asbestos or not,from mechanical systems.....	\$ 12.43	4.59

BOIL0193-001 10/01/2003

	Rates	Fringes
Boilermaker.....	\$ 30.17	14.29

BRDC0001-001 04/27/2003

	Rates	Fringes
Bricklayer.....	\$ 24.85	5.52

CARP0132-001 05/01/2004

	Rates	Fringes
Carpenter/Lather.....	\$ 22.50	4.83
Piledriver.....	\$ 20.85	5.50

CARP0132-003 05/01/2004

Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP

Contract No. FN5008
Date: December 3, 2004

	Rates	Fringes
Diver Tender.....	\$ 20.85	5.50
Diver.....	\$ 29.63	5.50

CARP1831-001 04/01/2003

	Rates	Fringes
Millwright.....	\$ 24.34	4.05

ELEC0026-001 06/07/2004

	Rates	Fringes
Electrician.....	\$ 29.55	9.17+3%+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King Jr.'s Birthday, Inauguration Day, Memorial Day, Fourth of July, Labor Day, Veterans Day, Thanksgiving Day, the day after Thanksgiving and Christmas Day or days designated as legal holidays by the Federal Government.

ELEC0026-008 07/01/2003

	Rates	Fringes
Motor Repairmen Removal and reinstallation of electrical motors.....	\$ 23.69	7.73+3%+a

a. PAID HOLIDAYS:
New Year's Day, Martin Luther King Jr.'s Birthday, Inauguration Day, Memorial Day, Fourth of July, Labor Day, Veterans Day, Thanksgiving Day, the day after Thanksgiving and Christmas Day or days designated as legal holidays by the Federal Government.

ELEC0070-001 03/31/2002

Rates	Fringes
-------	---------



Line Construction:		
Groundmen.....	\$ 14.00	2.45+17.5%
Linemen, Cable Splicers, Equipment Operators.....	\$ 24.48	2.45+17.5%
Truck with winch.....	\$ 14.00	2.45+17.5%

ENGI0077-001 05/01/2004

	Rates	Fringes
Power equipment operators: (HEAVY AND HIGHWAY CONSTRUCTION)		
GROUP 1.....	\$ 24.74	5.62+a+b
GROUP 2.....	\$ 24.28	5.62+a+b
GROUP 3.....	\$ 23.57	5.62+a
GROUP 4.....	\$ 21.54	5.62+a
GROUP 5.....	\$ 17.00	5.62+a
GROUP 6.....	\$ 26.11	5.62+a

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: 35 ton cranes & above, tower & climbing cranes, derricks, concrete boom pump, drill rigs (equivalent to L & Double L), mole.

GROUP 2: Backhoes, cableways, cranes, cherry pickers, elevating graders, hoists, paving mixers, power shovels, tunnel shovels, batch plants, shields, tunnel mining machines, gradalls, front end loaders, 3 1/2 cu. yds. and above, power driven wheel scoops and scrapers (50 cu. yds. struck capacity or above), rail tamper, draglines, boomcat, mucking machines, graders in tunnels, pile driving engines.

GROUP 3: Front end loaders below 3 1/2 cu. yds, boom trucks, hydraulic backhoes 1/2 yds. capacity or below rubber or track mounted, tug boats, power driven wheel scoops & scrapers, blade graders, motor graders, bulldozers, trenching machines, concrete mixer, speed swing pettibone, ballast regulator, concrete pump, mechanic, welder, mechanic welder, shotcrete machines, Hoeram, locomotive (standard, narrow gauge), tuggers.

GROUP 4: High lifts above 10 feet, boilers (skelton), asphalt spreaders, bullfloat finishing machines, concrete finishing

machines, concrete spreaders, fine graders, air compressors, welding machines, pumps, generators, well points, deep wells, hydraulic pumps, elevators, freeze uniits, tunnel motorman or dinky operator, roller, conveyors, well drilling machines, grout pump, fireman.

GROUP 5: Fork lifts, ditch witch, bobcat 1/3 cu. yd. and below, space heaters, sweepers, assistant engineers, oilers.

GROUP 6: Master mechanic.

a. PAID HOLIDAYS: New Years Day, Inaugural Day, Decoration Day, Independence Day, Labor Day, Martin Luther King's Birthday, Veterans' Day, Thanksgiving Day, Friday after Thanksgiving and Christmas Day.

b. PREMIUM PAY: Tower cranes and cranes 100-ton and over to receive \$1.00 per hour premium over Group One.

ENGI0077-002 06/01/2004

	Rates	Fringes
Power equipment operators: (PAVING AND INCIDENTAL GRADING)		
GROUP 1.....	\$ 20.05	4.75
GROUP 2.....	\$ 17.75	4.75
GROUP 3.....	\$ 16.60	4.75
GROUP 4.....	\$ 15.50	4.75
GROUP 5.....	\$ 14.35	4.75
GROUP 6.....	\$ 20.05	4.55

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: Gradall operator, Crane.
GROUP 2: Boom Truck, Milling Machine, Excavator, Rubber Tire Backhoe, Asphalt Paver, Asphalt Plant Engineer.
GROUP 3: Motor Grader, Track Loader, Rubber Tire Loader, Track Dozer, Concrete Paver.
GROUP 4: Broom Truck, Asphalt Roller.
GROUP 5: Air Compressor, Grade Rollers.
GROUP 6: Mechanic.

ENGI0077-003 07/12/2004



	Rates	Fringes
Power equipment operators: (SEWER, GAS AND WATER LINE CONSTRUCTION)		
GROUP 1.....	\$ 18.68	4.12+a
GROUP 2.....	\$ 18.28	4.12+a
GROUP 3.....	\$ 18.13	4.12+a
GROUP 4.....	\$ 18.05	4.12+a
GROUP 5.....	\$ 17.94	4.12+a
GROUP 6.....	\$ 17.77	4.12+a
GROUP 7.....	\$ 17.87	4.12+a
GROUP 8.....	\$ 17.77	4.12+a
GROUP 9.....	\$ 18.31	4.12+a
GROUP 10.....	\$ 17.66	4.12+a
GROUP 11.....	\$ 17.54	4.12+a
GROUP 12.....	\$ 17.45	4.12+a

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: Backhoes, Cableways, Cranes, Derricks, Draglines, Power Shovels, Tunnel Shovels, Tunnel Mucking Machines (1 cubic yard capacity or above).

GROUP 2: Backhoes, Boom Cats, Cableways, Cranes, Derricks, Draglines, Elevating Graders, Hoists, Paving Mixers, Pile Driving Engines, Power and Tunnel Shovels, Tunnel Mucking Machines, Batch Plant, Concrete Pumps.

GROUP 3: Operators of Hydraulic Backhoes of below 1/2 yard capacity.

GROUP 4. Trenching machines above 83 inches.

GROUP 5: Trenching machines (up to & including 83"), Boilers (Skelton), Well Drilling Machines.

GROUP 6: Air Compressors (Tunnel).

GROUP 7: Front-end Loaders (Hi-Lift) and Bulldozers on Sewer and Water Line Work.

GROUP 8: Concrete Mixers, Power Driven Wheel Scoops and Scrapers, Blade graders, Motor Graders, Tunnel Mechanics, Tunnel Motormen.

GROUP 9: Mechanics.

GROUP 10: Bulldozers, Hydraulic Tamper and Hoe Pack Operators.

GROUP 11: Rollers.

GROUP 12: Air Compressors, Pumps, Welding Machines, Well Points.

a.PAID HOLIDAYS: New Year's Day, Inaugural Day, Washington's Birthday, Decoration Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Christmas Day and Martin Luther King's Birthday.

 IRON0005-001 06/01/2003

	Rates	Fringes
Ironworkers: Structural, Ornamental and Chain Link Fence.....	\$ 24.00	8.975

 IRON0201-001 05/01/2003

	Rates	Fringes
Ironworkers: Reinforcing.....	\$ 22.45	9.75

 LABO0074-002 06/01/2004

	Rates	Fringes
Laborers: (HAZARDOUS WASTE REMOVAL, (EXCEPT ON MECHANICAL SYSTEMS): Preparation for, removing & encapsulation of hazardous materials from non-mechanical systems) Skilled Asbestos Abatement Laborers.....	\$ 15.39	3.30
Skilled Toxic and Hazardous Waste Removal Laborers.....	\$ 18.17	3.30



LABO0456-002 06/01/2004

	Rates	Fringes
Laborers: (PAVING & INCIDENTAL GRADING)		
Asphalt Raker, Concrete Saw Operator.....	\$ 15.66	4.00
Asphalt Shoveler.....	\$ 15.17	4.00
Asphalt Tammer, Concrete Shoveler.....	\$ 15.39	4.00
Jack Hammer.....	\$ 15.57	4.00
Laborer.....	\$ 15.06	4.00
Sand Setter, Form Setter....	\$ 16.24	4.00

LABO0456-003 06/01/2004

	Rates	Fringes
Laborers: (TUNNEL, RAISE & SHAFT (FREE AIR) (FOR HEAVY AND SEWER & WATER LINES CONSTRUCTION)		
GROUP 1.....	\$ 18.93	3.30
GROUP 2.....	\$ 19.46	3.30
GROUP 3.....	\$ 20.84	3.30
GROUP 4.....	\$ 21.39	3.30

LABORERS CLASSIFICATIONS

GROUP 1: Brakeman, Bull Gang, Dumper, Trackman, Concrete Man.

GROUP 2: Chuck Tender, Powdermen in Prime House, Form Setters and Movers, Nippers, Cableman, Houseman, Groutman, Bell or Signalman, Top or Bottom Vibrator Operator.

GROUP 3: Miners, Re-Bar Underground, Concrete or Gunnite Nozzlemen, Powdermen, Timbermen and Re-Timbermen, Wood Steel Including Liner Plate or any Other Support, Material, Motorman, Caulkers, Diamond Drill Operators, Riggers, Cement Finishers - Underground, Welders and Burners, Shield Driver, Air Trac Operator, Shotcrete Nozzleman and Potman.

GROUP 4: Mucking Machine Operator (Air).

LABO0456-004 06/01/2004

	Rates	Fringes
Laborers: (HEAVY AND HIGHWAY AND SEWER & WATER LINES CONSTRUCTION)		
GROUP 1.....	\$ 18.34	3.30
GROUP 2.....	\$ 18.60	3.30
GROUP 3.....	\$ 18.73	3.30
GROUP 4.....	\$ 18.86	3.30
GROUP 5.....	\$ 19.23	3.30
GROUP 6.....	\$ 19.69	3.30
GROUP 7.....	\$ 19.91	3.30
GROUP 8.....	\$ 20.72	3.30

LABORERS CLASSIFICATIONS

GROUP 1: Carloaders, choker setter, concrete crewman, crushed feeder, demolition laborers, including salvaging all material, loading, cleaning up, wrecking, dumpmen, flagmen, fence erector and installer, including installation and erection of fence, guard rails, median rails, reference posts, guide posts and right-of-way markers, form strippers, general laborers, railroad track laborers, riprap man, scale man, stake jumper, structure mover, includes foundation, separation, preparation, cribbing, shoring, jacking and unloading of structures, water nozzle man, timber buckler and faller, truck loader, water boys, tool room men.

GROUP 2: Combined air and water nozzle man, cement handler, dope pot fireman (nonmechanical), form cleaning machine, mechanical railroad equipment (includes spiker, puller, tie cleaner, tamper, pipe wrapper, power driven wheelbarrows, operators of hand derricks, towmasters, scootcretes, buggymobiles and similar equipment), tamper or rammer operator, trestle scaffold builders over one tier high, power tool operator (gas, electric or pneumatic), sandblast or gunnite tail hose man, scaffold erector, (steel or wood), vibrator operator up to 4 feet) asphalt cutter, mortar men, shorer and lagger, creosote material handler, corrosive enamel or equal, paver breaker and jackhammer operators.

GROUP 3: Multi-section pipe layer, non-metallic clay and concrete pipe layer (including caulker, collarman, jointer, rigger and jacker, thermit welder and corrugated metal culvert pipe layer.



GROUP 4: Asphalt block pneumatic cutter, asphalt roller, walker chainsaw operator with attachment, concrete saw (walking), high scalers, jackhammer operator (using over 6 feet of steel), vibrator operator (6 feet and over), well point installer, air trac operator.

GROUP 5: Asphalt screeder, big drills, cut of the hole drills, (1 1/2" piston or larger), down the hole drills (3 1/2" piston or larger), gunnite or sandblaster nozzleman, asphalt raker, asphalt tamper, form setter, demolition torch operator, shotcrete nozzlemen and potman.

GROUP 6: Powderman, master form setters.

GROUP 7: Brick paver (asphalt block paver, asphalt block sawman, asphalt block grinder; hastings block or similar type)

GROUP 8: Licensed powdermen.

LABO0456-005 06/01/2004

	Rates	Fringes
Laborers: (TUNNEL, RAISE AND SHAFT (Compressed Air) for HEAVY CONSTRUCTION ONLY		
Gauge Pressure (Pounds)		Work Period (Hours)
1-14	\$ 22.97	7..... 3.30
14-18	\$ 27.02	6..... 3.30

FOOTNOTE: On any requirement for air pressure in excess of 18 PSI, work periods and rates should be negotiated at a pre-bid conference.

LABO0456-006 06/01/2004

	Rates	Fringes
Laborers: (BRICK MASONRY WORK)		
Mason Tenders.....	\$ 13.95	3.30
Scaffold Builders, Mortarmen and Small		

**Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP**

**Contract No. FN5008
Date: December 3, 2004**

Equipment Operators..... \$ 14.65 3.30

MARB0002-003 05/01/2004

Rates Fringes

Marble & Stone Mason
Includes Pointing,
Caulking and Cleaning of
All types of Masonry,
Brick, Stone and Cement
Structures..... \$ 27.47 10.05

MARB0003-001 05/01/2004

Rates Fringes

Mosaic & Terrazzo Worker,
Tile Layer..... \$ 22.07 8.18

MARB0003-004 05/01/2004

Rates Fringes

Marble, Tile & Terrazzo
Finisher..... \$ 17.87 7.32

PAIN0051-001 06/01/2004

Rates Fringes

Painters:
All Industrial Work..... \$ 22.43 6.86
Bridges, Heavy Highway,
Lead Abatement and
Flame/Thermal Spray..... \$ 24.32 6.86
Commercial and Mold
Remediation, Painters,
Drywall Finishers and
Wallcoverers..... \$ 21.01 6.86
Metal Polishing and
Refinishing..... \$ 22.01 6.86

PLAS0891-001 05/01/2004

Rates Fringes



Cement Masons:
 HEAVY CONSTRUCTION ONLY.....\$ 23.73 4.945

 PLAS0891-002 06/01/2004

	Rates	Fringes
Cement Masons: (PAVING & INCIDENTAL GRADING)		
Cement Masons.....	\$ 16.25	4.10
Concrete Saw Operators.....	\$ 16.25	4.10
Form Setters.....	\$ 16.25	4.10

 PLUM0005-001 08/01/2004

	Rates	Fringes
Plumber.....	\$ 29.52	10.89+a

a. PAID HOLIDAYS: Labor Day, Veterans' Day, Thanksgiving Day and the day after Thanksgiving, Christmas Day, New Year's Day, Martin Luther King's Birthday, Memorial Day and the Fourth of July.

 * PLUM0602-005 09/01/2004

	Rates	Fringes
Steamfitter, Refrigeration & Air Conditioning Mechanic.....	\$ 29.17	11.22+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King's Birthday, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day and the day after Thanksgiving and Christmas Day.

 SHEE0100-001 07/01/2004

	Rates	Fringes
Sheet Metal Worker.....	\$ 28.43	9.76

 TEAM0639-001 03/07/2002

	Rates	Fringes
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Truck drivers: (HEAVY & HIGHWAY CONSTRUCTION)
Tandem & Triaxle (3 or more axles, including steering axle)..... \$ 15.00 5.02+a
Tractor-trailer, Low-boy.... \$ 18.00 5.02+a

a. VACATION: Employees will receive one (1) week's paid vacation after one (1) year of service.

TEAM0639-002 04/01/2002

	Rates	Fringes
Truck drivers: (HEAVY & HIGHWAY CONSTRUCTION) Concrete Mixer Drivers.....	\$ 15.95	5.07+a+b

a. PAID HOLIDAYS: New Year's Day, Martin Luther King, Jr. Day, Memorial Day, July 4th, Labor Day, Thanksgiving Day, Christmas Day, or any day celebrated publicly in the District of Columbia as one of the above holidays.

b. PAID VACATIONS: Employees with one (1) year of service shall be entitled to a vacation of one (1) week; five (3) years of service are entitled to two (2) weeks; fifteen(10) years of service are entitled to three 3 weeks; twenty (20) years of service are entitled to four (4) weeks.

* TEAM0639-005 09/01/2004

	Rates	Fringes
Truck drivers: (PAVING & INCIDENTAL GRADING) All paving projects where the grading is incidental to the paving.....	\$ 13.50	3.39

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.
=====

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after



award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

In the listing above, the "SU" designation means that rates listed under the identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations

Wage and Hour Division

U.S. Department of Labor

200 Constitution Avenue, N.W.

Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

=====

END OF GENERAL DECISION



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General Decision Number: MD030048 10/15/2004 MD48

Superseded General Decision Number: MD020048

State: Maryland

Construction Types: Heavy (Heavy, and Sewer and Water Line)

Counties: Montgomery and Prince George's Counties in Maryland.

**HEAVY CONSTRUCTION PROJECTS; SEWER AND WATER LINE CONSTRUCTION
PROJECTS (Montgomery County, Maryland ONLY)**

Modification Number	Publication Date
0	06/13/2003
1	02/27/2004
2	04/02/2004
3	05/14/2004
4	06/18/2004
5	06/25/2004
6	07/02/2004
7	07/09/2004
8	07/16/2004
9	08/20/2004
10	09/17/2004
11	09/24/2004
12	10/15/2004

ASBE0024-001 03/01/2004

Rates Fringes

**Asbestos Worker/Heat and
Frost Insulator**

Includes application of
all insulating materials,
protective coverings,
coatings and finishes to
all types of mechanical
systems. Also the
application of
firestopping material for
wall openings and
penetrations in walls,
floors, ceilings and

**Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP**

**Contract No. FN5008
Date: December 3, 2004**



curtain walls..... \$ 24.17 11.09

ASBE0024-002 03/01/2004

Rates Fringes

Hazardous Material Handler
Includes preparation,
wetting, stripping,
removal, scrapping,
vacuuming, bagging and
disposing of all
insulation materials,
whether they contain
asbestos or not, from
mechanical systems.....

\$ 12.43 4.59

* BOIL0193-001 10/01/2004

Rates Fringes

Boilermaker..... \$ 32.17 14.29

BRDC0001-001 04/27/2003

Rates Fringes

Bricklayer..... \$ 24.85 5.52

CARP0132-001 05/01/2004

Rates Fringes

Carpenter/Lather..... \$ 22.50 4.83
Piledriver..... \$ 20.85 5.50

CARP0132-003 05/01/2004

Rates Fringes

Diver Tender..... \$ 20.85 5.50
Diver..... \$ 29.63 5.50

CARP1831-001 04/01/2003

Rates Fringes

**Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP**

**Contract No. FN5008
Date: December 3, 2004**

Millwright..... \$ 24.34 4.05

ELEC0026-001 06/07/2004

Rates Fringes

Electrician..... \$ 29.55 9.17+3%+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King Jr.'s Birthday, Inauguration Day, Memorial Day, Fourth of July, Labor Day, Veterans Day, Thanksgiving Day, the day after Thanksgiving and Christmas Day or days designated as legal holidays by the Federal Government.

ELEC0070-001 03/31/2002

Rates Fringes

Line Construction:

Groundmen.....	\$ 14.00	2.45+17.5%
Linemen, Cable Splicers, Equipment Operators.....	\$ 24.48	2.45+17.5%
Truck with winch.....	\$ 14.00	2.45+17.5%

ENGI0077-005 07/19/2004

Rates Fringes

Power equipment operators:
(SEWER, GAS AND WATER LINE
CONSTRUCTION:
(Montgomery County, Maryland
ONLY))

GROUP 1.....	\$ 18.68	4.12+a
GROUP 2.....	\$ 18.28	4.12+a
GROUP 3.....	\$ 18.13	4.12+a
GROUP 4.....	\$ 18.05	4.12+a
GROUP 5.....	\$ 17.94	4.12+a
GROUP 6.....	\$ 17.77	4.12+a
GROUP 7.....	\$ 17.87	4.12+a
GROUP 8.....	\$ 17.77	4.12+a
GROUP 9.....	\$ 18.31	4.12+a
GROUP 10.....	\$ 17.66	4.12+a
GROUP 11.....	\$ 17.54	4.12+a
GROUP 12.....	\$ 17.45	4.12+a



POWER EQUIPMENT OPERATORS CLASSIFICATIONS

- GROUP 1: Backhoes, Cableways, Cranes, Derricks, Draglines, Power Shovels, Tunnel Shovels, Tunnel Mucking Machines (1 cubic yard capacity or above).
- GROUP 2: Backhoes, Boom Cats, Cableways, Cranes, Derricks, Draglines, Elevating Graders, Hoists, Paving Mixers, Pile Driving Engines, Power and Tunnel Shovels, Tunnel Mucking Machines, Batch Plant, Concrete Pumps.
- GROUP 3: Operators of Hydraulic Backhoes of below 1/2 yard capacity.
- GROUP 4: Trenching machines (above 83")
- GROUP 5: Trenching machines (up to and including 83"), Boilers (Skelton), Well Drilling Machines.
- GROUP 6: Air Compressors (Tunnel).
- GROUP 7: Front-end Loaders (Hi-Lift) and Bulldozers on Sewer and Water Line Work
- GROUP 8: Concrete Mixers, Power Driven Wheel Scoops and Scrapers, Blade graders, Motor Graders, Tunnel Mechanics, Tunnel Motormen.
- GROUP 9: Mechanics.
- GROUP 10: Bulldozers, Hydraulic Tamper and Hoe Pack Operators.
- GROUP 11: Rollers.
- GROUP 12: Air Compressors, Pumps, Welding Machines, Well Point

a. PAID HOLIDAYS: New Year's Day, Inaugural Day, Washington's Birthday, Decoration Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Christmas Day and Martin Luther King's Birthday.

ENGI0077-006 05/01/2004

	Rates	Fringes
Power equipment operators: (HEAVY CONSTRUCTION)		
GROUP 1.....	\$ 24.74	5.62+a+b
GROUP 2.....	\$ 24.28	5.62+a+b
GROUP 3.....	\$ 23.57	5.62+a
GROUP 4.....	\$ 21.54	5.62+a
GROUP 5.....	\$ 17.00	5.62+a
GROUP 6.....	\$ 26.11	5.62+a

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: 35 ton cranes & above, tower & climbing cranes, derricks, concrete boom pump, drill rigs (equivalent to L & Double L), mole.

GROUP 2: Backhoes, cableways, cranes, cherry pickers, elevating graders, hoists, paving mixers, power shovels, tunnel shovels, batch plants, shields, tunnel mining machines, gradalls, front end loaders, 3 1/2 cu. yds. and above, power driven wheel scoops and scrapers (50 cu. yds. struck capacity or above), rail tamper, draglines, boomcat, mucking machines, graders in tunnels, pile driving engines.

GROUP 3: Front end loaders below 3 1/2 cu. yds, boom trucks, hydraulic backhoes 1/2 yds. capacity or below rubber or rack mounted, tug boats, power driven wheel scoops and scrapers, blade graders, motor graders, bulldozers, trenching machines, concrete mixer, speed swing pettibone, ballast regulator, concrete pump, mechanic, welder, mechanic welder, shotcrete machines, Hoeram, locomotive (standard, narrow gauge), tuggers.

GROUP 4: High lifts above 10 feet, boilers (skelton), asphalt spreaders, bullfloat finishing machines, concrete finishing machines, concrete spreaders, fine graders, air compressors, welding machines, pumps, generators, well points, deep wells, hydraulic pumps, elevators, freeze units, tunnel motorman or dinky operator, roller, conveyors, well drilling machines, grout pump, fireman.

GROUP 5: Fork lifts, ditch witch, bobcat 1/3 cu. yd. and below, space heaters, sweepers, assistant engineers, oilers.

GROUP 6: Master mechanic.

a. PAID HOLIDAYS: New Years Day, Inaugural Day, Decoration Day, Independence Day, Labor Day, Martin Luther King's Birthday, Veterans' Day, Thanksgiving Day, Friday after Thanksgiving and Christmas Day.

b. PREMIUM PAY: Tower crane and cranes 100-ton and over to receive \$1.00 per hour premium over Group One.

 IRON0005-001 06/01/2003

	Rates	Fringes
Ironworkers:		
Structural, Ornamental and		
Chain Link Fence.....	\$ 24.00	8.975

IRON0201-001 05/01/2003

	Rates	Fringes
Ironworkers: Reinforcing.....	\$ 22.45	9.75

LABO0074-002 06/01/2004

	Rates	Fringes
Laborers: (HAZARDOUS WASTE REMOVAL, (EXCEPT ON MECHANICAL SYSTEMS): Preparation for, removing & encapsulation of hazardous materials from non-mechanical systems) Skilled Asbestos Abatement Laborers.....	\$ 15.39	3.30
Skilled Toxic and Hazardous Waste Removal Laborers.....	\$ 18.17	3.30

LABO0456-001 06/01/2004

	Rates	Fringes
Laborers: (HEAVY CONSTRUCTION) (Montgomery & Prince Georges Counties) SEWER & WATER LINES (Montgomery County ONLY)) GROUP 1.....	\$ 18.34	3.30
GROUP 2.....	\$ 18.60	3.30
GROUP 3.....	\$ 18.73	3.30
GROUP 4.....	\$ 18.86	3.30
GROUP 5.....	\$ 19.23	3.30
GROUP 6.....	\$ 19.69	3.30
GROUP 7.....	\$ 19.91	3.30
GROUP 8.....	\$ 20.72	3.30

LABORERS CLASSIFICATIONS

GROUP 1: Carloaders, choker setter, concrete crewman,

crushed feeder, demolition laborers, including salvaging all material, loading, cleaning up, wrecking, dumpmen, flagmen, fence erector and installer, including installation and erection of fence, guard rails, median rails, reference posts, guide posts and right-of-way markers, form strippers, general laborers, railroad track laborers, riprap man, scale man, stake jumper, structure mover, includes foundation, separation, preparation, cribbing, shoring, jacking and unloading of structures, water nozzleman, timber buckler and faller, truck loader, water boys, tool room men.

GROUP 2: Combined air and water nozzleman, cement handler, dope pot fireman (nonmechanical), form cleaning machine, mechanical railroad equipment (includes spiker, puller, tie cleaner, tamper, pipe wrapper, power driven wheelbarrows, operators of hand derricks, towmasters, scootcretes, buggymobiles and similar equipment), tamper or rammer operator, trestle scaffold builders over one tier high, power tool operator (gas, electric or pneumatic), andblast or gunnite tailhose man, scaffold erector,(steel or wood), vibrator operator up to 4 feet) asphalt cutter, mortar men, shorer and lagger, creosote material handler, corrosive enamel or equal, paver breaker and jackhammer operators.

GROUP 3: Multi-section pipe layer, non-metallic clay and concrete pipe layer (including caulker, collarman, jointer, rigger and jacker, thermit welder and corrugated metal culvert pipe layer.

GROUP 4: Asphalt block pneumatic cutter, asphalt roller, walker chainsaw operator with attachment, concrete saw (walking), high scalers, jackhammer operator (using over 6 feet of steel), vibrator operator (6 feet and over), well point installer, air trac operator.

GROUP 5: Asphalt screeder, big drills, cut of the hole drills, (1 1/2" piston or larger), down the hole drills (3 1/2" piston or larger), gunnite or sandblaster nozzleman, asphalt raker, asphalt tamper, form setter, demolition torch operator, shotcrete nozzlelemen and potman.

GROUP 6: Powderman, master form setters.

GROUP 7: Brick paver (asphalt block paver, asphalt block sawman, asphalt block grinder; hastings block or similar type)

GROUP 8: Licensed powdermen.

LABO0456-003 06/01/2004

Rates Fringes



Laborers: (TUNNEL, RAISE &
 SHAFT (FREE AIR)
 (FOR HEAVY AND SEWER & WATER
 LINES CONSTRUCTION)

GROUP 1.....	\$ 18.93	3.30
GROUP 2.....	\$ 19.46	3.30
GROUP 3.....	\$ 20.84	3.30
GROUP 4.....	\$ 21.39	3.30

LABORERS CLASSIFICATIONS

GROUP 1: Brakeman, Bull Gang, Dumper, Trackman, Concrete Man.

GROUP 2: Chuck Tender, Powdermen in Prime House, Form
 Setters and Movers, Nippers, Cableman, Houseman, Groutman,
 Bell or Signalman, Top or Bottom Vibrator Operator.

GROUP 3: Miners, Re-Bar Underground, Concrete or Gunnite
 Nozzlemen, Powdermen, Timbermen and Re-Timbermen, Wood
 Steel Including Liner Plate or any Other Support, Material,
 Motorman, Caulkers, Diamond Drill Operators, Riggers,
 Cement Finishers - Underground, Welders and Burners, Shield
 Driver, Air Trac Operator, Shotcrete Nozzleman and Potman.

GROUP 4: Mucking Machine Operator (Air).

 LABO0456-005 06/01/2004

Rates Fringes

Laborers: (TUNNEL, RAISE AND
 SHAFT (Compressed Air) for
 HEAVY CONSTRUCTION ONLY

Gauge Pressure (Pounds)	Work Period (Hours)	Rates	Fringes
1-14	7.....	\$ 22.97	3.30
14-18	6.....	\$ 27.02	3.30

FOOTNOTE: On any requirement for air pressure in excess of 18
 PSI, work periods and rates should be negotiated at a
 pre-bid conference.

 MARB0002-003 05/01/2004

Rates Fringes

**Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP**

**Contract No. FN5008
Date: December 3, 2004**

Marble & Stone Mason Includes Pointing, Caulking and Cleaning of All types of Masonry, Brick, Stone and Cement Structures.....	\$ 27.47	10.05
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MARB0003-001 05/01/2004

	Rates	Fringes
Mosaic & Terrazzo Worker, Tile Layer.....	\$ 22.07	8.18

MARB0003-004 05/01/2004

	Rates	Fringes
Marble, Tile & Terrazzo Finisher.....	\$ 17.87	7.32

PAIN0051-001 06/01/2004

	Rates	Fringes
Painters: All Industrial Work.....	\$ 22.43	6.86
Bridges, Heavy Highway, Lead Abatement and Flame/Thermal Spray.....	\$ 24.32	6.86
Commercial and Mold Remediation, Painters, Drywall Finishers and Wallcoverers.....	\$ 21.01	6.86
Metal Polishing and Refinishing.....	\$ 22.01	6.86

PLAS0891-003 05/01/2004

	Rates	Fringes
Cement Mason.....	\$ 23.73	4.945

PLUM0005-001 08/01/2004

	Rates	Fringes
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Plumber..... \$ 29.52 10.89+a

a. PAID HOLIDAYS: Labor Day, Veterans' Day, Thanksgiving Day and the day after Thanksgiving, Christmas Day, New Year's Day, Martin Luther King's Birthday, Memorial Day and the Fourth of July.

PLUM0602-005 09/01/2004

Rates Fringes

Steamfitter, Refrigeration &
Air Conditioning Mechanic..... \$ 29.17 11.22+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King's Birthday, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day and the day after Thanksgiving and Christmas Day.

SHEE0100-001 07/01/2004

Rates Fringes

Sheet Metal Worker..... \$ 28.43 9.76

TEAM0639-003 04/01/2002

Rates Fringes

Truck drivers: (HEAVY
CONSTRUCTION)
Concrete Mixer Drivers..... \$ 15.95 5.07+a+b

a. PAID HOLIDAYS: New Year's Day, Martin Luther King, Jr. Day, Memorial Day, July 4th, Labor Day, Thanksgiving Day, Christmas Day, or any day celebrated publicly in the District of Columbia as one of the above holidays.

b. PAID VACATIONS: Employees with one (1) year of service shall be entitled to a vacation of one (1) week; five (5) years of service are entitled to two (2) weeks; fifteen (15) years of service are entitled to three (3) weeks; twenty (20) years of service are entitled to four (4) weeks.

TEAM0639-004 03/07/2002

	Rates	Fringes
Truck drivers: (HEAVY CONSTRUCTION)		
Tandem & Triaxle (3 or more axles, including steering axle).....	\$ 15.00	5.02+a
Tractor-trailer, low boy....	\$ 18.00	5.02+a

a.VACATION: Employees will receive one (1) week's paid vacation after one (1) year of service.

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

In the listing above, the "SU" designation means that rates listed under the identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted

because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.

Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

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CONTRACTING REQUIREMENTS

00900 REVISIONS, CLARIFICATIONS, AND MODIFICATIONS

This Section provides an area for conforming the Project Manual with instructions issued to clarify, revise, add or delete Contract requirements issued both during the proposing process or after execution of the Agreement.

00910 PRECONTRACT REVISIONS

- A. Instructions: Insert here all Amendment Letters issued during the proposing process, and add the latest Specifications pages that were issued by Amendment to the appropriate Sections in order to conform the Project Manual and add the latest Drawing sheets in order to conform the Project Drawings.
- B. See Section 00491 for TECHNICAL PROPOSAL AS FINALLY ACCEPTED



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00920 CLAIMS

Instructions: Insert here all Design-Builder Claims.



THIS PAGE NOT USED

00930 RECORD CLARIFICATIONS AND PROPOSALS

Instructions: Insert here all instructions issued to clarify the work without Contract Modification, both Design-Builder requests for Contract modifications and Authority proposals for Contract Modifications. Include Change Order Proposals and Requests, Clarification Notices, Minor Changes in the Work, Proposal Requests, and Requests for Interpretation.

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00940 RECORD MODIFICATIONS

Instructions: Insert here all changes to the Contract issued after execution of the Agreement including PCO's and Change Orders.

END OF SECTION

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DIVISION 01

GENERAL REQUIREMENTS

END OF SECTION



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DIVISION 01 - GENERAL REQUIREMENTS

01000 GENERAL REQUIREMENTS

- A. This Section includes a compilation of General Requirements for the Contract and of physical aspects of construction that lists summary of work requirements, price and payment procedures, administrative requirements, quality requirements, temporary facilities and controls, product requirements, execution requirements, and facility operation requirements.

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Appendix A	WMATA ADA Accessibility Checklist

END OF SECTION

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SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

This Section describes, in general terms, the work to be performed by the Design-Builder and specifies the project milestones.

1.02 RELATED DOCUMENTS

All of the Contract Documents.

1.03 PROJECT WORK

- A. The Design-Builder shall design the project, and build it as designed, in accordance with the Mandatory Requirements in order to provide WMATA with a complete and finished project. The project shall function as an integral part of, and be fully compatible with, the existing WMATA system.
- B. The Design-Builder shall not solely rely on the description provided in this Section 01110 and Section 00100, SOLICITATION - REQUEST FOR PROPOSALS, to identify all project components. The Design-Builder shall determine the full scope of the work from a thorough examination of the Mandatory Documents and the project site, and as may be reasonably inferred from such examination.
- C. The Design-Builder shall obtain necessary permits, conduct survey and additional geotechnical and environmental investigations and work as necessary, perform designs and systems integration work, manage quality through the use of an effective and well-planned quality system, perform inspection and testing as necessary, and manage the safe construction and commissioning of the project. The Design-Builder's Designer of Record shall provide a design and produce "stand-alone" issued for construction drawings and "stand-alone" issued for construction specifications which incorporate and comply with WMATA's Design Criteria, and as-built record drawings, records and spare parts as required by the Project Documents.
- D. Except as specifically provided for in the Project Documents as listed in Section 00300, all materials, services and efforts necessary to achieve project completion and final acceptance, on or before project milestones, shall be the Design-Builder's sole responsibility.
- E. Permits and Plans
 - 1. Design-Builder shall prepare all necessary Designs applicable to obtain all necessary permits.
 - 2. The Design-Builder shall submit on site Water and Sewer plans for approval to Prince George's County, Montgomery County, the District of Columbia and WSSC as applicable. It is the Design-Builder's responsibility for obtaining final approval for all work.
 - 3. It is the Design-Builder's responsibility for obtaining all applicable jurisdiction's approval for Landscaping design plans and plant schedule and final approval for all Landscaping work.
 - a. It is the Design-Builder's responsibility for obtaining MDNR and MDE/ACOE final approval for all work.

4. Maintenance of traffic plans including temporary bridging, decking and support systems and calculations shall be designed and submitted to MDOT and/or Prince George's County and/or Montgomery County, and/or the District of Columbia as applicable for approval.
5. Sediment and Erosion control and Stormwater Management shall be accomplished for each phase of work to be performed and shall be approved by the applicable jurisdictional agencies. Sediment and Erosion controls and Storm Water Management facilities installed and/or constructed by Design-Builder shall be assumed to be in place and they shall be maintained until no longer needed or transferred to WMATA.
6. The Design-Builder is responsible for obtaining any and all necessary permits required to construct the projects.
7. All other necessary plans and permits shall be submitted and obtained by the Design-Builder as required by the Mandatory Documents.

F. Survey Work

The Design-Builder shall perform survey work. Related documents include: Section 01722, MOBILIZATION and Section 01721, LAYOUT OF WORK AND FIELD ENGINEERING,.

G. Design

The Design-Builder shall perform Design work. Related documents include: Section 01111, KEY DESIGN-BUILDER FUNCTIONS and 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.

H. ADAAG Design and Construction Compliance

ADAAG Regulations apply to all occupied space by both the public and by WMATA employees. In projects that address only a portion of an existing facility, ADAAG requirements state that the connection to public use space has to be accessible to the public at finish of construction. Alterations cannot decrease public accessibility. Accessible paths must be provided both within scope of the facility being constructed or renovated and to adjacent properties. The Design-Builder shall design and build the work in accordance with ADAAG requirements and this applies to facilities open to the public as well as facilities for WMATA employees per ADAAG reference 4.1.1.5.

I. Systems Integration

The Design-Builder shall perform and manage systems integration of work. Related documents include: Section 01111, KEY DESIGN-BUILDER FUNCTIONS, Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION, Section 01470, QUALITY SYSTEM and Section 01810, COMMISSIONING.

J. Quality

The Design-Builder shall establish and follow a Quality System. Related documents include: Section 00722, QUALITY CONTROL/QUALITY ASSURANCE, Section 01113, SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.

K. Inspection and Testing

The Design-Builder shall establish, perform and monitor inspection and testing. Related documents include: Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.

L. Safety

The Design-Builder shall establish and effective safety program, and manage project safety. Related documents include: Section 00744, PROTECTION OF PERSONS AND PROPERTY, Section 00844, SAFETY SUPERINTENDENCE REQUIREMENTS and Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS.

M. System Testing and Commissioning

The Design-Builder shall manage and perform testing of the system as a whole, and the commissioning of the system. Related documents include: Section 01113, SYSTEMS INTEGRATION, Section 01470, QUALITY SYSTEM and Section 01810, COMMISSIONING.

N. Project Record Documents and Training

The Design-Builder shall submit project record documents and perform training. Related documents include: Section 01780 CLOSEOUT SUBMITTALS and Section 01820, DEMONSTRATION AND TRAINING.

O. Site Specific Work Plan (SSWP)

The Design-Builder shall submit a SSWP in accordance with Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS.

1.04 PHYSICAL DESCRIPTION OF THE WORK

A. Description of Work:

1. Shop and Yard improvements with related site, utility, and systems work at three existing WMATA Service & Inspection (S & I) Yards: Brentwood Yard on the Red Line in the District of Columbia, Greenbelt Yard on the Green Line in Prince George's County, MD, and Shady Grove Yard on the Red Line in Montgomery County, MD

2. Work includes, but is not limited to, the following:

a. Brentwood Yard:

(1) Brentwood Yard covers an area of 30 acres and stores 86 cars. It includes a Repair Shop, which will undergo major renovations. The Shop, located in a congested area between mainline Metro tracks, is a brick and block building with a footprint of approximately 108,000 square feet and basement, ground floor and partial mezzanine levels. The main ground level is comprised primarily of open shop repair areas with a secondary administrative support office area at the south end of the building. The main level floor slab is reinforced concrete supported by concrete and steel columns. Six service tracks pass through the main level, three on the east side and three on the west side. There is an approximate 120-foot wide area between east and west tracks, which is used for heavy truck and wheel repair, light maintenance functions and the support offices. This 120-foot wide strip is where the renovations will occur. The administrative office area at the south end of the Shop occupies all three levels one on top of each other. The basement level occupies the full area beneath the ground floor level and is used for storage, light maintenance and to house the car hoist equipment.

(2) The 120-foot wide area referred to above will be vacated and retrofitted with three additional service and inspection (S&I) tracks, each with four S&I bays, adding to the existing six tracks and 28 bays. Installation of the new S&I tracks will require partial demolition of the first floor cast-in-place concrete slab for installation of track and rail car hoists. The new hoists will be founded on the existing basement floor slab, which may require supplemental

support. Major mechanical and electrical systems will have to be relocated and possibly supplemented.

- (3) Construction affecting the Brentwood Shop main floor, except for the relocated loading dock, shall be coordinated with WMATA to ensure that any disrupted maintenance functions at Brentwood due to construction activities can be accommodated at other WMATA facilities to allow car and parts maintenance to continue with minimal disruption. This may result in delayed access to the main floor until other facilities, e.g. Greenbelt, are available.
- (4) Construction in the Brentwood shop basement, however, can proceed at the Design Builder's discretion, except for the lunch room and office area at the south end of the basement, the hoist equipment room in the north end of the basement, the two hoist equipment enclosures and the wheel truing pit. WMATA will rearrange the storage area to vacate the area between column lines D and F. Design Builder will be responsible for relocating the Component Repair Shop from the basement to a Design Builder provided double wide trailer to be located in the Yard. The existing loading ramp which provides access to the basement will be available to the Design Builder, but on a shared basis so WMATA deliveries and access to the basement can continue.

b. Greenbelt Yard:

- (1) The existing Greenbelt Yard covers 45.5 acres and stores 284 cars. It includes an S&I Shop, Paint Shop, Operations Building and Traction Power Substation. The S&I Shop is a one story brick and block building with a footprint of 129,000 square feet. It has a main ground level comprised primarily of open track bays with a secondary two-level administrative support office area. The office area occupies two levels from main ground level through to a partial mezzanine level.
- (2) The maintenance functions displaced by the new S&I tracks at Brentwood will be relocated to Greenbelt Yard. The relocated Brentwood heavy truck and wheel repair functions will be consolidated and expanded in the existing Greenbelt Shop. This will require renovation to the existing Greenbelt Shop's reinforced concrete slab-on-grade to install the required truck lifts, turntables and rail. Lighter maintenance functions such as axle and air brakes, HVAC shop, electronics shop, etc. will be relocated from Brentwood to a new 72,000 square foot two-story building to be constructed at Greenbelt Yard in an existing parking lot between the S&I and Paint Shops. New shop equipment will be furnished and installed in the new Greenbelt Shop by the Design Builder as directed by the Authority's Representative. Greenbelt service functions and shop equipment displaced by consolidation of the heavy repair in the existing Shop will either be rearranged and kept in the existing shop or be relocated to the new building.

c. Shady Grove Yard:

- (1) Shady Grove Yard covers 43.2 acres and has a storage capacity of 168 cars. It includes an S&I Shop, Operations Building and Traction Power Substation. The S&I Shop is a one story brick and block building with a footprint of 73,000 square feet. It has a main ground level comprised primarily of open track bays with a secondary two-level administrative support office area. The office area occupies two levels, one on top of the other, from main ground level through to a partial mezzanine level.
- (2) At Shady Grove Yard a new one story, four-track 16 bay S&I shop will be constructed immediately adjacent to and attached to the west side of existing shop. A covered extension approximately 43 feet wide and 85 feet

long will be added to the south end of the existing shop to extend the blow-down pit tracks to accommodate a married pair of cars.

3. General Requirements: Improvements at the three yards are all within WMATA property limits. The contract includes all trackwork, utilities, and systems work. Work activities in the existing shops and yards must be phased in a manner so as to minimize disruption to on-going rail car maintenance operations. Replacement parking for WMATA employees, must be provided prior to removal of existing parking. Track cut-ins for new or relocated track shall be permitted only on weekends or between 11:00 p.m. and 4:00 a.m. on weekdays. (Sunday night through Friday morning). The Contractor will be responsible for final design, construction and integration into the existing yards of all new components and systems, inclusive of testing and training, except designs for alignment, trackwork, and conceptual stormwater management at Greenbelt Yard which will be provided by the Authority.
4. Specific features include but are not limited to:
 - a. Brentwood Yard Specific Features:
 - (1) Convert the existing heavy maintenance shop area to a 12-car Service & Inspection (S&I) area with vertical hoists, turntables and cranes; three tracks for two married pairs per track. Install track access for the new shop area from both ends of the Shop. Modify structure as necessary to accommodate new S&I tracks and hoists.
 - (2) Relocate heavy truck and wheel maintenance to Greenbelt as directed by the Authority.
 - (3) Provide in-line wheel truing capabilities on existing Shop Track #11.
 - (4) Construct replacement parking within the limits of the Yard for the existing parking to be removed for the new access tracks.
 - (5) Relocate basement level loading dock, which will be made obsolete with the installation of the rail car hoists, to first floor loading dock.
 - (6) Modify existing floor framing of Mezzanine offices over the new tracks to provide 11'-2" clearance for rail cars to pass below.
 - (7) Modify electrical, mechanical, traction power, yard interlocking control and communications rooms and systems as required to accommodate the new shop area and tracks. Modify the Yard Control Panel as required to include the new tracks.
 - (8) Relocate utilities, conduit, cable, piping and ductwork as necessary to accommodate new installation.
 - (9) Modify existing freight elevator to mezzanine level to be ADA/ANSI compliant.
 - (10) Reference environmental reports listed in Section 00341 for extent of asbestos containing material and lead based paint and potential for contaminated soils and water.
 - b. Greenbelt Yard Specific Features:
 - (1) Heavy truck and wheel maintenance functions from Brentwood to be relocated to Greenbelt as described above. Increase the current four truck repair lifts to 12. Provide additional turntables and cranes.

- (2) Construct a two-story approximate 72,000 SF new building in parking lot adjacent to Paint Shop to house relocated shop functions from Brentwood, (other than heavy truck and wheel repair), and service areas and equipment displaced from the existing Greenbelt Shop (motor repair, electro-mechanical shop, pneudraulic shop, HVAC shop and storage) as a result of consolidating all heavy truck and wheel maintenance in the existing shop building.
 - (3) Replace parking that is displaced by the new building.
 - (4) Relocate maintenance-of-way (MOW) tracks to accommodate new parking.
 - (5) Relocate storage containers and materials now located with construction limits.
 - (6) Modify electrical, mechanical, traction power and communications rooms and systems as required to accommodate the new shop and track.
 - (7) Relocate utilities, conduit, cable, piping and existing track as necessary to accommodate new installation.
 - (8) Reference environmental reports listed in Section 00341. Groundwater will require treatment before discharging.
- c. Shady Grove Specific Features:
- (1) Construct a new four track 16-car S&I building with mezzanine level and track access from both ends of the building. New building to be adjacent and directly accessible to existing shop.
 - (2) Construct a covered extension on the south end of the existing shop and extend the blow-down pit to accommodate a married pair of cars. The current blow-down pit can only accommodate one car of a married pair.
 - (3) Modify mezzanine in existing shop by expanding Men's Locker Room into existing Lunch and Vending Room.
 - (4) Modify electrical, mechanical, traction power, yard interlocking control and communications rooms and systems as required to accommodate the new shop and track. Modify the Yard Control Panel as required to include the new tracks.
 - (5) Replace parking and outside storage that is displaced by the new building and tracks. This will require excavation and removal from the site of cut from an existing spoil hill within the loop track.
 - (6) Relocate utilities, conduit, cable, piping and existing track as necessary to accommodate new installation.
 - (7) Relocate bypass track and maintenance of way (MOW) tracks 7, 8, 10C and 10D to accommodate new shop. Contractor must provide for continued access and storage for equipment stored on the existing MOW tracks. This can be handled by phasing of work or possible installation of new tracks along west side of existing storage tracks.
 - (8) Relocate salt dome, storage containers and materials now located with construction limits.
 - (9) Relocate glycol tanks and fuel dispenser to accommodate realigned access road.

- (10) Relocate utilities in proposed building footprint: fuel oil tank, 78" RCP Storm Sewer, 24W ATC/Comm Ductbank, waterlines of varied sizes, various electrical and traction power ductbank.
- (11) Relocate S&I track No. 6.
- (12) Reference Environmental Reports listed in Section 00341 for extent of asbestos-containing materials and lead based paint and for potential of encountering contaminated soils and water.

B. Limits of Work

Limits of work are as shown on the Drawings.

C. Temporary Facilities

Temporary facilities include temporary construction for use by the Design-Builder. Related Documents include: Section 01510, TEMPORARY UTILITIES; Section 01520, TEMPORARY CONSTRUCTION FACILITIES; 01530, TEMPORARY CONSTRUCTION; and 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.

D. Site Preparation

1. Site preparation will include excavation and rough grading of the site at certain locations to provide adequate room to perform construction, and to provide staging and laydown areas, then backfill adjacent to completed structures. Related documents include: Project Drawings; Division 02 specifications.
2. After construction, the sites are to be landscaped as required by local governing jurisdictions and as approved by the jurisdictional authorities.

E. Civil

Civil works will include sediment and erosion control, stormwater management, and storm collection and de-watering, support of the excavation, excavation, grading, then backfill over and adjacent to completed structures. Related documents include: Project Drawings; Division 02 specifications.

1. Design-Builder will coordinate with other contractors and Authority employees through the Authority Representative on the establishment and operation of work areas and rough grading of sites.
2. Design-Builder shall develop grading plans and cross sections that provide for rough grading of sites before other operations.
3. Design-Builder shall adhere to current existing Yard elements and field conditions when constructing parking lots, access roads, sidewalks, and Yard facilities in order that they match. Pavement shall be in accordance with the Design Criteria. Design mixes for bituminous concrete and concrete shall be per WMATA Standard and Technical Specifications and/or jurisdictional requirements.
4. Restore pavements as soon as possible. Design of pavement and marking must be approved by agencies having jurisdiction.
5. Design-Builder shall provide temporary fencing around the construction area.
6. Discharge from erosion to storm water management ponds shall be monitored for acidity.

F. Site Work

1. Excavation and grading and sediment and erosion control
2. Utilities and stormwater management
3. Paving and striping
4. Landscaping and site furniture for parking structures and landscaping, wetlands mitigation and forest conservation for the Shop and Yard work
5. Lighting
6. Signage
7. Walkways
8. Fencing
9. Systems work including COMM, Trackwork, Traction Power, ATC and Outside Plant Cabling

G. Roadworks

Roadworks will include the installation of parking lots and entrances, temporary Design-Builder's and permanent access roads, grade crossings, and striping. Detours and staging will be required for an uninterrupted circulation and use of the existing Access Roads.

H. Utilities and Stormwater Management

1. Utilities will need to be protected and supported over excavation, relocated, and installed as shown in the Mandatory Documents.
2. Design-Builder will coordinate with PEPCO on the design and construction of electric service power feeder.
3. Stormwater management shall be performed as required by local jurisdictions.
4. Related documents include: Project Drawings; Division 02 specifications.

I. Structures

Facility Structures include:

1. S&I Shops
2. Related documents include: All drawings and specifications and provided documents of the existing S&I Shops and provided documents of the Yard for Shop work.

J. Mechanical, Plumbing, Electrical and Systems Work

1. Heaters and fans in utility rooms.
2. Dry standpipe and fire suppression and alarm systems as required by jurisdictional Code and Design Criteria.
3. Restrooms as required per ADAAG regulations.

4. Communications Systems as specified.
5. Air Conditioning Split System Units in Equipment and Communications rooms.
6. Positive water drainage systems (drains, risers, and sewers).
10. Oil/Grit Separators for Shop and Yard Improvements as necessary.
11. COMM equipment and cabling as shown and specified.
12. ATC equipment and cabling as shown and specified.
13. Trackwork as shown and specified.
14. Traction power equipment and cabling as shown and specified.
15. Related documents include: All drawings and specifications, and provided documents of the Yard for Shop and Yard work.

K. Graphics and Signage

1. Pedestrian, Vehicular, Way Finding as required.
2. Slab and Pavement Markings.
3. Related documents include: All drawings and specifications and provided documents of the Yard for Shop and Yard work.

1.05 PROJECT MILESTONES

Project Milestones are as set out in Section 00888, LIQUIDATED DAMAGES.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION



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SECTION 01111

KEY DESIGN-BUILDER FUNCTIONS

PART 1 GENERAL

1.01 SUMMARY

This Section specifies several key functions that are to form part of the Design-Builder's role, and the responsibilities relating to those functions.

A. The key Design-Builder functions include those of the:

1. Design Professional
2. Construction Firm
3. Key Personnel

1.02 RELATED DOCUMENTS

Section 00400, Procurement Forms and Supplements

Section 00700, General Conditions

Section 00800, Supplementary Conditions

Section 01112, General Requirements - Summary of Work Requirements: Design Requirements and Program Criteria

Section 01113, General Requirements - Summary of Work Requirements: Systems Integration

Section 01310, General Requirements - Administrative Requirements: Project Management and Coordination

Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures

Section 01470, General Requirements - Quality Requirements: Quality System

Section 01780, General Requirements - Execution Requirements: Closeout Submittals

1.03 DESIGN PROFESSIONAL

A. The Design-Builder shall include, as a part of its team, a Design Professional (Designer) as defined in Section 00701 of the General Conditions. The Design-Builder shall submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, verification of the firm name and credentials of the Designer, Major Subcontractors and Key Personnel submitted in the TECHNICAL PROPOSAL AS FINALLY ACCEPTED, Section 00491, to the Authority Representative within ten (10) calendar days after award of the Contract for the Authority Representative's review and acceptance as specified in Section 00726, COMMENCING THE



WORK,. Before substituting any Design Firm or Key Personnel or entering into any subcontracts with substitute subcontractors, the Design-Builder shall submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, a written statement to the Authority giving the name and address of the proposed replacement, the portion of the work it is to perform, and any other information tending to prove that it has the necessary facilities, skill, past experience and financial resources to perform the work in accordance with the terms and conditions of this project, as specified in Section 00710, PROJECT MANAGEMENT AND SUPERINTENDENCE AND KEY PERSONNEL.

- B. Firms and individuals that comprise Design Professional must be approved to practice by the applicable jurisdiction's professional board of architects and engineers to practice in the field of architecture and / or engineering.
- C. The Design Professional's responsibilities shall include but not be limited to the following:
 - 1. Perform and/or manage the performance of all design for the entire project in accordance with the Project Requirements of this Contract, recognized standards, and all jurisdictional and permit requirements including building codes.
 - 2. Be the architect / engineer of record for the design of all work including but not limited to architectural, structural, mechanical, electrical, civil, systems and other engineering features of the work, all as evidenced by the Design Professional's professional seal on the Final Design documents.
 - 3. Design Submittal Reviews and Certifications: The Designer shall prepare the design and submit the specified completion level designs as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Designer shall complete an ADA Facilities Accessible Checklist and certify that the design complies with ADAAG regulations as described in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA and Section 01470, QUALITY SYSTEM and submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
 - 4. Field Engineering: Manage and/or review and approve all shop and fabrication drawings for conformance to final and / or issued for construction drawings and specifications as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and all Contract Record Drawings and other Closeout Submittals as specified in Section 01780, CLOSEOUT SUBMITTALS.
 - 5. Construction Submittal Reviews and Certifications: The Design-Builder shall provide field engineering as specified in Section 01721, LAYOUT OF WORK AND FIELD ENGINEERING and all professional services during construction for on-site observation, attendance at project meetings as specified in Section 01312, PROJECT MEETINGS, and general consultation as required to complete the Project. The Designer of the Designer-Builder Team shall have primary responsibility for these tasks. The Designer is also responsible for reviewing and approving all required construction submittals as specified in this Section and in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, and also for submittals as specified in the Final Design Specifications developed from the pertinent requirements of the WMATA Standard and Technical Specifications, Divisions 2 through 16 of this Project Manual, and others that are specified in the Project Manual beyond those referenced above and all items listed in the approved Schedule of Submittals as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, before submittal to the Authority and jurisdictional agencies and utility companies through the Authority

Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Design-Builder shall be responsible for obtaining all necessary approvals and permits. In addition, the Design-Builder is responsible for submitting to the Authority in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, QA/QC Manager's Statement of Compliance for Payment Verification that the Design-Builder's Quality System is effectively controlling the quality of the work, certifications for the final products, and certifications for the overall construction and the functioning of systems and equipment installations as specified in Section 01470, QUALITY SYSTEM and Section 01113, SYSTEMS INTEGRATION. These certifications are to be turned over to the Authority for the project records in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Section 01780, CLOSEOUT SUBMITTALS. Submittal review and approval and certification milestones shall be included in the Design-Builder's schedule in accordance with the Schedule requirements of this Project Manual in Section 01322, CONTRACT PROGRESS REPORTING.

6. For further information, refer to Section 00708, RESPONSIBILITY OF THE DESIGN-BUILDER FOR DESIGN-RELATED SERVICES, Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION, Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, Section 01470, QUALITY SYSTEM, and Section 01780, CLOSEOUT SUBMITTALS.

1.04 CONSTRUCTION FIRM

- A. The term Construction Firm (Builder) in this Section shall refer to all members in the Design-Build Team that take part in the manufacture, fabrication, installation, and construction of the work as defined in Section 00701 of the General Conditions. The Design-Builder shall submit verification of the firm name and credentials of the Builder, Major Subcontractors and Key Personnel submitted in the TECHNICAL PROPOSAL AS FINALLY ACCEPTED, Section 00491, to the Authority Representative within ten (10) calendar days after award of the Contract for the Authority Representative's review and acceptance as specified in Section 00726, COMMENCING THE WORK,. Before substituting any Construction Firm or Key Personnel or entering into any subcontracts with substitute subcontractors, the Design-Builder shall submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, a written statement to the Authority giving the name and address of the proposed replacement, the portion of the work and material it is to perform and furnish, and any other information tending to prove that it has the necessary facilities, skill, past experience and financial resources to perform the work in accordance with the terms and conditions of this project, and acquire written Authority approval for substitutions before they may be utilized on the Project as specified in Section 00710, PROJECT MANAGEMENT AND SUPERINTENDENCE AND KEY PERSONNEL.
- B. The Builder of the Designer-Builder Team shall perform all construction, provide all construction materials and equipment, install all equipment and Systems, and undertake all efforts necessary or appropriate to construct the Project in accordance with the approved Final Design Drawings and Final Design Specifications; the Project Schedule; all applicable jurisdictional codes and regulations; jurisdictional approvals and permits and utility approvals; the approved QC/QA Plan; the approved Safety Plan; and all safety, environmental and other applicable requirements so as to complete the Project and achieve Final Acceptance by the dates specified. QA/QC Plan shall include Testing and Inspections in accordance with jurisdictional codes. All personnel involved in performance of construction work shall be experienced and qualified to perform their trade and all construction work shall be performed in a skilled and workmanlike manner. The work shall include field engineering, quality control, manufacturing, procuring, delivering, storing, setting up, constructing, installing, all testing services required during construction, documenting, and quality

assurance by the Designer, and warranting and placing in service the complete project. The Design-Builder shall use the firms and personnel identified in the Technical Proposal as finally accepted. The Design-Builder shall not change the designated construction firms(s) and personnel or shift construction and field engineering Work from one firm to another (including changes in Work performed by Subcontractors) without the prior written approval of the Authority Representative.

- C. Prior to the manufacture, installation, or construction of any part of the work, the Construction Firm shall receive "issued for construction" drawings and/or specifications, issued by the Design Professional that govern that part of the work.
- D. The Construction Firm shall comply with the "Issued for Construction" design requirements established by the Design Professional.
- E. The Construction Firm will obtain Design Professional approval of all shop, fabrication or working drawings, if any, prior to submittal to the Authority for approval in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and prior to the manufacture, installation, or construction of that part of the work and of all Contract Record Drawings and other closeout submittals as specified in Section 01780, CLOSEOUT SUBMITTALS.
- F. For further information, refer to Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, Section 01470, QUALITY SYSTEM, and Section 01780, CLOSEOUT SUBMITTALS.

1.05 KEY PERSONNEL

- A. Overall Program Manager: Oversees complex multi-discipline design engineering work efforts and construction work efforts and all associated programs and supervises key management personnel.
- B. Design Engineering Manager: Manages complex multi-discipline design engineering work efforts including the preparation of Final Design Drawings and Final Design Specifications and approval of all design and construction submittals.
- C. Field Engineering Manager: Manages complex multi-discipline field engineering work efforts including the preparation of shop, working, and as-built drawings and other required technical documentation during construction and of contract record drawings and other closeout submittals upon completion of the project that are to be approved by the Design Engineering Manager. Please note that the Design Engineering Manager may be appointed as Field Engineering Manager during the construction phase.
- D. Construction Project Manager: Manages complex multi-discipline construction work efforts and coordinates with subcontractors' Construction Project Managers.
- E. Construction General Superintendent: Supervises complex multi-discipline construction work efforts and coordinates with subcontractors' Construction General Superintendents.
- F. Quality System Manager for QA/QC: Manages complex multi-discipline design and construction QA/QC work efforts and is responsible to ensure that:
 - 1. An appropriate quality program is established that addresses quality assurance and quality control as described in Section 01470, QUALITY SYSTEM.

2. Appropriate input is received from the Design Professional, manufacturers, suppliers, and others to establish appropriate test parameters and test programs.
- G. Systems Integration Manager: Leads and coordinates systems integration efforts as specified in Section 01113, SYSTEMS INTEGRATION. Please note that the Systems Integrator may be appointed as Design Engineering Manager during both the design and construction phases provided the Systems Integrator meets the minimum qualifications for that position.
- H. Key staff/field personnel: Technical, supervisory, and other personnel responsible as applicable for design, shop and as-built drawings and specifications preparation and in reviewing and certifying plans prior to submission, contract planning and scheduling, overseeing construction safety programs and ensuring safety is maintained, supervising construction crews and coordinating the work of subcontractors including the installation of equipment and Systems; in providing quality control/quality assurance services; in providing systems integration services; and in coordinating any operational issues.
- I. See Section 00204, PROPOSAL FORMAT, PROCEDURES AND EVALUATION FACTORS, AND INSTRUCTIONS for qualifications of required key personnel identified by the Authority and in addition, see the Design-Builder's TECHNICAL PROPOSAL AS FINALLY ACCEPTED, Section 00491, for those and any other personnel essential for performance of the work as identified by the Design-Builder and for their qualifications. Also see Section 00710, PROJECT MANAGEMENT, SUPERINTENDENCE AND KEY PERSONNEL and Section 01310, PROJECT MANAGEMENT AND COORDINATION for responsibilities of key personnel. All positions shall be filled by competent personnel satisfactory to the Authority Representative. Each position shall be held by a separate full-time employee, unless otherwise specifically approved by the Authority. Individuals holding these key positions shall not be changed without permission of the Authority Representative. The Design-Builder shall submit verification of the names and credentials of the individuals submitted in the TECHNICAL PROPOSAL AS FINALLY ACCEPTED, Section 00491, to the Authority Representative within ten (10) calendar days after award of the Contract for the Authority Representative's review and acceptance as specified in Section 00726, COMMENCING THE WORK, and acquire written Authority approval for substitutions of any key personnel before they may be utilized on the Project.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

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SECTION 01112

DESIGN REQUIREMENTS AND PROGRAM CRITERIA

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies design requirements and Program Criteria for the Project.
- B. The purpose of this Contract is for WMATA to receive a complete system that functions efficiently as a part of the overall WMATA system and within the local community. The Project Drawings and Project Manual set out the Project Requirements that define the WMATA's intent. It is the Design-Builder's responsibility, through design, and systems integration as applicable, to refine the drawings and specifications provided by WMATA into a complete, unified whole which is compatible with the existing setup.

1.02 RELATED DOCUMENTS

- Section 00700, General Conditions
- Section 00800, Supplementary Conditions
- Division 01, General Requirements

1.03 GENERAL

- A. The Design-Builder is advised that the some of the Project Drawings may use terms such as "by others" to indicate other crafts, trades or disciplines outside the specific scope of the individual drawing or specification section. The Design-Builder is required to provide all work required for a turnkey installation regardless of the use of the foregoing, or similar, phrases.
- B. The design scope of work specified in this Section is only a summary, and in no way limits the responsibility of the Design-Builder for performing all the work in strict accordance with the Project Drawings and Project Manual and the Final Design Specifications and Final Design Drawings Issued for Construction.
- C. The Design-Builder is responsible to make allowances to accommodate variations in material, size and quantities between the preliminary design provided by WMATA and the approved Design-Builder final design to be implemented.

1.04 GENERAL DESIGN REQUIREMENTS

- A. The Design-Builder shall schedule a Pre-Design-Build Meeting with the Authority prior to beginning any design work in order to review Project requirements and discuss any issues for clarification as specified in Section 01312, PROJECT MEETINGS. The sequence of Design Submittals shall be consistent with the Milestone Summary Schedule, the Detailed Project Schedule and Cash Flow Payment as specified in Section 01322, CONTRACT PROGRESS REPORTING. The Design-Builder's Overall Program Manager and Design Manager shall meet with the Authority to establish a schedule for the submittals as specified in Section 01312, PROJECT MEETINGS.

- B. The Designer of the Design-Builder Team shall perform the Design services as specified in Section 01111, KEY DESIGN-BUILDER FUNCTIONS for the Project required by the Contract Documents and in accordance with the approved Quality System as specified in Section 01470, QUALITY SYSTEM. The Authority will review and approve the design as being in general conformance with the functional requirements contained in the Contract Documents in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Design-Builder shall use the firms and personnel identified in Section 00204, PROPOSAL FORMAT, PROCEDURES AND EVALUATION FACTORS, AND INSTRUCTIONS, Section 00491, TECHNICAL PROPOSAL AS FINALLY ACCEPTED and Section 01111, KEY DESIGN-BUILDER FUNCTIONS. The Design-Builder shall not change the designated design firms(s) and personnel or shift design and engineering Work from one firm to another (including changes in Work performed by Subcontractors) without the prior written approval of the Authority Representative.
- C. Designer: All design and field engineering Work required to be performed by the Design-Builder hereunder shall be performed by or under the supervision of licensed professionals under the laws of the jurisdiction in which the Project is located or who have the ability to obtain such through reciprocity.
- D. Code Requirements: The design shall be carried out in accordance with the latest version of the applicable codes of jurisdiction in which the Project is located, as well as other codes and regulations that apply to the work being performed on the Project Site. In addition, the Design-Builder shall adhere to the Code Requirements as set out in the Design Criteria including using the above cited jurisdiction where county and/or state codes are referred to, and also shall verify that the project requirements of the Contract comply with the above-mentioned codes and regulations. In addition to applicable codes and regulations of the jurisdictional authorities, the Design-Builder shall also incorporate into the Design all WMATA requirements; however, the more stringent of these requirements govern. Also the Design-Builder shall incorporate any required environmental mitigation, and the preservation, restoration and reconstruction of indicated features.
- E. ADAAG: All design and construction for new facilities and for renovations, alterations, and relocations of existing facilities and all acquisition and installation of equipment having ADA content shall be in compliance with ADAAG requirements. Any part of the construction/installation/renovation work not meeting these requirements of these regulations shall be removed and replaced by the Design-Builder, all at no additional cost to the Authority. All WMATA facilities must meet Federal Transit Authority (FTA) ADA requirements, and the Design-Builder's attention is directed to the fact that without exception all WMATA construction projects are subject to FTA audits review assessment of the facilities as actually built with regard to ADAAG regulations. The Design-Builder shall secure the latest version of these regulations from the FTA. Also, the Design-Builder is urged to acquire the FTA's Accessibility Handbook for Transit Facilities publication for the Design-Builder's use as an information guide. The ADAAG Design Compliance Certification Form attached at the end of this Section which addresses design conformance with ADAAG regulations for relevant items reflected in each required level of design completion shall be certified by the Design-Builder and shall accompany each design review submittal as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The ADA Facilities Accessibility Checklist Form also attached at the end of this Section shall be completed concurrent with the design of relevant items and shall be submitted along with each required level of design completion review submittal as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
- F. Conflicts in Requirements and /or Criteria: The Design-Builder shall identify and make known to the Authority as soon as practicable but in no case less than five (5) days after the Designer knows of any potential conflicts among the requirements and criteria either indicated in the Project Manual and/or Project Drawings as specified in Section 00703, GENERAL REQUIREMENTS, DRAWINGS AND SPECIFICATIONS or required by local, state or federal jurisdictions that affect the scope, cost or quality of this work. The notification shall include a clear statement of the

conflict, the source of the requirement and/or criteria and a recommended solution to the potential conflict. The Design-Builder shall submit the original and six copies and one electronic copy of the notification in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Authority will determine solely the solution to the conflict based on either the Designer's recommendation or its own evaluation. The Designer shall incorporate that decision into the design with a minimum of impact to the scope, cost and/or quality of the work.

- G. Utilize Project Drawings, Project Manual and other Contract Documents as the basis for design. The Contract Documents establish requirements for the preparation of design and are not to be used for construction, instead the approved Final Design Drawings and Final Design Specifications prepared by the Design-Builder as part of the design process shall be utilized.
- H. Indicate in the Design Drawings where utilities, agencies, and other contractors will perform design, construction and maintenance of their facilities in relation to this Contract. The Design-Builder shall coordinate its design work with the work of others to ensure compatibility of design and construction. All such work shall be shown on the Final Design Drawings as "work by others", if applicable.
- I. Technical Specifications in CSI Format: The Designer shall develop and provide the stand-alone Design Specifications for this project in the latest edition of CSI Format, and also cross reference these to the Section Numbers of the WMATA Standard and Technical Specifications of the Project Manual.
- J. The Designer's final designs shall provide for layouts, installations and typical circuits and the incorporation of components, equipment, and systems as applicable.
- K. The Designer shall be responsible for obtaining all the necessary utility and jurisdictional approvals for the design. Submittal review and approval and certification milestones shall be included in the Design-Builder's schedule in accordance with the Schedule requirements in Sections 00725, 00825 and 01322 of this Project Manual.
- L. Design Submittal Review:

Authority Review: The Authority explicitly reserves the right to also review and approve the Design items at the specified design progress levels identified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
- M. Prepare and submit reports substantiating design analyses and calculations as required in accordance with accepted industry practice to support the basis of design and development of Final Design Drawings and submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
- N. Design: In all aspects of the design, the proposed facilities shall operate as one entity upon completion of the Contract.

1.05 DESIGN CONTROL

- A. The Design-Builder shall establish and maintain documented procedures to verify and control designs in order to ensure that the Project Requirements are met as described in Section 01470, QUALITY SYSTEM and Section 01113, SYSTEMS INTEGRATION.
- B. The Design-Builder shall prepare plans for each design and development activity and define responsibility for their implementation as described in Section 01470, QUALITY SYSTEM and Section 01113, SYSTEMS INTEGRATION.

- C. The Design-Builder shall assign design and verification activities to qualified personnel equipped with adequate resources as described in Section 01470, QUALITY SYSTEM and Section 01113, SYSTEMS INTEGRATION.
- D. The Design-Builder shall verify its understanding of the design by making submittals to communicate its intended course of complying with the Project Requirements in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
- E. The Design-Builder shall design and submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, test, acceptance and verification criteria and/or procedures for the product being specified as described in Section 01470, QUALITY SYSTEM and Section 01113, SYSTEMS INTEGRATION. Test and acceptance criteria and/or procedures may be used by the Authority to verify designs and products. The design verification process shall test the design to assure that it meets Contract requirements.
- F. The Design-Builder shall conduct formal design reviews before submitting a design to the Authority for all required design progress submittals in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Designer of the Design-Builder Team is responsible for preparing, reviewing and approving the Design Drawings and Design Specifications before submittal to jurisdictional authorities and utility companies through the Authority Representative. The Design-Builder shall form a Design Review Team of no less than two qualified individuals, not including the Design Manager or individuals who prepared the design, with relevant experience and expertise who shall review the design internally. The Design-Builder shall submit resumes for reviewers in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. In addition, this Design Review Team shall conform to any jurisdictional requirements for the Team. Designs submitted shall be accompanied by a signed certificate indicating that each member of the Design Review Team has reviewed the document and found it proper in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Design-Builder shall maintain records of all Design Reviews and submit them to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Authority Representative has the authority to remove any and all individuals from a Design Review Team if, in his the Authority Representative's opinion, insufficient review has been performed. In such a case, the Design-Builder shall immediately submit resumes for replacement reviewers for approval by the Authority.

1.06 CONFIGURATION MANAGEMENT

- A. The Design-Builder shall be responsible for configuration management and document change control for the duration of this Project as more fully described in Section 01470, QUALITY SYSTEM and Section 01113, SYSTEMS INTEGRATION. Configuration management of drawings, specifications, documents, systems, operating and maintenance documentation, and the physical materials is the responsibility of the Design-Builder. The Design-Builder shall maintain document change control, including drawings, manuals and specifications, and shall update all documents as the design and installation progresses. Configuration management system shall provide an accurate historical record that can trace decisions made through the life of the Contract. At the end of the Contract, the Design-Builder shall submit to WMATA in accordance with Section 01780, CLOSEOUT SUBMITTALS a complete configuration management system fully documented with all required information including the version status of all system components and all documents and all approved submittals and certificates as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Section 01780, CLOSEOUT SUBMITTALS for part of the Project records.
- B. The Authority Representative has the right to accept or deny a requested design change. If it will require a change to one or more of the Project Requirements, the Authority will only consider a requested design change with the following support documentation:

1. A valid reason for a change.
 2. Evidence that the desired change is feasible.
 3. An explanation of why the change is desirable.
 4. Estimates of effects on performance, costs and schedule.
 5. Submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
 6. Only upon approval by the Authority Representative may a change or revision may be implemented.
- C. The Design-Builder shall submit a Contract Documents Submittals Log consisting of all Design Drawings, Design Specifications, design calculations, analyses and reports to be prepared by the Design-Builder as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Section 00720, SUBMITTALS.

1.07 PROGRAM CRITERIA

The Authority has furnished, as part of this procurement, Program Criteria that is to be the basis of the Technical Proposal. All design elements, as proposed, shall follow the Criteria as specified.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION

3.01 DESIGN MANAGEMENT

The Design-Builder shall appoint a Design Engineering Manager to lead and coordinate the Design-Builder's design effort as a part of the Design Professional. For further information, see Section 00204 PROPOSAL FORMAT, PROCEDURES AND EVALUATION FACTORS, AND INSTRUCTIONS, Section 00491 TECHNICAL PROPOSAL AS FINALLY ACCEPTED and Section 01111, KEY DESIGN-BUILDER FUNCTIONS.

3.02 IMPLEMENTATION

- A. Prepare the design by developing detailed Final Design Drawings, Final Design Specifications, design calculations, analyses and reports, with all engineering required in accordance with accepted industry practice for completion of the Construction in accordance with the approved Final Design Drawings and Final Design Specifications "Issued for Construction".
- B. Provide the engineering design as specified for facilities owned by states, cities, agencies, districts, and utilities including service connections, facility modifications and relocations as applicable.
- C. Coordinate and resolve any conflicts for locations and sizes of openings, conduits, equipment placement, power and HVAC requirements as applicable, clearances and weights of all elements among all the disciplines.
- D. The Authority Representative shall be notified immediately in writing as specified in Section 00703, GENERAL REQUIREMENTS, DRAWINGS AND SPECIFICATIONS, upon identification of design

issues or problems which may affect schedule, or the work of utilities or other contracts. The Design-Builder shall submit the notification in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

- E. Final Design Drawings and Final Design Specifications, design calculations, analyses and reports and certifications shall be stamped and signed by the Design Professional in accordance with the State or Local Jurisdiction Professional Engineers Act and equivalent requirements for architects and landscape architects. A statement by the Design Professional who signed the drawings that the drawings and specifications conform to applicable architectural, engineering, Systems and Authority requirements and to the appropriate jurisdictional regulations shall accompany Design Reviews as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Section 01470, QUALITY SYSTEM.
- F. The Design-Builder shall coordinate its design, through the Authority Representative, with governmental, public and private agencies and others. Such coordination shall include attending conferences as may be authorized and required by the Authority. The Design-Builder shall prepare and submit to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES within ten working days, a memorandum of record of all such conferences attended. The Design-Builder shall promptly bring to the attention of the Authority Representative, by written notice submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, any betterments or other work requested by private and public agencies and property owners that have not already been authorized by the Authority.

3.03 INTERFACE REQUIREMENTS

- A. The Design-Builder shall be responsible to design, furnish and install systems and materials which interface with and are fully compatible with other systems and design the system interfaces to function in a fully compatible similar manner as existing with regard to safety, security, reliability and maintainability as specified in Section 01113, SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.
- B. The Design-Builder shall be responsible to investigate, design, and coordinate the respective systems designs and their interfaces with other systems and facilities provided under this Contract and with existing systems and structures as necessary. This coordination shall include the scheduling of interface design, installation and testing efforts to avoid delays in their completion as specified in Section 01113, SYSTEMS INTEGRATION, Section 01470, QUALITY SYSTEM, Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING.
- C. Systems which require functional and physical interface coordination may include as applicable, but are not limited to:
 - 1. Power and Energy Management System.
 - 2. Drainage Systems.
 - 3. Communications Systems including Voice and Data.
 - 4. Closed Circuit Television (CCTV).
 - 5. Structural Connections.
 - 6. Roadway and Civil Works.
 - 7. Existing Underground Utilities.
 - 8. Traffic Maintenance during Construction.
 - 9. Continuous uninterrupted operations of the Existing Facilities and Roadways.

10. Traction Power Systems.
 11. Trackwork Systems.
 12. Automatic Train Control (ATC) Systems.
 13. Fire Intrusion Alarm (FIA).
 14. Private Automatic Branch Exchange (PABX).
 15. Public Address System (PAS)
 16. Carrier Transmission System (CTS).
 17. Automated Energy Management System (AEMS).
 18. Mechanical Systems.
 19. Plumbing Systems.
 22. Electrical Systems.
- D. Interface and Compatibility requirements within various other interfaces for the Communications Systems include:
1. Coordinate locations for Fire and Intrusion Alarm System and other security systems by Others with new security fencing for Yard. Coordinate provisions for Fire and Intrusion Alarm System for Shop. Local Fire Jurisdictional Authorities: Coordinate provisions for fire detection and alarm to ensure compliance.
 2. Coordinate provisions for Yard Talkback system coverage at new track switchpoint locations in Yard.
 3. Coordinate elevator emergency telephone additions. Coordinate Shop Administrative and Emergency Trip telephones.
 4. Coordinate Shop PAS expansion with existing Yard PAS system.
 5. Coordinate Shop CTS equipment and connectivity with existing Yard CTS system.
 6. Coordinate Shop CCTV expansion with existing Yard CCTV system.
- E. Interface and Compatibility requirements for Trackwork:
1. Coordinate embedded trackwork in Shop with new Yard trackwork and new Yard trackwork and appurtenances with existing Yard trackwork.
 2. Coordinate provisions for rail heaters in Yard.
- F. Interface and Compatibility requirements for ATC:
1. Coordinate new Yard ATC equipment with existing Yard ATC.
 2. Coordinate modification of Yard Control Machine.
- G. Interface and Compatibility requirements for Traction Power:

1. Coordinate new Shop Traction Power DC stinger rail, rectifier and DC and AC switchgear and Yard Traction Power with existing Yard Traction Power.
- H. Interface and Compatibility requirements for the Utility Systems:
1. Coordinate equipment location and drain inlets and pipes. Coordinate new drain inlets and pipes with existing manholes, drain inlets and pipes. Coordinate new sanitary sewer pipes with existing manholes and pipes.
 2. Coordinate electrical power requirements and location of equipment, feeders and ductbanks.
- I. NOT USED
- J. Interface and Compatibility requirements for the Automated Energy Management System:
1. Coordinate AEMS requirements for Shop.
- L. Develop a Systems Interface Report as specified in Section 01470, QUALITY SYSTEM and in Section 01113, SYSTEMS INTEGRATION which shall identify all system interfaces and describe in detail the functional and physical interfaces between new and existing systems. The descriptions shall include interface locations, operating parameters and applicable test points.
1. The Systems Interface Report shall assign primary and secondary responsibilities to the providers of the interfaced systems and provide assurances that the systems provided under this Contract are fully compatible and that interface connections will not degrade, compromise or otherwise interfere with the normal operations of either of the interfaced systems.
 2. The Systems Interface Report shall provide assurances that the systems provided under this Contract are interfaced in a manner similar to existing WMATA systems performing the same functions. Differences in the manner in which the systems are interfaced shall be clearly described and subject to the approval of the Authority's Representative.
 3. The Systems Interface Report shall provide a direct reference to one or more test procedures contained in the Design-Builder's approved Systems Integration Testing and Cut-In Program as specified in Section 01470, QUALITY SYSTEM and in Section 01113, SYSTEMS INTEGRATION which will verify that each system interface fully satisfies the requirements described herein.
 4. The Systems Interface Report shall be developed before or concurrent with the systems designs and shall be submitted for review along with each relevant design submittal as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The submitted report shall address System Interfaces reflected in the design submittal.
- M. The Design-Builder controls the installation, its current configuration, and the appropriate documents to support it. The Design-Builder shall issue engineering recalls, update installed material, and update support material such as test equipment and documentation as specified in Section 01470 QUALITY SYSTEM and in Section 01113, SYSTEMS INTEGRATION.

ATTACHMENTS TO SECTION 01112:

1. The Design-Builder shall complete and submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, the following ADAAG Design Certification in conjunction with the completed Checklist Sections in the Preliminary, Intermediate, Pre-Final and Final Level of Design submissions specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

CERTIFICATE OF DESIGN COMPLIANCE WITH ADAAG REGULATIONS

The Design-Builder hereby certifies that it's Design complies with all applicable Regulations of ADAAG.

CONTRACT NO.: _____

DATE: _____

DESIGNER'S NAME: _____

DESIGN-BUILDER NAME: _____

DESIGN MANAGER'S SIGNATURE: _____

OFFICER'S SIGNATURE: _____

TITLE: _____

2. **WMATA ADA Accessibility Checklist Forms (See Appendix A):** The Design-Builder shall submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, the WMATA ADA Accessibility Checklist Forms in the appropriate level of completeness, respective to the Intermediate, Pre-Final and Final Level of Design submissions specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

- a. As the design is developed, the Designer shall complete each checklist item as described herewith. The Designer shall enter the sheet number into the column 'REFERENCE DWG. NO.' where the checklist item is referenced in the Design Drawings. The column 'REFERENCES' contain the paragraph or section numbers, in the sub-columns 'FTA' and 'ADAAG', where the checklist item is referenced in the FTA Accessibility Handbook for Transit Facilities and the ADAAG Regulations, respectively. The Designer shall indicate if the particular area of the Design indicated in the checklist item complies with the requirements by entering an 'X' into the appropriate sub-column, 'YES' or 'NO', found below the column 'COMPLIANCE'. If compliance with the requirements indicated in the checklist item does not apply to the project, then indicate as not applicable with an 'X' in the sub-column 'N/A'. In any given submission before the Final Level of Design submission, checklist items that cannot be referenced to any drawing or compliance with ADAAG regulations cannot be verified due to the preliminary level for completion of the Design, the Designer shall enter "To Be Determined" into the column 'COMMENTS'. The 'COMMENTS' column shall also be used by the Designer to clarify compliance issues if necessary. The Designer shall enter a sequential line item number into the column 'ITEM NO.' before the Final Level of Design submission. All line items under each column, in every Checklist Section, shall be fully completed before the Final Level of Design submission.

END OF SECTION

SECTION 01113

SUMMARY OF WORK REQUIREMENTS: SYSTEMS INTEGRATION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies systems integration requirements for the Project.
- B. The purpose of this Contract is for WMATA to receive a complete system that functions efficiently as a part of the overall WMATA system and within the local community. The Project Drawings and Project Manual Specifications set out the Project Requirements that define WMATA's intent. The designs of Communications, Train Control, Trackwork, (Final Trackwork Design provided by the Authority) Mechanical, Electrical and Traction Power systems as applicable are conceptual, with standard system drawings and some typical drawings provided. It is the Design-Builder's responsibility to complete these designs and integrate these systems into the overall WMATA system. The Design-Builder is expected to advance the designs into a single unified whole.
- C. Systems Integration shall ensure that individual elements fit into components, that components fit into subsystems, subsystems fit into systems, and that systems fit into the existing facilities and/or WMATA operating system as applicable. The WMATA operating system includes train operations and the operations of existing facilities such as the Operations Control Center (OCC), Maintenance Operations Center (MOC) and Yards.
- D. As part of the Systems Integration process, the Design-Builder shall implement a systems engineering program designed to assure attainment of the reliability, availability and safety goals of WMATA.
 - 1. In addition to the Initial Systems Integration Plan submitted with the Technical Proposal, provide a Systems Integration Design document that defines the process for accomplishing these goals.
 - 2. Develop the Systems Integration Design to provide the Work in a finished turnkey state that reflects these goals.
 - 3. Develop special drawings for the sole purpose of demonstrating coordination between crafts, disciplines and systems.
 - 4. Provide a Work Breakdown Structure addressing form, fit and function of all systems and subsystems.

1.02 RELATED DOCUMENTS

Section 00371, WMATA Construction Safety and Environmental Manual Requirements
Section 00381, Safety and Security Certification Program Plan Requirements
Section 00391, System Safety Program Plan Requirements
Section 00700, General Conditions
Section 00800, Supplementary Conditions
Division 01, General Requirements
Divisions 2 through 16, Standard and Technical Specifications Requirements

Safety Rules and Procedures Manual
Metrorail Safety Rules and Procedures Handbook

1.03 GENERAL

- A. The Design-Builder is advised that the some of the Project Drawings may use terms such as “by others” to indicate other crafts, trades or disciplines outside the specific scope of the individual drawing or specification section. The Design-Builder is required to provide all work required for a turnkey installation regardless of the use of the forgoing, or similar, phrases.
- B. The design scope of work specified in this Section is only a summary, and in no way limits the responsibility of the Design-Builder for performing all the work in strict accordance with the Contract Documents.

1.04 SYSTEMS INTEGRATION PROCESS REQUIREMENTS

The Design-Builder shall establish and maintain a systematic, documented, comprehensive, verifiable and continuous Systems Integration process applied throughout the duration of the Contract to implement the intent of the Contract Documents and the Final Design Drawings and Final Design Specifications Issued for Construction. At a minimum, the Design-Builder’s systems integration effort shall:

- A. Provide a Systems Integration design document that systematically identifies and formally documents all interfaces and identifies a process for handling each interface.
- B. Provide a mechanism, and assign project responsibility for interface management and control, such that every interface has a single entity within the Design-Builder’s organization accountable for engineering and verifying the interface.
- C. Define methods to confirm interface compatibility and demonstrate said compatibility through tests or other approved verification methods.
- D. Assure that reliability, availability, maintainability, and safety requirements are propagated through all systems and system elements so as to meet the overall availability, dependability and safety criteria set out in this Contract.
- E. Allow WMATA to independently assess the effectiveness of, and audit, the Design-Builder’s Systems Integration process.
- F. Coordinate all disciplines, civil/structural/architectural, utilities, landscaping, trackwork, mechanical, electrical, train control, communications, traction power, etc., as applicable, to ensure that all systems fit together and there are no conflicts.

1.05 TRAINING

When required, the Design-Builder shall provide WMATA with training in the operation of specific interfaces. This training shall be generally consistent with current WMATA practice as described in this Contract in Section 01820, DEMONSTRATION AND TRAINING and typically shall be made a part of the system training program. Each system training program shall explicitly devote training to identifying and explaining interfaces. When no system training is otherwise specified, the Design-Builder shall provide additional training on the specific interface.

1.06 SYSTEMS DESIGN INTEGRATION

- A. The Design-Builder shall provide systems design integration. The Design-Builder shall systematically identify and document all technical interfaces, by means of an Interface Matrix which shall list all systems and major system elements, define which elements have a direct or indirect interaction and describe each interface by means of an Interface Control Document.
- B. Design-Builder's systems design integration shall:
1. Provide the Systems Integration Procedure which shall:
 - a. Define a method for tracking physical, electrical, electronic and software interfaces.
 - b. Define a method for tracking contacts and human interfaces.
 - c. List all major system components as applicable (e.g., track, train control, traction power, communications, electrical, mechanical, etc.) and their interfaces.
 - d. List all suppliers and subcontractors and their interfaces.
 - e. Identify WMATA interface points for existing systems.
 - f. Identify major coordination milestones.
 - g. Identify major system integration demonstrations.
 - h. Identify conflict resolution procedures.
 2. Provide the Systems Operations Description. In this document the Design-Builder shall, in text, flow charts and simple graphics, describe what the system is supposed to do and how the system is supposed to do it. The purpose of this document is to ensure that the Design-Builder and WMATA have a common understanding of the system's use and operation so that WMATA receives a truly turnkey product that will function as desired. This document will be in sufficient detail to assure a complete understanding of WMATA's intent and the Design-Builder's approach to meeting that intent.
- C. The Systems Integration Design shall be provided in stages:
1. The Preliminary 30% Systems Integration Design shall be delivered 90 Calendar Days after NTP. The 30% design will:
 - a. Provide draft Description of Facility Operations and/or WMATA operating system as applicable.
 - b. Provide draft Systems Integration Procedure.
 - c. Provide a working model of the Systems Integration Database.
 - d. Identify the Design-Builder's Systems Integrator.
 - e. Identify all major systems.
 - f. Identify all major coordination efforts.
 - g. Identify any interfaces that are on the critical path.

- h. Identify WMATA reliability, availability and safety goals.
 - i. Address generally as applicable:
 - (1) Consolidation of duct banks and conduit runs.
 - (2) Switch machine layouts.
 - (3) Electrical distribution.
 - (4) Community interfaces:
 - (a) Fire procedures.
 - (b) Medical/police procedures.
 - (c) Fuel spill procedures.
 - (d) etc.
2. The Intermediate 60% Systems Integration Design shall be delivered 150 Calendar Days after NTP. The 60% design will build on comments of the Preliminary 30% design review and will:
- a. Provide a final draft Description of Facility Operations and/or WMATA operating system as applicable.
 - b. Provide a final draft Systems Integration Procedure.
 - c. Deliver a populated Systems Integration Database.
 - d. Identify all systems, their interfaces and schedule impact.
 - e. Identify all coordination efforts.
 - f. Identify any interfaces that are on the critical path.
 - g. Identify compliance with WMATA reliability, availability and safety goals.
 - h. Address in detail as applicable:
 - (1) Consolidation of duct banks and conduit runs.
 - (2) Switch machine layouts.
 - (3) Electrical distribution.
 - (4) Emergency procedures and/or WMATA operating system/community interfaces.
 - (5) Medical/police procedures.
 - (6) Fuel spill procedures.
 - (7) All high priority interfaces.

3. The Final 100% Systems Integration Design shall be delivered with the 100% Final Level of Review for Design Documents specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, will build on the comments of the 60% design review, and will as applicable:
 - a. Provide a complete set of Final Design Specifications and Final Design Drawings including cut sheets, progressed to the 100% level.
 - b. Provided written disposition of the 90% design review comments.
 - c. Provide the Facility Operations Description and/or WMATA operating system as applicable.
 - d. Provide Systems Integration Procedure.
 - e. Deliver a fully populated Systems Integration Database.
 - f. Update all impacts.
 - g. Identify all coordination efforts.
 - h. Identify any interfaces that are on the critical path.
 - k. Identify compliance with WMATA reliability, availability and safety goals.

D. Integration Design and Documentation:

1. The Design-Builder shall provide full technical documentation of each interface and when required provide detailed descriptive and operations procedures for operation of any particular interface. Systems Integration services shall extend high level interfaces such as interactions with WMATA operations and maintenance, local fire fighters, and others as applicable. When required, the Design-Builder shall provide operations and/or procedures manuals to define exactly how each interface is designed and operates.
2. The Design-Builder shall design and document all systems interfaces. When the systems integration process results in a complete integrated product with no special parts or features, the normal Final Design Drawings and Specifications and approved Shop Drawings as applicable will suffice for complete documentation. For example, switch layouts detailing the rail, switch machine, timber, snow-melters, junction boxes, etc. as applicable would not require additional interface drawings or documentation. When the systems integration process requires a separate element, physical or otherwise, to assure proper operation, separate and full documentation will be required. For example, if a fuel spill or fire requires WMATA personnel to perform certain functions such as opening the emergency entrance for emergency vehicles, the Design-Builder shall be required to document this interface in a procedure. Required documentation may take the form of additional drawings, procedures, manuals, flow charts, or other material. The Authority Representative shall be the sole arbiter of what documentation is required.
3. Documentation includes test, verification, certification documents, and other records that relate to the performance of any particular interface. When required by the Authority Representative, the Design-Builder shall design procedures and methods to assure the interface works as desired. The Design-Builder shall provide Certificates of Compliance when required by the Authority Representative.

4. All documentation provided under this Contract shall be in standard (U.S.) English. Document format and layout shall be consistent with current WMATA practice.

1.07 SYSTEMS INTEGRATION PROGRESS MEETINGS

Systems Integration Progress Meetings shall be held as specified in Section 01312, PROJECT MEETINGS.

1.08 INTERFACE DATABASE

- A. The Design-Builder shall develop and maintain an interface database that lists all physical, mechanical, electrical, electronic, software, operational and other interfaces. The database will be developed in the software of the Design-Builder's choice provided the software is ODBC (Open Data Base Connectivity) compliant and the data tables can be imported directly into Microsoft Access. The Design-Builder shall provide the Authority Representative two licensed copies of the database software used and upgrades, if any are required, so that WMATA may also run the database. The Design-Builder shall submit the database structure to the Authority Representative for approval. Further enhancements can be added to the database provided the initial approved data fields are maintained unchanged upon approval of the Authority Representative. The Design-Builder shall submit updated copies of the interface database at each progress meeting and when requested by the Authority Representative. Databases are further described in Section 01470, QUALITY SYSTEM.
- B. The Design-Builder shall develop a relational database to document all Interfaces and related information. The database will have a full set of reporting tools and the Design-Builder shall retain the services of a data base developer who is familiar with these reporting tools and who can create custom reports. The Design-Builder shall demonstrate the developer's adequacy by providing a sample data base with sample reports showing how this tool can be used to manage the physical system interfaces. The Authority Representative shall be the sole judge of the adequacy of the data base, its structure, or the developer.
- C. Data fields/tables to be included in the database would include such items as:
 1. Interface ID number.
 2. Work Breakdown Structure reference.
 3. Type of interface as applicable:
 - a. Mechanical.
 - b. Electrical.
 - c. Physical.
 - d. Data/protocol.
 - e. Operational.
 4. Interface Level as applicable:
 - a. Between subsystems.
 - b. Between subsystems and major systems.

- c. Between major systems.
 - d. Between the Facility and/or WMATA operating system and the community.
5. Purpose of interface.
6. Side one identification:
 - a. Side one standard.
 - b. Side one contact (person).
7. Side two identification:
 - a. Side two standard.
 - b. Side two contact (person).
8. Status.
9. Safety standard.
10. Open Issues/Conflicts.
11. Person taking action.
12. Projected resolution date.
13. Scheduled test date:
 - a. Test results (pass/fail).
14. Scheduled demonstration date:
 - a. Demonstration results (pass/fail).
15. Schedule conflict (yes/no).
16. Results/Impacts.
17. List of all standard interfaces:
 - a. Characteristics of all standard interfaces.
 - b. Referenced specifications of all standard interfaces.
18. List of all nonstandard interfaces:
 - a. Characteristics of all nonstandard interfaces.
 - b. Referenced specifications for all nonstandard interfaces.
19. Training requirements.
20. Contacts:

- a. Name.
- b. Organization.
- c. Address.
- d. Phone.
- e. Fax.
- f. E-mail.

1.09 INTERFACE STANDARDS

- A. The use of English (US customary units) standard measures shall be consistent with the current use of those standards at WMATA. No new or different measures, or items that adhere to different measures, shall be introduced into the WMATA system without the express written approval of the Authority Representative. Where explicit standards exist, the Design-Builder shall not deviate from those standards without the express written approval of the Authority Representative.
- B. The current use of maintenance, operational, safety or other practices will, at the Authority Representative's discretion, define these practices as defacto standards. A standard shall be deemed to exist when a previously existing interface, similar to that required by this Contract, is already in use on WMATA property. Standard, in this context, means that this is the "standard" way to make this interface at this location. The Design-Builder is to provide a system that is consistent with current practices and the defacto standards so as to minimize effects on the balance of the system. The Design-Builder shall adhere to defacto standards unless an explicit written waiver is granted. The Design-Builder is obligated to notify the Authority Representative in writing of any deviations from a defacto standard.
- C. When no existing standard for an interface exists, the Design-Builder shall submit a proposed standard interface to the Authority Representative. The Design-Builder is to minimize the number of interface types.
- D. The Design-Builder shall maintain, in the interface database, a complete listing of all interfaces, both standard and nonstandard, and their relevant characteristics. The Design-Builder shall also maintain a library of standards and specifications relevant to the system interfaces. The Design-Builder shall be required to provide WMATA with copies of such standards and specifications at no additional cost, when requested by the Authority Representative. The Design-Builder shall be required to provide samples of interface materials (e.g., connectors, protocol conversion software, black boxes), at no additional cost, when requested by the Authority Representative.

1.10 SUBMITTALS

- A. Submit for Authority Representative's approval:
 - 1. Systems Interface Design.
 - 2. Systems Interface Database.
 - 3. Drawings.
 - 4. Manuals.
 - 5. Operations procedures.

6. Flow charts.
7. Verification procedures - 90 days before use.
8. Test procedures - 90 days before use.
9. Inspection records - within 10 calendar days of inspection.
10. Test results - within 10 calendar days of test.
11. Certificates of compliance - before acceptance.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION

3.01 SYSTEMS INTEGRATION MANAGER

- A. The Design-Builder shall appoint a Systems Integration Manager as specified in Section 00204, PROPOSAL FORMAT, PROCEDURES AND EVALUATION FACTORS, AND INSTRUCTIONS, Section 00491, TECHNICAL PROPOSAL AS FINALLY ACCEPTED and SECTION 01111, KEY DESIGN-BUILDER FUNCTIONS to lead and coordinate the Design-Builder's systems integration efforts. The Design-Builder shall not change the designated person without the prior written approval of the Authority.

3.02 IMPLEMENTATION

- A. It is the Design-Builder's responsibility to implement System Integration as specified in Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING. System integration will have been achieved once the Design-Builder demonstrates that all subsystems operate as a unit with each other and within the overall WMATA system as applicable.
- B. Composite Clearance Verification Drawings:
 1. The Design-Builder shall provide composite clearance verification drawings that demonstrate the spatial location of all utilities and their relation to other utilities, facilities, and items such as foundations. The Composite Clearance Verification drawings shall also demonstrate horizontal clearances for train movement such as signals, platform edges, railings, emergency trip stations, fence posts, and other similar items as applicable.
- C. Train Control as applicable:
 1. It is the Design-Builder's responsibility to complete the train control system design and to integrate this system into the Facility and/or the existing WMATA system. The train control system shall be tied into the existing train control system. The Design-Builder shall communicate and coordinate with authority personnel to assure there is seamless operation from the new extension onto the mainline and in the reverse direction. The materials and methods shall be materially identical and shall not require special tools or special training.
 2. The existing system shall provide interface points from TC/COMM facilities and track circuits at stations or existing right of way near the project limits, and in some instances with facilities in the Jackson Graham Building. The Design-Builder shall interface with these facilities and

circuits, and complete the installation. The Design-Builder shall be ultimately responsible to make this interface work as intended and must integrate with the existing system to assure this happens.

D. Track Switches and Associated Apparatus as applicable:

1. It is the Design-Builder's responsibility to complete the design and to integrate this system into the new Facility and/or the existing WMATA system. The Design-Builder shall coordinate and integrate the work of all subcontractors to provide satisfactory switch layouts. The switch machine installation work shall be integrated with duct and cable installation, switch installation, signal installation, snow-melters for surface locations, and rail and traction power apparatus. The Design-Builder shall submit a single layout drawing for the purpose of demonstrating that the individual components work together and do not interfere with any other installation, function or maintenance operation to be performed on the switch or any associated apparatus.

E. Traction Power as applicable:

1. It is the Design-Builder's responsibility to complete the provided traction power system design and to integrate this system into the new Facility and/or the existing WMATA system. Coordinate all traction power design and work with the construction project as necessary to assure a complete and integrated finished project. The traction power equipment and installation design shall be coordinated with the substation or tiebreaker building design and with the associated train control room, communications room and station as required.

F. Communications as applicable:

1. It is the Design-Builder's responsibility to complete the communications system design and to integrate this system into the new Facility and/or the existing WMATA system. The Design-Builder is required to work closely with the Authority Representative, to assure a seamless fit between the devices installed in the existing system and new work. The Design-Builder shall also work with WMATA personnel at the Jackson Graham Building to assure the proper and smooth installation of new communications equipment in that location. The Design-Builder is directed to pay special attention to the electrical and data interfaces that are required between new and existing systems. There are systems, specified in the Contract, that are required to work as extensions of existing systems and therefore must be of particular and specific design and manufacture with no allowed substitutes.
2. The Design-Builder is directed to review the Facilities communications systems physical, electrical, electro-magnetic and software characteristics and complete the initial design presented in these Project Drawings. The provided system must be sized to meet the minimum requirements set forth in these specifications with a reasonable amount of spare capacity left over. The Design-Builder shall make a complete accounting of all communications circuits, including type of circuit and use, to be provided in the Facility area and submit that listing to the Authority Representative. The Design-Builder is required to size the communications system sufficiently to meet all the current needs with a minimum of 20% spare pairs, or circuits. This listing shall incorporate all systems using communications circuits including the AEMS, fire alarm, data systems, etc.

G. Mechanical, Electrical and Plumbing as applicable:

1. It is the Design-Builder's responsibility to complete the provided mechanical electrical and plumbing systems design and to integrate these systems into the new Facility and/or the existing WMATA system. This work specifically includes elevators, escalators, ventilation, drainage, fire protection, and heating, ventilation and air conditioning, as well as all other

mechanical, electrical and plumbing equipment or systems required for the Project. Coordinate all design and work with the construction project as necessary to assure a complete and integrated finished project. The equipment and installation design shall be coordinated with the facility design and with the associated external systems as required.

H. Conflicts and Omissions in the Plans and Specifications:

1. The Design-Builder is required to bring conflicts and omissions in the Plans and Specifications to the attention of the Authority Representative, in writing, within three working days of discovery. When reporting to the Authority Representative on a conflict, the Design-Builder shall make a written report that: states the nature of the conflict, the conflicting specification sections or drawings, and its suggested resolution for the conflict. See Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Section 01470, QUALITY SYSTEM for further instructions on configuration control.

3.03 SYSTEM PERFORMANCE DEMONSTRATION AND TESTING

- A. The Design-Builder shall provide a system of progressive testing to assure that system components interface properly. It is the Design-Builder's responsibility to appropriately test all interfaces and certify that the interfaces work properly and meet all Contract requirements. The Design-Builder shall create test procedures and test data sheets that fully exercise the interface and prove that the interface performs its intended function. The Design-Builder shall submit each interface test procedure to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES for approval prior to performing the test.
- B. Each test procedure will describe:
1. What parameters are to be tested.
 2. What the minimum pass/fail criteria is.
 3. What qualifications are required to perform the test.
 4. What test equipment is required.
 5. Step by step procedures for the test.
 6. Test data sheets or test report forms.
 7. Test certification process.
- C. The Authority Representative has the right to reject any test procedure or require additional tests if, in the Authority Representative's sole opinion, the proposed test does not adequately exercise or demonstrate the performance of the interface.
- D. The Design-Builder shall notify the Authority Representative a minimum of 15 working days in advance of each test. All test results shall be submitted to the Authority Representative within 10 working days of the test.
- E. The integrated test program shall culminate in a Project Performance Demonstration that shall simulate all operations and shall exercise all systems and system elements. The Performance Demonstration Plan and Procedures shall be submitted for approval as part of the final design review package. The Performance Demonstration shall include testing of anticipated normal and

abnormal operations, in addition to simulations of emergency operations. The Design-Builder shall provide a Performance Demonstration Plan that delineates the following:

1. Tests to be performed.
 2. Date and time when each test is to be performed.
 3. An outline of the test parameters.
 4. Pass/fail criteria which must be quantified and measurable.
- F. The Performance Demonstration shall be in accordance with Section 01820, DEMONSTRATION AND TRAINING and shall include those static and dynamic tests used to demonstrate that the Design-Builder designed the systems and subsystems according to the specification and that performance specified. This Performance Demonstration shall include:
1. All necessary functional and performance testing conducted during construction and manufacture of the system elements to ensure compliance with the specification; and
 2. Operational tests which include integrated testing of system interfaces to assure that the project as a whole is capable of operating as specified.
- G. The Design-Builder shall, in addition to interface testing, demonstrate to the Authority Representative's satisfaction, that all critical system components work together properly as a whole system and with the existing systems as a macro-system under operating conditions. These demonstrations will also confirm operation of the systems safety features. Inter-operability demonstrations will be conducted at the earliest possible opportunity.
- H. Acceptance testing will include a demonstration that the Design-Builder has fulfilled all contractual obligations for systems integration. The Design-Builder is required to submit for approval in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, a test plan 90 days prior to the acceptance test, to confirm all systems interface properly with themselves and with existing systems. Acceptance testing for systems integration may be part of a project's comprehensive acceptance test/inspection plan or it may be separate. In either case, it must be clearly identified as acceptance testing for systems integration.
1. The Design-Builder shall furnish upon installation and testing of any system's operation or upon completion of a project but before re-starting the operation of the renovated system or facility as applicable, a systems and safety certification for each of the systems as well as a Safety and Security Certification for the entire project and/or WMATA operating system as applicable before the start of the revenue service as specified in Section 00381, the Safety and Security Certification Program Plan Attachment to the Project Manual; as specified in Section 00391, the System Safety Program Plan Attachment to the Project Manual; and as further specified in the Safety Rules and Procedures Manual; Section 01810, COMMISSIONING; and Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS.

3.04 SYSTEM INTEGRATION MONITORING AND AUDIT

- A. WMATA will have the right to monitor and audit the systems integration process. The Design-Builder shall facilitate these audits by providing information and arranging for WMATA's auditors to have access to all relevant records. The Design-Builder shall provide timely information to WMATA about any interface problem that is identified, and the steps being taken to resolve it. The Design-Builder shall also invite WMATA to attend meetings held within the Design-Builder's organization or with subcontractors to resolve interface definitions or systems integration issues.

The Design-Builder shall furnish WMATA with minutes of such meetings within 10 calendar days after such meeting, regardless of whether WMATA attends.

- B. In addition, WMATA reserves the right to witness all interface and systems integration tests. The Design-Builder shall inform the Authority Representative of each upcoming test at least 14 calendar days before it is scheduled to be performed. WMATA reserves the right to direct supplemental testing of a component, element, subsystem or system in the interest of verifying achievement of specified performance levels, at no cost to the Authority.

END OF SECTION

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SECTION 01114

SAFETY / ENVIRONMENTAL REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies construction safety and environmental safety and security requirements for the Project.

1.02 RELATED DOCUMENTS

Section 00371, WMATA Construction Safety and Environmental Manual Requirements
Section 00381, Safety and Security Certification Program Plan Requirements
Section 00391, System Safety Program Plan Requirements
Section 00700, General Conditions
Section 00800, Supplementary Conditions
Division 01, General Requirements
Divisions 2 through 16, Standard and Technical Specifications Requirements
Safety Rules and Procedures Manual
Metrorail Safety Rules and Procedures Handbook

1.03 SAFETY REQUIREMENTS

- A. The Design-Builder shall be responsible for ensuring compliance with the protection of persons and property requirements of Section 00743 and Section 00744 of the General Conditions.
- B. The Design-Builder shall employ and assign to the work, safety superintendence as specified in Section 00844 of the Supplementary Conditions.
- C. The Department of System Safety and Risk Protection (SARP), in coordination with the Authority Representative and the Design-Builder, will conduct the Safety and Security Certification Program to certify that all reasonable and practical measures have been taken to optimize the operational safety and security of WMATA during planning, design and construction/installation and prior to the start of the revenue service, system operation or before re-starting the operation of the renovated system or facility as applicable. The Safety Certification Program will be conducted in accordance with Section 3.3.5, System Safety Certification of the Authority's System Safety Program Plan Attachment to the Project Manual as specified in Section 00391, SYSTEM SAFETY PROGRAM PLAN REQUIREMENTS; Section 2.2/0, Safety Certification Program of the Safety Rules and Procedures Manual; and the Safety and Security Certification Program Plan Attachment to the Project Manual as specified in Section 00381, SAFETY AND SECURITY CERTIFICATION PROGRAM PLAN REQUIREMENTS; and as further specified in Section 01113, SYSTEMS INTEGRATION; Section 01470, QUALITY SYSTEM; Section 01810, COMMISSIONING; and Section 01820, DEMONSTRATION AND TRAINING.
- D. The jurisdictional Fire Marshals prohibit the use of oxygen-acetylene welding/cutting equipment or flammable materials anywhere in the Metrorail system during revenue hours. After each work shift, all flammable materials must be removed from the Metrorail system. The storage of hazardous and flammable materials (including such items as rags, mops, paper towels, or other combustible materials contaminated with hazardous or flammable products) on WMATA property, is restricted. Design-Builders, seeking to store hazardous or flammable materials on WMATA property, must request permission from the Authority Representative. It may not always be possible to grant permission to store hazardous or flammable materials on WMATA

property. If permission is granted, the Design-Builder must store the materials in compliance with the jurisdictional codes and regulations. In addition, six copies of the material safety data sheet (MSDS) for each specific chemical and the quantity of each chemical to be stored on the site shall be provided to the Authority Representative. The Design-Builder shall acquire permits for use of hazardous materials as required by the jurisdictional Fire Marshal.

- E. The use of explosives for the performance of Contract work will not be permitted without written authorization from the Authority Representative.
- F. Prior to performing any work on or above or under the right-of-way, arrangements shall be made through the Authority Representative for access rights and power outage in accordance with WMATA SOP's No. 19, 28, and No. 33 contained in the Metrorail Safety Rules and Procedures Handbook (MSRPH) and Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS; with OAP No. 100-9 contained in Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS; and with OAP No. 200-10. All special requests for access, single tracking, power outages, escorts, and other Authority support shall be submitted in writing through the Authority Representative to the appropriate OPER officials within the time frame as set forth in Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS
- G. For any work within Confined Spaces, the Design-Builder and all subcontractors shall comply with all OSHA, state and local jurisdictional rules and regulations for confined spaces. As a minimum, the Design-Builder shall follow 29 CFR §1910.146 for all permit confined space work on Authority property, including construction. A detailed site specific Confined Space Program shall be submitted to WMATA for review for all work requiring entry into permit confined spaces as defined by 29 CFR §1910.146. No work shall be performed in any area considered to be a permit confined space until the Design-Builder's Confined Space Program is reviewed by WMATA. Prior to the initial entry into any confined space (permit or non-permit), the Design-Builder shall coordinate entry with the Authority Representative and take air quality readings to establish base readings and conditions. At a minimum, oxygen, lower explosive limit, carbon monoxide, and hydrogen sulfide, shall be measured. Measurement of additional parameters may be required depending on the location of the space and potential for atmospheric hazards related to contamination or work activities. These results shall be provided to the Authority Representative for recording purposes and will determine if atmospheric hazards exist which would classify the space as a permit-required confined space. Continuous and follow-up monitoring of air quality shall meet OSHA requirements, and all subsequent results shall be provided to the Authority Representative.
 - 1. Prior to the start of any work involving non-permit or permit-required confined spaces, the Design-Builder shall submit to the Authority Representative the original and six paper copies and an electronic copy of the following:
 - a. Written Job Hazard Analysis for any work to be performed in the confined space, including MSDS's for chemicals to be used in the space. Design-Builders must submit MSDS's for ALL chemicals to be used on Authority property to the Authority Representative, along with a brief description of how and where they will be used, and if wastes will be generated. The MSDS's will be reviewed by WMATA's Department of System Safety and Risk Protection(SARP) and if approved, the materials can be used in the system. If they are rejected, the Design-Builder must identify a substitute that will meet SARP's criteria for approval in addition to the Authority Representative's criteria for performance. The MSDS's must be recent (preferably less than 3 years old) and comply with the OSHA Hazard Communication Standard 29 CFR §1910.1200. The Design-Builder is responsible for complying with the requirements of the MSDS's.
 - b. Written Emergency Response Plan which identifies emergency responders for rescue operations.

- c. Written plan for a temporary Fire Protection System as specified in Section 00744, PROTECTION OF PERSONS AND PROPERTY for use during the term of the Contract, which shall be subject to approval by the Authority Representative. Design-Builder shall ensure that work activities do not adversely impact existing fire protection system(s) i.e., sprinklers, stand pipes, portable extinguisher, etc.
 - d. Identification of air monitoring devices that will be used to monitor air quality at the work site. Provide copies of most recent manufacturer calibration and all Design-Builder field calibration checks. As a minimum, WMATA requires field calibration checks on air monitoring instruments, each day (or shift) before use. As a minimum, the field calibration check information must include the date, time, calibration check data, and the printed name and signature of the person performing the calibration check.
 - e. Documentation to show that all personnel working in or near non-permit confined spaces are trained in Confined Space Awareness.
2. In addition, the following is required for work in involving permit-required confined spaces, the Design-Builder shall submit to the Authority Representative the original and six paper copies and an electronic copy of the following:
- a. Written site specific Confined Space Program.
 - b. Confined space permit for applicable space. Each permit is valid for a maximum of 24 hours. (Submit to the Authority Representative at least 48 hours before entry.)
 - c. Written Respiratory Protection Program.
 - d. Documentation to show that all personnel required to wear respiratory protection have received respiratory protection training, have been fit tested for the respirators they are required to wear (applies to tight fitting respirators) and have been medically evaluated, to verify that they have no health problem that would interfere with their safe use of a respirator.
 - e. A warning sign to identify the work site as a permit-required confined space requiring authorization to enter.
 - f. As applicable, the Design-Builder is required to notify the State of Maryland at least 24 hours prior to entering permit-required confined spaces.
- H. Design-Builder must provide a Job Hazard Analysis prior to the start of each phase of work.
- I. Work clothing consists of long pants, shirts with long or short sleeves, sturdy work boots, and appropriate personal protective equipment. Jewelry that hangs, loose clothing or clothing with non-detachable hoods, drawstrings, or anything that can become entangled in machinery, shall not be worn on the work site, if machinery is in use on the work site. Personal protective equipment such as hard hats and footwear shall meet the requirements of 29 CFR §1910.135 and §1910.136. Athletic-type footwear shall not be worn on WMATA work sites.
 - J. Smoking is prohibited in the Metrorail system, at WMATA facilities, and in WMATA vehicles. The Authority Representative, will select a designated smoking area outside the system and/or facilities and Design-Builder employees will be informed of its location. Design-Builder personnel found smoking in non-designated areas on WMATA property or in the Metrorail system will be subject to removal from WMATA property. The Design-Builder's Safety Superintendent shall be responsible for ensuring compliance.

- K. The OSHA standard for sanitation, 29CFR & 1910.141, shall be followed. Prior to starting work, the Design-Builder shall furnish for the Design-Builder's staff, necessary toilet convenience secluded from public view. They should be kept in a clean and sanitary condition and should comply with the requirements and regulations of the area in which the work is being performed. Potable drinking water shall be provided with individual cups and sanitary conditions for the water dispenser shall be maintained. A common drinking cup and other common utensils are prohibited.
- L. Design-Builder and subcontractor employees shall cooperate with representatives of the Authority and federal, state, and local regulatory agencies during site inspections or investigations. Inspection and investigation activities do not involve directing of Design-Builder's work, but may involve interviews with Design-Builder and subcontractor personnel. The Department of Capital Projects Management (CAPM), Office of Environmental Services (ENSV) and Department of System Safety and Risk Protection (SARP) will notify the Authority Representative of any operation that is not in compliance with federal, state, or local health and safety or environmental regulations or WMATA policy and procedures, and that may require the Design-Builder or subcontractor to stop work on a specific task or operation.
- M. For any work at heights above 6 feet, the Design-Builder must submit a detailed, site-specific Fall Protection Plan. The Design-Builder must comply with the most stringent OSHA requirements for Walking-Working Surfaces (29 CFR Part 1910 Subpart D), Scaffolds (29 CFR Part 1926, Subpart L), and Fall Protection 29 CFR Part 1926, Subpart M.
- N. The Design-Builder and all subcontractors shall comply with 29 CFR §1910.95, Occupational Noise Exposure for all work on Authority property, including construction. This standard requires that employees exposed to continuous noise in excess of the OSHA Action Level, participate in a Hearing Conservation Program. Instruments used for noise measurements must be appropriate for the type of noise being measured (impact/impulse or continuous).
- O. If the work involves removal of paints or coatings, the Design-Builder must test the paint or coatings to determine if they contain heavy metals such as lead that require special handling and disposal considerations. As a minimum, testing should be conducted for the eight Resource Conservation and Recovery Act (RCRA) of 1976 and amendments metals (arsenic, barium, cadmium, chromium, lead, mercury, silver, and selenium). If any of these are present, the components will require special handling and disposal to prevent exposure to workers, patrons, the community, and the environment. The Design-Builder and/or subcontractor performing lead-based paint abatement, removal, or control, must have all licenses and accreditation required by the jurisdiction in which the work is performed. Jurisdictions that do not have their own state lead plans fall under the auspices of the Environmental Protection Agency (EPA). The Design-Builder's and subcontractor's employees are required to have medical monitoring to meet the requirements of 29 CFR 1910.1025 and 1926.62. As a minimum, medical monitoring shall consist of biological monitoring for lead and zinc protoporphyrin and shall include a physician's medical determination. As a minimum, biological monitoring shall be conducted immediately prior to working on a WMATA property where the employee may be exposed to lead, and immediately upon completion of this work. The Design-Builder and subcontractor employees shall receive training for lead workers and supervisors as required by the jurisdictional regulations. Documentation shall be provided to the Authority Representative prior to commencement of work. All documentation shall be authentic and verifiable. All materials must be handled and disposed of in compliance with the jurisdictional regulations. MSDS's for replacement paints/coatings must be reviewed by WMATA prior to use on WMATA property.
- P. If the work involves removal of insulation, flooring, cove base, mastic, ceiling tile, roofing materials, or any other material that is suspected of containing asbestos, the Design-Builder must have the materials sampled and analyzed to determine if they contain asbestos. If the

Design-Builder and/or subcontractor will be handling or removing asbestos-containing materials, the Design-Builder and/or subcontractor must have all licenses and accreditations required by the jurisdiction in which the work is performed. The Design-Builder's and subcontractor's employees are required to have medical monitoring to meet the requirements of 29 CFR 1910.1001 and 1926.1101. The Design-Builder and subcontractor employees shall receive training for asbestos workers and supervisors, as required by the jurisdictional regulations. Documentation shall be provided to the Authority Representative prior to commencement of work. All documentation shall be authentic and verifiable. All materials must be handled and disposed of in compliance with the jurisdictional regulations. All replacement materials shall be free of asbestos. Design-Builders shall follow the WMATA Technical Specifications for Asbestos Removal.

- Q. Design-Builder and subcontractor employees shall not be exposed to asphalt fumes in excess of the National Institute for Occupational Safety and Health (NIOSH) recommended ceiling limit of 5 milligrams of asphalt fumes per cubic meter of air (5 mg/m³), in any 15 minute period. NIOSH provides recommendations for control of asphalt fumes.
- R. Work that generates visible dust requires submission of a Dust and Debris Control Plan to prevent exposure of employees, patrons, and the community to dust including crystalline silica dust. Submit air monitoring data to demonstrate effectiveness of dust control measures. If dust cannot be controlled, submit Respiratory Protection Program in compliance with 29 CFR §1926.103 or 29 CFR §1910.134, and be prepared to submit evidence of air monitoring, training documentation, medical clearance for respirator use, and respirator fit tests for tight-fitting respirators.
- S. The Design-Builder shall ensure that the level of exhaust emissions from equipment such as air compressors and generators, are within acceptable limits to comply with clean air regulations and that workers are not exposed to exhaust fumes or gases (carbon monoxide, sulfur dioxide, nitrogen oxides, hydrogen sulfide, aldehydes) in excess of the most stringent of occupational exposure limits.
- T. For all work generating Waste Water, the Design-Builder shall submit a Waste Water Discharge Plan that describes how the Design-Builder will treat and release wastewater generated by activities at the work site, for all work that generates wastewater. Design-Builder shall also comply with Consolidated Plan prepared by WMATA for Bus Divisions and Rail Yards as applicable.
- U. For Abrasive Blasting activities all MSDS's for abrasives shall be submitted through Authority Representative to Department of System Safety and Risk Protection (SARP) prior to abrasive blasting activities. Only abrasives containing less than 1 percent crystalline silica shall be used for abrasive blasting.
- V. For Hot Work activities, the Design-Builder and subcontractors shall provide documentation on certification for personnel who perform welding on WMATA property. Ventilation in accordance with OSHA regulations, shall be provided for hot work such as welding, cutting, or brazing.
- W. At the work site, a First Aid Kit shall be provided and fully equipped to meet the needs of the anticipated work force. Employees expected to render First Aid or CPR must have the proper current certifications and be trained in Bloodborne Pathogens in accordance with 29 CFR §1910.1030.
- X. The Design-Builder shall be responsible for all subcontractors, suppliers and other persons working under its direction, to comply with all requirements as noted above and herein, and shall disseminate these requirements to those personnel. Design-Builders and subcontractors shall ensure that their personnel complete safety training by WMATA on the rules and

procedures for working on the Right-Of-Way before starting such work.

- Y. The Design-Builder shall immediately report all accidents and incidents (including near misses) that occur during the performance of the work to the Authority Representative.
- Z. Work shall not be performed in any area in use by the public, unless specifically required by the Contract or directed in writing by the Authority Representative. The Design-Builder shall give at least 48 hours notice to the Authority Representative before beginning such work.
- AA. In cases where the movement of motorized equipment is necessary, flag persons shall be provided to warn and direct personnel and patrons away from the area of travel. Flag persons must be certified as trained in proper flagging techniques and Design-Builder employees involved in traffic control and devices must be certified as trained in traffic management as required by the State or local jurisdiction. Certification must be documented. The Authority Representative shall be notified before using heavy equipment in or near stations and their entrances, building entrances, bus bays, sidewalks, etc. Under no circumstances shall motorized equipment be left unattended with the motor idling. Always remove keys from motorized equipment not in use. Provide proper blocks as necessary to prevent running away of any equipment.
- BB. When it is necessary to maintain use of work areas involving stations, sidewalks, elevators, platforms, bus shelters, vehicular roadways, building entrances, corridors, etc., the Design-Builder shall protect the area with guardrails, substantial barricades, temporary fences, overhead protection, and temporary partitions as deemed necessary by the Authority Representative. Under no circumstances will yellow or orange tape strung between barricades, or the like, be acceptable as a substantial barricade. Open manholes, access openings or other breaks in the normal walking surface shall be isolated, from personnel and the public, using barricades.
- CC. Sidewalks, entrances, platforms, mezzanines or any other location where personnel or the public traverses, shall always be kept clear of obstruction, tools, ladders, work debris, excavation materials, etc. When necessary, temporary sidewalks or pathways shall be provided for pedestrian traffic. Temporary sidewalks or pathways shall be free of tripping hazards and protected by proper guardrails and barricades. Temporary means of egress and access shall be marked for easy recognition. If work is required above sidewalks or pathways, substantial overhead protection shall be provided. Protected walkways shall be approved by the Authority Representative.
- DD. Appropriate warning signs and instructional safety signs shall be conspicuously posted in all areas involving construction activities. Work involving electrical systems or equipment in or near the area to which personnel or the public have access shall be isolated using barricades, partitions, etc. Exposed, live circuits shall not be left accessible to personnel or the public or left dangling overhead. Before completion of the work, the Design-Builder shall:
 - 1. Ensure that all wiring is insulated and properly positioned.
 - 2. Verify grounding, bonding, or both, of all metallic conduit, wiring or electrical equipment that is in the areas of contractual effort, and to which the public can make contact.
 - 3. Notify the Authority Representative immediately in those instances where verification cannot be made.
 - 4. Ensure that personnel working near the platform edge, or in the Right-of-Way, wear reflective safety vests with the tear-away feature, to identify them to passing trains, as directed by Operations Planning and Administrative Support (OPAS) at the right-of-way

safety training required in this Section. The safety vests shall comply with the ANSI/ISEA 107-1999 guideline entitled American National Standard for High-Visibility Safety Apparel. All of the Design-Builder's personnel are required to attend safety training provided by WMATA before starting work near the platform edge or in the Right-of-Way.

EE. Use of Cranes and Derricks:

1. General Safety Requirements. Comply with the following:
 - a. 29 CFR §1910.180 through §1910.189.
 - b. 29 CFR §1926.550 through §1926.556
 - c. U.S. Army Corps of Engineers, Safety Manual EM-385-1-1.
2. No part of any Crane or Derrick Boom shall swing over WMATA patrons, tracks or stations without an Authority Representative-approved shield, or an Authority Representative-approved procedure.
3. Placement of Crane or Derrick shall be coordinated with the Authority Representative.
4. Rights for use of the Crane or Derrick affecting Metrorail Operations are granted through SOP's No. 19 and 33 of the Metrorail Safety Rules and Procedures Handbook and in Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS.
5. A supervisory or a red tag power outage is required. Exceptions may be granted on an individual basis after a review and approval by the Authority.
6. Hardhat requirements are enforced.
7. "Swing Stop" requirements may be instituted based on the hazards involved.
8. Use of Cranes and Derricks over common corridor railroads and highways is under the rules of the affected common corridor railroad or highway owner.

FF. All jobsite visits for visitors and tours shall be coordinated through the Authority Representative in accordance with the appropriate WMATA Safety Manual, and associated insurance document if applicable, as specified in Section 00371.

GG. Due to concerns with long-boom cranes threatening employee walking paths during pick and placement of construction materials, all cranes used for erecting components structure on the project shall be equipped with Load Moment Indicating devices (LMI) or Rated Capacity Indicators (RCI), an anti-two-block device. All crane operators shall be certified to operate the type of crane used by the National Commission for the Certification of Crane Operators (2750 Prosperity Ave., Suite 120, Fairfax, VA 22031-4312. Telephone 703 560-2391). Six copies of the CCO Certificate shall be submitted to the Authority Representative before the operator works on the site. To increase the factor of safety when picking structural elements of the building, all cranes shall have load capacity charts reduced (de-rated) by a factor of 30%. For example, if the load chart at a given radius and boom angle indicates a total load capacity of 10,000 lbs., the crane will be limited to 7,000 lbs. (10,000 lbs. - 30%[3,000 lbs.] = 7,000 lbs.). A lift plan, showing all pertinent information demonstrating that the total load does not exceed 70% of the maximum, shall be submitted to the Authority Representative, before crane delivery to the project site.

1.04 ENVIRONMENTAL SAFETY REQUIREMENTS

- A. The Design-Builder and subcontractors shall be responsible for complying with the most stringent of federal, state, or local environmental regulations for air, water, land, and waste in order to maintain the safety and health of employees, WMATA patrons, and the community.
- B. If the work task requires specialized licenses for example "lead or asbestos abatement contractor's license", Design-Builder and subcontractors shall be required to show evidence of such registration, prior to commencement of work. If the work requires specialized training, for example lead or asbestos training, Design-Builder and subcontractors shall be required to show evidence that their employees have received such training, prior to commencement of work.
- C. If the work requires transportation of hazardous materials or hazardous substances, Design-Builder and subcontractors are required to provide evidence of Department of Transportation General Awareness Driver's Training in compliance with 49 CFR §172 and Commercial Driver's License in compliance with 49 CFR §390-397, prior to commencement of work.
- D. All hazardous materials and hazardous substances, must be stored in "Performance Oriented Packaging" in compliance with 49 CFR §178, Subpart L.
- E. If the work requires disposal of hazardous wastes, disposal must be to a Treatment/Storage/Disposal facility with a Part B Permit and the waste hauler must have a state or local license and U.S. EPA identification number. The Design-Builder and subcontractors shall be required to provide evidence of all applicable licenses and permits along with the name and address of the waste disposal facility where hazardous waste materials are to be disposed, prior to commencement of work.
- F. If the work involves response to spills of hazardous materials, hazardous substances or hazardous wastes, the Design-Builder or subcontractor personnel shall have appropriate training that complies with 29 CFR §1910.120.

1.05 SUBMITTALS

- A. The Design-Builder and subcontractors performing the work shall submit the original and six copies of the appropriate documentation in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, 60 calendar days prior to commencing the construction work:
 - 1. Record of federal, state, or local violations of environmental and occupational safety and health regulations for the last 3 years.
 - 2. Organizational Health and Safety Program including OSHA required programs applicable to the work and site. For work and sites not addressed in the original Organizational Health and Safety Program submitted with the Technical Proposal as specified in Section 00204 and the Proposal as Finally Accepted in Section 00491, and with the updated Project Management Plan as specified in Section 01310, PROJECT MANAGEMENT AND COORDINATION, addenda may be added when the work and sites are identified, however, the addenda must be submitted to the Authority Representative for review and approval by WMATA prior to the commencement of specified work.
 - 3. Job Hazard Analysis (prior to each phase of work).
 - 4. Site-specific Emergency Response Plan.
 - 5. Site-specific Temporary Fire Protection System Plans.

6. Site-specific Waste Water Discharge Plan (if wastewater is generated).
7. Site-specific Pollution Control Program.
8. Site-specific Dust and Debris Control Plan.
9. Bloodborne Pathogens Exposure Control Plan.
10. Hearing Conservation Program if employees are exposed to continuous noise in excess of the OSHA Action Level.
11. Respiratory Protection Program if employees are exposed to dust (including crystalline silica) or other toxic atmospheres in excess of the OSHA permissible exposure limits. If a respiratory program is required, the Design-Builder also must provide documentation of training, medical clearance for respirator use and respirator fit testing.
12. Hot Work Program.
13. Lockout Tagout Program.
14. Site-specific Confined Space Program.
15. Documentation to show that all Confined Space entrants and attendants are trained in Confined Space Entry, including hands-on-training or Confined Space Awareness as applicable and possess applicable licenses and certifications.
16. Results of noise monitoring, air monitoring, and soil, water or waste sampling. These to be submitted at least weekly during work activities.
17. Documentation of medical surveillance.
18. Documentation and Certifications of Assistant Safety Superintendent's and First Aid Attendant's, as applicable, experience in construction safety.
19. Identity of all materials or chemicals the Design-Builder will use on Authority property (including welding rods), material safety data sheets (MSDS's) for these products, and a brief explanation of how they will be used and if any wastes will be generated.
20. Identity of equipment that may generate toxic atmospheres such as gasoline or diesel-powered generators, welding and cutting equipment.
21. Documentation of licenses and certificates required for lead or asbestos abatement or other work requiring licensing or certification such as welding.
22. Documentation of licenses, certificates, and U.S. EPA identification numbers required for transportation of hazardous materials, hazardous substances, or hazardous wastes.
23. Documentation of licenses, permits, and certificates required for disposal of hazardous wastes including the name and address of the waste disposal facility where hazardous waste materials are to be disposed.
24. Certificates of Insurance, including pollution liability coverage, endorsed to WMATA is required for Design-Builder or subcontractors performing work involving hazardous materials, hazardous substances, hazardous wastes, or contaminated soil or water.

25. CCO Certificate before the crane operator works on the site.
26. Site-specific Fall Protection Plan.
27. Identification of air monitoring devices that will be used to monitor air quality at the work site. Provide copies of most recent manufacturer calibration and all Design-Builder field calibration checks.

1.06 SAFETY AWARENESS PROGRAM - [Not Applicable]

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

SECTION 01115

SAFETY AND SECURITY CERTIFICATION PROCESS

PART 1 GENERAL

1.01 Summary

- A. This section specifies the process used to certify the WMATA system's safety and security.

1.02 Related Documents

- A. WMATA Safety & Security Certification Program Plan
B. Project Specific Safety and Security Program Plan (To be provided prior to award.)
C. Preliminary Certifiable Elements List (CEL) (To be provided prior to award.)
D. WMATA Daily ATC Certification Procedures
E. WMATA ATC System Integrity Maintenance Practices
F. FTA Handbook for Transit Safety & Security Certification
G. Section 01113, System Integration
H. Section 01114, Safety & Environmental Requirements
I. Section 01142, Site Specific Work Plan

1.03 General

- A. The purpose of the Safety and Security Certification Program is to ensure that:
1. The design, construction, fabrication, installation, testing and commissioning of all critical elements (civil, structural and systems) have been evaluated for conformance with the safety and security requirements and to verify their readiness for operational use.
 2. WMATA's bus and rail systems are operationally safe and secure for customers, employees and the general public.
- B. The objective is to achieve acceptable risk through a systematic approach to hazard management, criteria adherence, design and construction certification and review, and formal contract acceptance. This is accomplished through documentation and verification that:
1. System Safety hazards are identified and assessed and undesired risk levels are corrected to acceptable or manageable risk levels.
 2. Security vulnerabilities are identified and assessed and documented action is taken to resolve identified unwarranted risk.
 3. Appropriate codes, guidelines and standards have been reviewed to provide a basis for safety and security considerations in the final design documents.
 4. Facilities and/or systems and/or equipment have been designed, constructed, inspected and tested in accordance with applicable codes and standards.

1.04 Safety and Security Certification Process Requirements

The Design Builder shall establish and maintain a systematic, documented, comprehensive, verifiable, and continuous system Safety and Security Certification process applied throughout the duration of the contract to implement the intent of the WMATA Safety & Security Certification Program Plan. At a minimum, the Design Builder's Safety & Security Certification efforts shall:

- A. Comply with the Project Specific Safety & Security Certification Program Plan.
- B. Perform a Safety Hazard and Security Threat Analysis.

- C. Participate in working groups whose purpose will be to review the status of the items on the Certifiable Elements List (CEL). (The preliminary CEL furnished the Design Builder will be general in nature and shall be broken down into more detail as the design evolves.)
- D. Maintain an electronic CEL and update it based on input from the working group.
- E. Demonstrate and Certify that Final Design has been performed in compliance with and satisfies all applicable codes and standards.
- F. Conduct test and inspections as necessary to document compliance on all safety critical work.
- G. Maintain a database that documents design approvals, approvals of design changes, variance approvals, inspections, tests, and certification of items on the CEL.
- H. Maintain a document management system that enables retrieval of documentation that demonstrates approvals, inspections, tests and certifications have been achieved for each certifiable element.
 - I. Assign a Certification Manager that oversees the Safety & Security Certification process.
 - J. Generate a System Safety and Security Certificate at the completion of the project.

1.05 Additional Information - [Not Applicable]

Part 2 Products - [Not Applicable]

Part 3 Execution

3.01 Certification Manager

- A. The Design Builder shall appoint a Certification Manager to lead and coordinate the Design Builder's Safety & Security Certification Program Plan. The Certification Manager shall have more than 10 years of safety and security related experience working with large multiple disciplinary rail transit projects in a management role and specific design experience with transit facilities and systems (train control, communications, fire protection, and traction power).

Part 4 Measurement and Payment

4.01 Payment

- A. Compensation in the amount of one percent of the base bid of the contract shall be retained until the Safety and Security Certification Program Plan documentation, defined in 1.04 above, has been received and approved.

END OF SECTION

SECTION 01141

ACCESS TO SITE

PART 1 GENERAL

1.01 SUMMARY

This Section specifies restrictions that may affect construction operations including identification cards for site access and hours of work.

1.02 RELATED DOCUMENTS

Section 00742, General Conditions - Accident Prevention

Section 00744, General Conditions - Protection of Persons and Property

Section 00787, General Conditions - Indemnification and Insurance Requirements and Special Provisions of Insurance Furnished by Design-Builder

Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements

Section 01142, General Requirements - Summary of Work Requirements: Coordination with Occupants and Operations

Section 01143, General Requirements - Summary of Work Requirements: Use of Site

1.03 ACCESS TO SITE - IDENTIFICATION CARDS AND TRAINING

- A. The Design-Builder and its subcontractors working at the project site shall provide their personnel with distinctive badges showing the employer's name and the employee's name, number, and photo I.D. These badges shall be displayed in a prominent manner on each person while engaged on the work. Access to the sites shall be granted only to properly accredited representatives of the Design-Builder and its subcontractors.
- B. As applicable, the Design-Builder and subcontractors requiring entry into the rail revenue operating system, including rail maintenance yards, for performance of Contract work shall provide such employees requiring entry with photo identification cards issued by the Authority. The Design-Builder shall obtain and be responsible for administering the use of the identification cards in accordance with Authority POLICY/INSTRUCTION No. 6.10/1, July 29, 1993. The ID cards are not valid for transportation on Metrobus or Metrorail and will be valid for the duration of the Contract up to a maximum of one year.
- C. Right-of-Way (ROW) Safety Training, as administered by the Authority, will be required Design Builder and Sub Contractor employees prior to working in the Yards. Design Builder's Safety Superintendent shall schedule the ROW Safety Training through the AR.
- D. A comprehensive Shop tour/indoctrination is required for all Design Builder and Sub Contractor employees prior to initiation of the work. The Design Builder's Safety Superintendent shall schedule the tour/indoctrination through the AR.

1.04 ACCESS TO SITE - HOURS OF WORK

- A. The Design-Builder shall work such hours per shift, with or without overtime, as many shifts per day and as many days per week as necessary to complete the various parts of the work and the entire work within the dates specified and within the restrictions listed below and in Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS, if any.
- B. The Design Builder and Sub Contractors shall not begin work on any day until authorized to do so by the AR or the AR's appointed designee.

- C. The Design-Builder shall coordinate and schedule all work with the Authority to ensure that the Design-Builder's activities do not interfere with the operation of or access to the Authority's facilities.
- D. Restrictions if any on the hours for removal of existing work to be demolished and any other work which will affect train or employee operations and/or vehicular or pedestrian traffic; delivery of supplies, equipment and components to the site; and any other specific restrictions relating to coordination are listed in Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS.

1.05 HOURS OF OPERATION

- A. Yard Operations are continuous 24 hours a day, 7 days a week.
- B. Non-revenue hours are defined as the hours during which train service is closed to passenger traffic:
 - 1. Monday through Friday 0000h to 0500h
 - 2. Saturday and Sunday 0300h to 0700h
- C. Revenue hours are the hours during which train service is open to passenger traffic. Except when these hours are extended for special events or disrupted due to emergencies, they are:
 - 1. Monday through Thursday: 5:00 AM to 12:00 Midnight.
 - 2. Friday: 5:00 AM to 3:00 AM Saturday.
 - 3. Saturday: 7:00 AM to 3:00 AM Sunday.
 - 4. Sunday: 7:00 AM to 12:00 Midnight.
- D. Rush hours are Monday through Friday 0500h to 0930h and 1500h to 1900h.
- E. Non-rush hours are the revenue hours during which train service is not designated as rush hour traffic:
 - 1. Monday through Thursday: 0930h to 1500h and 1900h to 2400h.
 - 2. Friday: 0930h to 1500h and 1900h to 0300h Saturday.
 - 3. Saturday and Sunday: All revenue hours.
- F. Metrorail Safety Rules
 - 1. The Design-Builder's work shall be performed and conducted in accordance with the Washington Metropolitan Area Transit Authority (WMATA) "Metrorail Safety Rules and Procedures Handbook". Attention should be focused on the following sections:
 - Section 1 – General Rules
 - Section 2 – Rules of Conduct

Section 3 – Operating Rules – Flagging
Section 4 – Safety Rules

2. Standard Operating Procedures (SOP)

SOP 2 – Emergency Removal and Restoration of Third Rail Power
SOP 28 – Removal & Restoration of Third Rail Power for Work by WMATA
SOP 33 – Removal & Restoration of Third Rail Power for Work by Design-Builder Forces

3. The following WMATA communication numbers should be noted:

Metro Police	(202) 962-2121
Safety	(202) 962-2687
Track & Structures	(202) 962-5136
OCC	(202) 962-1787
Rail Systems	(202) 962-5201
Local Police, Fire, Emergency	911

4. WMATA Access Control Plan will be determined after preliminary meetings with the WMATA AR and shall be part of the Site Specific Work Plan specified in Section 01142, Coordination with Occupants and Operations. This plan will address ingress and egress to the Yards, emergency contacts sources and specific limits of Design Builder work activity.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

THIS PAGE NOT USED

SECTION 01142

COORDINATION WITH OCCUPANTS AND OPERATIONS

PART 1 GENERAL

1.01 SUMMARY

This Section specifies restrictions that may affect construction operations including coordination with occupants and operations and preparation of Site Specific Work Plans (SSWP).

1.02 RELATED DOCUMENTS

Section 00742, General Conditions - Accident Prevention
Section 00744, General Conditions - Protection of Persons and Property
Section 00787, General Conditions - Indemnification and Insurance Requirements and Special Provisions of Insurance Furnished by Design-Builder
Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements
Section 01141, General Requirements - Summary of Work Requirements: Access to Site
Section 01143, General Requirements - Summary of Work Requirements: Use of Site
Section 01310, General Requirements - Administrative Requirements: Project Management and Coordination
Section 01322, General Requirements - Administrative Requirements: Contract Progress Reporting
Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures
Section 01470, General Requirements - Quality Requirements: Quality System

Section 01550, General Requirements - Temporary Facilities and Controls: Maintenance of Traffic, Construction Sequence and Staging, Access and Parking
WMATA's Construction Safety and Environmental Manual Or Coordinated Safety Program and Reporting Procedures Manual, the Safety and Security Certification Program Plan as specified in Section 00381 and the System Safety Program Plan as specified in Section 00391.

1.03 HOURS OF OPERATION

Hours of operation are specified in Section 01141, ACCESS TO SITE.

1.04 DELIVERY OF SUPPLIES, EQUIPMENT AND COMPONENTS AND REMOVAL OF EXISTING WORK

A. Removal of existing work to be demolished and any other work which will affect train or employee operations at the Yard location shall be coordinated with the Authority's Yard Master as well as the Shop Superintendent through the Authority's Representative (AR). No work will commence without prior notification and approval from the Authority.

1.05 SPECIFIC RESTRICTIONS RELATING TO COORDINATION

A. Site Specific Work Plan (SSWP): The Site Specific Work Plan shall be prepared by the Design-Builder and shall expand upon the narrative explanation of the Design-Builder's approach to the work that is included in this Contract as a part of Section 00491 TECHNICAL PROPOSAL AS FINALLY ACCEPTED. It shall address all major areas of concern, including construction techniques, staging, sequencing, scheduling, and methods for minimizing disruptions to Yard

Operations as applicable. The plan shall encompass elements, which apply to the whole project (staging areas, work windows, safety measures), as well as elements specific to a particular construction area (contract limits, schedule, phasing). The plan does not need to include or duplicate elements addressed elsewhere, but shall reference these other documents and plans as appropriate. The SSWP is subject to approval by the Authority Representative (AR).

1. As a reference, the general requirements for the sequencing and staging of the Design-Builder's work are specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING, and the general requirements for the submittal of detailed construction schedules are specified in Section 01322, CONTRACT PROGRESS REPORTING.
2. The Design-Builder shall outline and establish his access to the work area as specified in Section 01141, ACCESS TO THE SITE.
3. The following are the procedural requirements to enable the Design-Builder to plan the work, develop an SSWP, and be granted concurrence for track outages, power outages, and track occupancy. This section also specifies the general requirements for the staging of the Design Builder's work and for the submittal of detailed construction schedules. As a general reference, the Design Builder should outline and establish its access to the work areas including gates in the WMATA protective fence and gaps in the contact rail for personnel movement. In addition, the Design Builder should outline its methods and procedures for measuring stray current during single track.
 - a. Request for service outages, service disruptions, shutdowns, diversions, or work that will occupy or foul the track shall require the development of a Site Specific Work Plan (SSWP) by the Design Builder and approval of the plan by the Authority Representative. No work shall be performed without an approved SSWP.
 - b. The SSWP shall provide a description of work, time-scaled logic network, breakdown of labor force by company and crew including shift changes, type of equipment that will be utilized, equipment access to the site, Design-Builder's watchmen, WMATA flagging, protection personnel, construction methods, traffic detours, arrangements for emergency clearing and restoration of services, and sketches defining the configuration of facilities at the end of the Design-Builder's activities as applicable. The SSWP shall also include a listing of all submittals, testing, and cut-over procedures associated with the work as applicable as specified in Section 01113, SYSTEMS INTEGRATION, Section 01470, QUALITY SYSTEM, and Section 01810, COMMISSIONING. In addition, the Design-Builder's SSWP shall provide for the safe operation of vehicular and pedestrian traffic as applicable and the safety of all personnel including the public at all times.
 - c. In addition to the requirements for a Site Specific Work Plan (SSWP), all construction operations that interfere with the normal operations or that require outages, track occupancy, or protection shall be detailed in a time-scaled logic network. This network is to fully detail the extent of work proposed and the Design-Builder's plan and means for its accomplishment. Specific separate operations shall be highlighted in these submittals. All work by others that has the potential of delaying the work by the Design-Builder, shall be identified clearly in terms of scope and scheduled so that it can be coordinated. Also, the submittal and re-submittal of the SSWP shall be identified as a scheduled milestone activity in the project schedule.
 - d. The SSWP shall be submitted by the Design-Builder to the AR for concurrence 28 calendar days prior to start of construction work. The AR will respond within 14 calendar days of receipt of the SSWP submittal. Any changes to the submittal once reviewed and approved by WMATA are subject to a subsequent review by WMATA.

- e. The SSWP shall be updated if necessary and reissued weekly to reflect any changes that may have occurred during the 28 calendar day period between the original issue and the date of work execution.
- f. Not later than 14 calendar days before the planned work, the revised submittal incorporating all changes and reflecting the final work plan shall be submitted to the AR. The final revisions of the schedule that incorporates all changes and reflects the final work plan shall be distributed by the Design-Builder to all parties involved.
- g. The Design-Builder shall not perform any of the work required until written approval has been received from WMATA.
- h. WMATA will not grant track outages, powers outages, or track occupancy until the Design Builder's SSWP has been reviewed by the Authority Representative and approved in writing. The Design Builder is advised the WMATA reserves the right to cancel or re-schedule an approved outage in the event of an operating emergency (derailment, system failure, power failure, etc.) in which support/protection personnel may not be available.

B. Outages

- 1. Work shall be scheduled and sequenced in conformance with approved Construction Schedules as described in the Contract.
- 2. Clarification of Starting and Ending time for outages.
 - a. WMATA will define the work window in accordance with the SSWP.
 - b. WMATA will clear all rail traffic from the section affected by the outage and perform operational functions to prepare the track and/or power for removal from service.
- 3. The design Builder must be mobilized with sufficient manpower including qualified supervisory personnel, equipment and materials to make substantial progress during each outage or occupancy. All necessary material required for a particular task to be completed during the outage must be inspected and approved by the Authority Representative and on the site a minimum of ten (10) days in advance of the scheduled outage. All equipment assigned for each task shall be inspected, maintained in accordance with manufacturer's recommendations, with sufficient spare fuel, oil, and repair parts to ensure operable condition for the duration of each task. If mobilization of sufficient manpower, equipment, or material do not comply with the SSWP, the Authority Representative will deny outage with no allowance for compensation.
- 4. The Design Builder is advised that there may be other Capital or Maintenance Construction projects occurring in the vicinity of this contract. The Design Builder will be expected to cooperate in coordinating its outages with other outages. WMATA shall be solely responsible for determining which contract outage request has priority when there is more than one request for any given day.

C. Weather

- 1. Inclement weather shall not be used as a basis for any claims for a delay or completion of the work within the outage, occupancy, and the restoration of rail service. The Design Builder shall provide the means for protection from adverse elements. Additional time but not additional cost will be allowed due to adverse weather conditions.

- D. Interruptions to Operations
1. The Design Builder's attention is called to the fact that other construction or maintenance may be in progress concurrent with this contract. In order to minimize interruptions required for the progression of this work, the Design Builder shall schedule work in coordination with track power usage required for the progress of other work where possible.
 2. The Design Builder shall attend update meetings chaired by the Authority Representative and all other parties performing work or scheduled to perform work on the interfacing activities. The Design Builder shall make it mandatory that all subcontractors attend this scheduling meeting.
- E. Safety Plan: The Design-Builder shall produce a Safety Plan and other submittals as described in Section 01114, SAFETY AND ENVIRONMENTAL REQUIREMENTS, and as described elsewhere in the Contract. Items described below shall be taken into account in developing safety submittals.
1. Safety is a primary concern that affects all levels of WMATA activities, including planning, design, construction, testing and operations and maintenance of all WMATA transportation systems. Therefore, all WMATA personnel and appropriate Design-Builders are responsible for ensuring the safety of passengers, employees, and the general public who come in contact with the WMATA system as applicable, as well as property adjacent to the system or site as applicable. Construction methods and practices shall be safe and efficient, while maintaining the maximum operation of the system or site as applicable.
 2. The Design-Builder has direct responsibility for conducting the construction operation in a manner that will provide a safe working environment for all employees as well as protect the general public and all those parties who may come in contact with, or be exposed to this project as applicable. The Design-Builder shall prepare and implement a written General Safety Program as outlined in WMATA's Project Safety Guidelines specified in Section 01114, SAFETY AND ENVIRONMENTAL REQUIREMENTS and the Safety Document Attachments to this Project Manual and the other Safety Documents referenced in this Contract. The program should cover, at a minimum:
 - a. Work site hazard identification and mitigation
 - b. Fall protection plans and procedures
 - c. Injury reporting, handling and accident investigations
 - d. Crane/hoisting equipment certifications and work procedures as applicable
 - e. Daily employee safety briefings
 - f. Weekly safety meetings
 - g. First aid - Location of supplies, employees qualified to administer CPR and first aid
 - h. Safety inspections
 - i. Fire prevention/protection
 - j. Protection of environment
 - k. Utility protection as applicable - Use of Miss Utility
 - l. Public and property - Railroad and private as applicable

- m. Emergency procedures
 - n. Identify on-site emergency coordinator
 - o. Method of protection to be used on track where work is to be performed as applicable - Type of barriers used to keep Design-Builder personnel and equipment away from operating track and method of installation and removal of barriers
 - p. Barricades or stop signs as applicable to protect work limits
 - q. Procedures for working on or around the tracks or right of way and for working on or around the contract rail system as applicable (Work Blocks/Red Tag)
 - r. List of emergency telephone numbers for the appropriate Design-Builder personnel for WMATA's use
 - s. Training
 - t. Communication
3. Prior to construction, the Design-Builder shall also be responsible for the preparation of a site specific safety work plan and time line for each site or combination of sites as applicable. This plan shall be submitted to WMATA for approval, and shall include, but not be limited to, the following information:
- a. Emergency action plan
 - b. Identification of all work site hazards/problems
 - c. On-Track worker protection plan as applicable
 - d. Step-by-Step outline of construction process for each site and equipment to be used
 - e. WMATA Manpower and Equipment Request Form and/or a test procedure if applicable
 - f. Timetable for completion, with WMATA approval prior to NTP
4. In addition, the Design-Builder shall have all work personnel complete and pass the WMATA Track Access Safety Course/Roadway Worker Protection Training as applicable.

1.06 SPECIFIC CONDITIONS

- A. The Design Builder should note that Rail Car Maintenance Operations at all three project locations (Yards) will be on-going, 24 hours a day, 7 days a week, during the construction period of this contract. The Design Builder shall not adversely impact Yard Operations, rail car or employee traffic, while performing any aspect of this contract.
- B. Generally, work can be performed both during revenue and non-revenue hours if sufficient protection is provided for yard operations; and protection systems and hours of work will be agreed upon between the Authority Representative and the Design-Builder. All work is subject to adequate prior scheduling of work that complies with the time frames for approval of work schedules as detailed below, and in those cases, compliance with the SOP No. 19, 28, and 33 requirements for working within WMATA Metro Stations or on the Rail Right of Way specified in Section 1.06 and 1.07 of this Section, will be strictly enforced. All work shall be in accordance with all noise control procedures, dust control procedures and all other procedures, as stipulated herein and as approved. Also, the Design-Builder may be subject to restrictions on hours of work for material

and equipment deliveries as coordinated with Yard Operations.

- C. The Design-Builder is warned of the presence of electric contact rail, 750 volts DC, on the WMATA tracks and moving trains on the WMATA tracks and shall take necessary precautions to prevent damage to life and property through contact with the electrical or operating systems. The Design-Builder's attention is directed to the fact that any contact with live electrical contact rail may result in severe burn or death. Prior to performing any work on a segment of track, arrangements shall be made through the Authority Representative for access rights and power outage in accordance with WMATA Metrorail Safety Rules and Procedures, Standard Operating Procedures No. 19, 28, and No. 33 and Operations Administrative Procedures No. 100-9 and No. 200-10. All special requests for access, single tracking, power outages, escorts, and other Authority support shall be submitted in writing in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES through the Authority Representative to appropriate WMATA OPER officials. See Section 01114 SAFETY/ENVIRONMENTAL REQUIREMENTS of these General Requirements.
 - D. Greenbelt Yard Tracks and Shady Grove Yard tracks are electrically isolated from the mainline tracks. Therefore, any outage request for a section of track in those Yards must be approved by the Assistant Superintendent of Operations in charge of that particular Yard. Brentwood Yard tracks are not isolated from the mainline tracks. Therefore, outage request for a section of track in the Brentwood Yard could effect mainline tracks and must be approved by both, the Yard Superintendent and the Superintendent of OCC and appear on the General Order.
 - E. Personal Protective Equipment (PPE): Necessary PPE for Design-Builder employees and training for correct usage shall be provided by the Design-Builder, and such safety equipment must be employed by Design-Builder personnel while on Authority property. The Design-Builder's work force shall wear safety and protective clothing as required by OSHA and WMATA to include wearing orange safety vests. See Section 01114 SAFETY/ENVIRONMENTAL REQUIREMENTS of these General Requirements.
 - F. The Design-Builder is responsible for training its employees in the proper utilization of materials in order to make them aware of any hazards associated with use of these products, and shall provide WMATA with evidence that such training was conducted as specified in Section 01114 SAFETY/ENVIRONMENTAL REQUIREMENTS of these General Requirements.
 - G. No hazardous or flammable materials shall be stored on WMATA property at any time. The Design-Builder shall acquire permits for use of hazardous or flammable materials as required by the jurisdictional Fire Marshals. See Section 01114 SAFETY/ENVIRONMENTAL REQUIREMENTS of these General Requirements.
 - H. Lighting: Whenever by reasons of conditions created by the Design-Builder in constructing fences, barricades, or otherwise, illumination by artificial means becomes necessary in order to protect persons and property, the Design-Builder shall furnish and maintain adequate illumination at the site. See Section 01114 SAFETY/ENVIRONMENTAL REQUIREMENTS of these General Requirements.
- 1.07 APPLICABLE WMATA 'S STANDARD OPERATING PROCEDURES SOP 19: MAINTENANCE AND TESTING ON REVENUE FACILITIES, SOP 28: REMOVAL AND RESTORATION OF THIRD RAIL POWER FOR WORK BY WMATA MAINTENANCE FORCES - MAINLINE REVENUE SOURCES, AND SOP 33: REMOVAL AND RESTORATION OF THIRD RAIL POWER FOR WORK BY DESIGN-BUILDER'S/CONTRACTOR'S FORCES - MAINLINE, REVENUE SYSTEM
- A. Metrorail Standard Operating Procedure No. 19 Maintenance and Testing on Revenue Facilities
 - 1. Purpose and Applicability

- 19.1 The purpose of this Standard Operating Procedure (SOP) is to ensure consistency and provide guidance for all personnel desiring the use of the revenue railroad for maintenance or testing of vehicles or facilities. This SOP is applicable to Design-Builders, Contractors, subcontractors, consultants and all other personnel (including WMATA employees) desiring access to the revenue railroad or Rail Transportation (RTRA) facilities for maintenance or testing.
2. Responsibilities
- 19.2 The General Superintendent of RTRA is responsible for approval of the operational plan for all tests to be performed on the revenue railroad or on RTRA facilities.
- 19.3 The General Superintendent of the Operations Control Center (OCC) is responsible for approval, issuance, and implementation of the General Orders. They are used to define track sections for maintenance and testing, and will remain in effect until fulfilled, superseded, or cancelled by the Superintendent of OCC.
- 19.4 Authority offices, Design-Builders, contractors and consultants are responsible for scheduling all activities in accordance with this SOP.
- 19.5 Superintendents assigned to RTRA are responsible for providing support services when requested, and subsequently approved in accordance with this SOP.
- 19.6 Test Directors are responsible for test approval by the appropriate office to assure safe operation during tests.
- 19.7 Personnel requiring access rights are responsible for: advising OCC of their work areas, and after approval by OCC, monitoring the appropriate radio frequencies during access.
3. Exclusive Rights
- 19.8 All requests to obtain exclusive use of a section of yard track must be submitted to and approved by the Assistant Superintendent of Operations in charge of the specified yard.
- 19.9 All requests to obtain exclusive use of a section of mainline track must be submitted to and approved by the Superintendent of OCC and appear on the General Order.
4. Access Rights
- 19.10 All requests to obtain access rights for authorized WMATA personnel must be coordinated with and be approved by OCC before entering the right-of-way. OCC must also be notified when personnel have completed their tasks and are clear of the right-of-way. All other access rights must appear on the General Order.
5. General Order Procedures
- 19.11 All requests for rights must be submitted in writing to the Superintendent of OCC by 1700 on the Wednesday preceding the scheduled week. When a holiday falls on a Thursday, all requests must be submitted by 1000 Wednesday.
- 19.12 Only the Superintendent of OCC may approve the issuance of General Orders for requests after track allocations have been scheduled.
- 19.13 The time limits for the General Orders are defined as:

- a. Schedule Week - 0001 Saturday through 2359 the following Friday.
- b. Schedule Monday through Friday - 0030 to 0330.
- c. Schedule Saturday and Sunday - 0230 to 0630.

NOTE: When red tags are issued, an earlier clearing time may be required, and any deviation from these scheduled times must be approved by the Superintendent of the OCC.

19.14 All requests must include the following information:

- a. Department requesting rights.
- b. Date and hours of the request.
- c. Line, Track and Chaining.
- d. Contact rail status.
- e. Equipment to be utilized.
- f. Individual making the request.
- g. Purpose of the request.

6. General Order Format and Content

19.15 General Orders will be identified by bold type reading:

GENERAL ORDER

19.16 The heading will include the date of the order, the number of the General Order and to whom the Order is addressed. Numbers will be continuous on a yearly basis.

19.17 The General Order will identify for each approved area:

- a. The work to be performed and type of rights requested.
- b. The Design-Builder, contractor or Authority Department involved.
- c. The date and hours affected.
- d. The identification and location of the work area involved.
- e. The contact rail status when necessary.
- f. Instructions for flagging when necessary.

7. Suspension of a General Order

19.18 OCC has the authority to suspend or cancel a portion of, or all of, a General Order when conditions require it.

19.19 When a General Order is cancelled, OCC will immediately notify all concerned parties and document all actions taken.

8. Modification of a General Order
 - 19.20 After publication of a General Order, modifications will not be allowed except for emergencies or for cancellation of rights. All cancellations will be documented by OCC identifying the rationale for the cancellation.
 - 19.21 Emergency modifications of General Orders will be allowed only when conditions exist which will cause a portion of the mainline to be taken out of service during revenue hours.
9. Conducting Tests (Other than Routine Maintenance Tests)
 - 19.22 Personnel requiring the revenue railroad or RTRA facilities for tests shall:
 - a. When requiring exclusive rights for the mainline tracks, request those rights in accordance with Section E of this SOP and attach a copy of the request to the test procedure.
 - b. Submit to RTRA, no later than ten (10) working days prior to the test, a test request identifying:
 1. The purpose.
 2. The expected results.
 3. The Test Director (by name).
 4. All personnel participating and/or observing (by name).
 5. A detailed operational plan including:
 - (a) Operating scenario.
 - (b) RTRA personnel required.
 - (c) Equipment and facilities to be used.
 - 19.23 The Test Director shall be responsible for obtaining a "Covenant not to Sue" from all non-WMATA personnel involved in a test.
 - 19.24 After approval of the operational plan by the General Superintendent of RTRA, the appropriate RTRA Superintendent shall provide the necessary support as identified in the test procedure. Also, a single point of contact shall be provided for the Test Director. This individual will be responsible for the safety of the RTRA personnel and equipment while the test is being performed. Any modification to the operational scenario will be coordinated through the individual designated as the single point of contact.
- B. Metro Rail Standard Operating Procedure #28 REMOVAL AND RESTORATION OF THIRD RAIL POWER FOR WORK BY WMATA MAINTENANCE FORCES - MAINLINE REVENUE SYSTEM

Purpose;

The purpose of this Standard Operating Procedure is to delineate responsibilities and procedures for removal and restoration of third rail power for work by WMATA maintenance forces on the mainline.

Scope;

This SOP is applicable to all WMATA personnel working on the rail system.

1. Guidelines for Removing Power

- 28.1
 - a. Power will be removed to perform maintenance on the third rail or items connected to the third rail by red tag outage.
 - b. Power will be removed for maintenance of equipment and structures in the track bed, other than the third rail and its connected equipment, by supervisory outage.

- c. When requesting a mainline Red Tag power outage, request the outage by providing the Chain Markers of the third rail gaps which bracket the work area.
- d. Power outage need only cover the actual work area. Protected work areas outside of the actual work area do not require a power outage.
- e. Depending on the amount and type of materials/tools being transported to or from the work site, either carried or by rail cart, a supervisory power outage may be required from the point of entry. At the direction of the supervisor/escort at the time of, or prior to entry to the track, OCC shall provide a supervisory power outage.

NOTE 1: Certain inspection and maintenance of equipment and structures in the track bed may not require power removal.

2. Procedures for Removal and Restoration of Power for Red Tag Outages

28.2 Removal;

- a. The WMATA maintenance personnel that requires the outage shall submit the request via GOTRS (General Orders - Track Rights System). Each request must; identify the department supplying a qualified escort, specify the track number(s), chaining of the outage area, start and stop time of the outage, and identify any support required from other departments. CENG Planning will notify the requestor of the approval or disapproval of the request via GOTRS.
- b. The Maintenance Operation Center (MOC) will, in coordination with the Operations Control Center (OCC), initiate the power outage.
- c. Power crews will rack out and block tag the appropriate yard disconnect switches and/or circuit breakers at the involved substations, as directed by MOC, and confirm the third rail is de-energized with an approved voltage tester.
- d. When the outage area has been secured (racked out, tagged and tested), MOC will activate and hold the red tag for the outage area and record the date/time and numbers of the breakers involved.
- e. The maintenance supervisor, crew leader, escort or member of the WMATA maintenance activity who is to be the Red Tag Holder shall, prior to the start of work, contact the MOC to verify that the red tag has been activated and obtain the red tag number.
- f. The Red Tag Holder shall, after receiving the red tag number, contact OCC advising them of the red tag number and request permission to enter the track bed to test the third rail and protect the work area as follows:
 - 1. Place a reflective rubber mat in the track bed, at each end of the actual work area, to identify the actual work area for the crew (Figure 2).
 - 2. Connect a third rail warning device(s) on each section of third rail in the actual work area. Each third rail warning device shall be tested before being connected to the third rail.
 - 3. Install shunt straps and place red limit lights at each end of the protected work area (Figure 2).
 - 4.
 - a. If an interlocking is contained within the protected work area, request OCC to place normal calls on the switches in the interlocking, establish a route on the work track and place prohibit exits on the signals on the work track. Then place a shunt strap between the entrance and exit signal on the work track. Example: if working on track one at a diamond interlocking, place the shunt strap between 02 and 04 signal. (Figure 3)
 - b. If an interlocking of any other configuration (diverging turnout, universal or pocket) is contained within the work area, request OCC to place the appropriate call on the switch to protect the work area, establish a route on the work track and place prohibit exits on the signals on the work track. Then place a shunt strap between the entrance and exit signals

on the work track.

5. The maintenance supervisor, crew leader, or escort shall notify OCC before work begins to confirm that shunt straps, limit lights and third rail warning devices (safety equipment) are in place. If an interlocking is within the protected work area, ensure that switches are in the desired positions and the procedures outlined in 28.2 (section f., number 4.a. and b.) have been followed and the protected work area has been established.
6. OCC shall then verify track occupancy at the locations of the shunt straps, as specified in the General Order.
- g. The maintenance supervisor, crew leader, or escort in charge of the WMATA maintenance activity will, prior to starting work, brief the personnel of the work crew on applicable WMATA safety rules/procedures, track(s) involved, work area limits, red tag number and any restrictions on the work as specified by the Power Outage or General Order.
- h. In the event the work continues through an MOC or OCC shift change, it will be the responsibility of the initial MOC or OCC Supervisor to advise the relief person of the details of involving the work taking place, including the name of the Red Tag Holder and/or the person in charge of the work crew.
- i. If the Red Tag Holder is to be relieved, both the original Red Tag Holder and the new Red Tag Holder must contact MOC and OCC advising them of the change prior to making the change.

28.3 Restoration;

- a. The maintenance supervisor, crew leader or escort will, prior to or at the schedule stop time of the outage, contact MOC and OCC advising them that the work is completed and that the work area will be cleared and inspected.
 - b. The maintenance supervisor, crew leader or escort will, upon completion of the inspection, contact MOC advising them that the work area has been inspected for re-energization, all personnel/equipment are clear and the red tag can be cleared identifying it by number.
 - c. The maintenance supervisor, crew leader or escort will, after contacting MOC, contact OCC advising them that all personnel/equipment are clear of the work area and that the red tag has been cleared through MOC.
 - d. OCC will, prior to allowing personnel to leave the area, verify removal of the shunt straps when the work has been completed, time period has ended or when requiring the personnel to clear.
 - e. OCC will ensure that the times the shunt straps are applied and removed are recorded on the OCC radio tape and/or in writing.
 - f. OCC will remove prohibit exit commands only after the person holding the red tag has reported personnel and equipment clear of the track.
 - g. When the red tag is cleared, MOC will in coordination with OCC, direct power crews to remove block tags, rack in and place in remote the appropriate circuit breakers at the involved substations.
 - h. MOC will advise OCC that the breakers for each outage area are positioned to be re-energized.
 - i. MOC and OCC will cause announcements to be made on MOC and OCC radio nets that power is being restored.
 - j. OCC will restore power by supervisory control as described in SOP 2.17 and notify MOC of any circuit breakers that do not close.
3. PROCEDURES FOR REMOVAL AND RESTORATION OF POWER FOR SUPERVISORY OUTAGES

- 28.4 Removal
- a. The WMATA maintenance personnel requiring the outage will, submit the request -via GOTRS (General Orders Track Rights System). Each request must: identify the department supplying the qualified escort, specify the track number(s), chaining of the outage area, and start and stop time of outage. CENG Planning will notify the requester of the approval or disapproval of the request via GOTRS. OCC will record approved requests in the power outage or restoration request log.
 - b. The maintenance supervisor, crew leader or escort will, prior to allowing the crew to begin work, request from OCC permission to enter the track bed before the outage is initiated and then:
 1. Verify that the approved voltage tester is working properly.
 2. Make a radio check with OCC to confirm that radios are working properly.
 3. Request the supervisory outage be initiated.
 - c. OCC will initiate the outage recording the date/time that power removal was completed, the breaker number(s) involved, and the name of the person in charge of the work crew in the request log.
 - d. OCC will then contact the maintenance supervisor, crew leader or escort and advise him/her to test the third rail with an approved voltage tester and confirm that it is de-energized.
 - e. When the maintenance supervisor, crew leader or escort confirms to OCC that the third rail is de-energized, he/she will protect the work area as follows:
 1. Place a reflective rubber mat in the track bed, at each end of the actual work area, to identify the actual work area for the crew (Figure 2).
 2. Connect third rail warning device(s) on each section of third rail in the actual work area. Each third rail warning device shall be tested before being connected to the third rail.
 3. Install shunt straps and place red limit lights at each end of the protected work area (Figure 2).
 4.
 - a. If an interlocking is contained within the protected work area, request OCC to place normal calls on the switches in the interlocking, establish a route on the work track and place prohibit exits on the signals on the work track. Then place a shunt strap between the entrance and exit signal on the work track. Example: if working on track one at a diamond interlocking, place the shunt strap between 02 and 04 signal. (Figure 3)
 - b. If an interlocking of any other configuration (diverging turnout, universal or pocket) is contained within the work area, request OCC to place the appropriate call on the switch to protect the work area, establish a route on the work track and place prohibit exits on the signals on the work track. Then place a shunt strap between the entrance and exit signals on the work track.
 5. The maintenance supervisor, crew leader, or escort in charge of the work crew shall notify OCC before work begins to confirm that shunt straps, limit lights and third rail warning devices (safety equipment) are in place. If an interlocking is within the protected work area ensure that switches are in the desired position(s) and the procedures outlined in 28.4 (section e., number 4.a. and b.) have been followed and the protected work area has been established.
 - f. The maintenance supervisor, crew leader or escort will, prior to allowing the crew to begin work, brief personnel of the work crew that the third rail is to be considered energized at all times and not to make contact with it or its connected equipment. In addition, personnel will be advised of any applicable rules, procedures or restrictions.

- g. The maintenance supervisor, crew leader or escort must maintain contact with OCC during the work in the event OCC would have to clear the work area and restore power in response to an emergency. In addition, the maintenance supervisor, crew leader or escort will periodically check the third rail to confirm it is still de-energized.
- h. In the event that the work continues through an OCC shift change, it will be the responsibility of the initial OCC Supervisor to advise the relief person of the outage and the name of the person in charge of the work crew.
- i. In the event that the work continues through the work crew's shift change, it will be the responsibility of the initial maintenance supervisor, crew leader or escort to advise OCC of the name of the person in charge of the relief crew. At all times, OCC must be kept informed as to who is in charge and responsible for clearing the work area.

28.5 Restoration

- a. The maintenance supervisor, crew leader or escort will, prior to the schedule stop time of the outage, advise MOC and OCC that the work is completed and that the work area will be cleared and inspected.
- b. The maintenance supervisor, or crew leader or escort will, upon completion of the inspection, contact MOC and OCC advising them that the work area has been inspected for re-energization, all personnel/equipment are clear of the track(s) and give OCC clearance to re-energize the third rail in the area.
- c. When OCC receives the clearance from the maintenance supervisor, crew leader or escort and no other crews are holding the same third rail area out of service, OCC will ensure that announcements are made on their radio net and the MOC net that third rail power is being restored in the work area.
- d. After announcements have been made, OCC will re-energize the third rail in the cleared work area. OCC will record the request to re-energize in the power outage or restoration request log and also the time the restoration was completed.

C. Metrorail Standard Operating Procedure No. 33 Removal and Restoration of Third Rail Power for Work by Design-Builders'/Contractors' Forces - Mainline, Revenue System

1. Guidelines for Removing Power

33.1

- a. Power will be removed to perform work on the third rail, or items connected to the third rail, by red tag outage, and with WMATA escort by the appropriate WMATA activity (Section B).
- b. Power will be removed for work on equipment and structures in or over the trackbed, other than the third rail and its connected equipment, or work that intrudes into the dynamic outline of the train, by supervisory outage, and with WMATA escort by the appropriate WMATA activity.
- c. When requesting a mainline Red Tag power outage, request the outage by providing the Chain Markers of the third rail gaps which bracket the work area.
- d. Power outage need only cover the actual work area. **Protected work areas outside of the actual work area do not require a power outage.**
- e. Depending on the amount and type of materials/tools being transported to or from the work site, either carried or by rail cart, a supervisory power outage may be required from the

point of entry. At the direction of the supervisor/escort at the time of, or prior to entry to the track, OCC shall provide a supervisory power outage.

NOTE 1: Design-Builder/Contractor work that is not in or over the trackbed, does not intrude into the dynamic outline of the train, and is not affected by train movements or third rail status will not, require power removal. Such Design-Builder/Contractor work, shall require a WMATA escort.

NOTE 2: A management representation of each Design-Builder/Contractor who will be performing work on the rail system will, prior to the scheduling of the work, receive an Authority orientation to the rail system rules, procedures, restrictions, and other pertinent information as applicable. The Design-Builder/Contractor will be required to acknowledge receiving the orientation by authorized signature.

NOTE 3: Each Design-Builder/Contractor employee who will be performing work on the rail system, prior to performing that work will receive and pass an approved Authority course on the rail system rules, procedures, restrictions and any other pertinent information as applicable. Upon successful conclusion of the course a Design-Builder/Contractor ID will be issued identifying the individual as have been authorized to work on the right of way. This badge shall be displayed at all times while on Rail facilities.

2. Procedures for Removal and Restoration of Power for Red Tag Outage

33.2 Removal:

- a. The Design-Builder/Contractor who requires the outage shall, in coordination with the appropriate WMATA activity, submit the request via GOTRS (General Orders - Track Rights System). Each request must: identify the Department supplying a qualified escort, specify the track number(s), chaining of the outage area, and start and stop time of the outage. CENG Planning will notify the requestor of the approval or disapproval of the request via GOTRS.
- b. The Maintenance Operation Center (MOC) will, in coordination with the Operations Control Center (OCC), initiate the power outage.
- c. Power crews will rack out and block tag the appropriate yard disconnect switches and/or circuit breakers at the involved substations, as directed by MOC, and confirm that the third rail is de-energized with an approved voltage tester.
- d. When the outage area has been secured (racked out, tagged and tested) MOC will activate and hold the red tag for the outage area and record the date/time and numbers of breakers involved.
- e. The WMATA escort shall, prior to starting the work, contact the MOC to verify that the red tag has been activated and obtain the red tag number.
- f. The WMATA escort shall, after receiving the red tag number, contact OCC advising them of the red tag number and request permission to enter the trackbed to test the third rail.
 1. Place a reflective rubber mat in the track bed, at each end of the actual work area to identify the actual work area for the crew (Figure 2).
 2. Connect a third rail warning device(s) on each section of third rail in the actual work area. Each third rail warning device shall be tested before being connected to the third rail.

3. Install shunt straps and place red limit lights at each end of the protected work area (Figure 2).
 4. a. If an interlocking is contained within the protected work area, request OCC to place normal calls on the switches in the interlocking, establish a route on the work track and place prohibit exits on the signals on the work track. Then place a shunt strap between the entrance and exit signal on the work track. Example: if working on track one at a diamond interlocking, place the shunt strap between 02 and 04 signal. (Figure 3).
 - b. If an interlocking of any other configuration (diverging turnout, universal or pocket) is contained within the work area, request OCC to place the appropriate call on the switch to protect the work area, establish a route on the work track and place prohibit exits on the signals on the work track. Then place a shunt strap between the entrance and exit signals on the work track.
 5. The escort in charge of the work crew shall notify OCC before work begins to confirm that shunt straps, limit lights and third Rail warning devices (safety equipment) are in place. If an interlocking is within the protected work area, ensure that switches are in the desired positions and the procedures outlined in 33.2 (section f., number 4.a. and b.) have been followed and the protected work area has been established.
 6. OCC shall then verify track occupancy at the locations of the shunt straps, as specified in the General Order.
 - g. The WMATA escort shall, prior to allowing the Design-Builder/Contractor to start work, brief the personnel of the work crew on applicable safety rules/procedures, track(s) involved, work area limits, red tag number, and any restrictions on the work as specified by the Power Outage or the General Order. The Design-Builder/Contractor must comply with the rules, procedures, and any restrictions set forth by the escort.
 - h. In the event the work continues through an MOC or OCC shift change, it will be the responsibility of the initial MOC or OCC supervisor to advise the relief person of the outage and the name of the person in charge of the work crew.
 - i. In the event the work continues through the escort's shift change, it will be the responsibility of the initial escort to advise the MOC and the OCC of the new escort's name. At all times, OCC must be kept informed as to who is in charge and is responsible for clearing the work area.
- 33.3 Restoration:
- a. The WMATA escort shall, prior to or at the scheduled stop time of the outage, contact MOC and OCC advising them that the work is completed, and that the work area will be cleared.
 - b. The WMATA escort shall, upon completion of the inspection, contact MOC advising them that the work area has been inspected for re-energization, all personnel/equipment are clear, and the red tag can be cleared identifying it by number.
 - c. The WMATA escort shall, after contacting MOC, contact OCC advising them that all personnel/equipment are clear of the work area and that the red tag has been cleared through MOC.
 - d. OCC will, prior to allowing personnel to leave the area, verify removal of the shunt straps when the work has been completed, time period has ended or when requiring the activity to clear.
 - e. OCC will ensure that the times the shunt straps are applied and removed are


recorded on the OCC radio tape and/or in writing.

- f. OCC will remove prohibit exit commands only after the person holding the red tag has reported personnel and equipment clear of the track.
- g. When the red tag is cleared, MOC will, in coordination with OCC, direct power crews to remove tags, rack in and place in remote the appropriate circuit breakers at the involved substations.
- h. MOC will advise OCC that the breakers for each outage area are positioned to be re-energized.
- i. MOC and OCC will cause announcements to be made on the MOC and OCC radio nets that power is being restored.
- j. OCC will restore power by supervisory control, as described in Safety Rule 42.17 and notify MOC of any circuit breakers that do not close.

3. Procedures for Removal and Restoration of Power for Supervisory Outage

33.4 Removal:

- a. The Design-Builder/Contractor who requires the outage shall, in coordination with the appropriate WMATA activity, submit the request via GOTRS (General Orders Track Rights System). Each request must: identify the Department supplying the qualified escort, specify the track number(s), chaining of the outage area, and start and stop time of outage. CENG Planning will notify the requestor of the approval or disapproval of the request via GOTRS. OCC will record approved requests in the power outage or restoration request log.
- b. The WMATA escort shall, prior to allowing the Design-Builder/Contractor to begin work, request from OCC permission to enter the trackbed before the outage is initiated and then:
 1. Verify that the approved voltage tester is working properly.
 2. Make a radio check with OCC to confirm that radios are working properly.
 3. Request the supervisory outage be initiated.
- c. OCC will initiate the outage, recording the date/time that power removal was completed, the breaker number(s) involved, and the name of the escort in charge of the work crew, in the request log.
- d. OCC will then contact the WMATA escort and advise the escort to test the third rail with an approved voltage tester and confirm that it is de-energized.
- e. When the WMATA escort confirms to OCC that the third rail is de-energized, the WMATA escort will protect the work area as follows:
 1. Place a reflective rubber mat in the track bed, at each end of the actual work area, to identify the actual work area for the crew (Figure 2).
 2. Connect third rail warning device(s) on each section of third rail in the actual work area. Each third rail warning device shall be tested before being connected to the third rail.
 3. Install shunt straps and place red limit lights at each end of the protected work area (Figure 2).
 4.
 - a. If an interlocking is contained within the protected work area, request OCC to place normal calls on the switches in the interlocking, establish a route on the work track and place prohibit exits on the signals on the work track. Then place a shunt strap between the entrance and exit signal on the work track. Example: if working on track one at a diamond interlocking, place the shunt strap between 02 and 04 signal. (Figure 3)
 - b. If an interlocking of any other configuration (diverging turnout, universal or pocket) is contained within the work area, request OCC to place the appropriate call on the switch to protect the work area, establish a route on the work track and place prohibit exits on the signals on the work track. Then place a shunt strap between the entrance and exit signals on the work track.

- 
5. The person in charge of the work crew shall notify OCC before work begins to confirm that shunt straps, limit lights and third rail warning devices (safety equipment) are in place. If an interlocking is within the protected work area, ensure that switches are in the desired position(s) and the procedures outlined in 33.4 (section e., number 4. a. and b.) have been followed and the protected work area has been established.
 - f. The WMATA escort will, prior to allowing the Design-Builder/Contractor to begin work, brief personnel of the work crew that the third rail is to be considered energized at all times and not to make contact with it or its connected equipment. In addition, personnel will be advised of any applicable safety rules and procedures, track(s) involved, work area limits, and any restrictions on the work as specified by the General Order. The Design-Builder/Contractor must comply with the rules, procedures, and any restrictions set forth by the escort.
 - g. The WMATA escort must maintain contact with OCC during the work in the event OCC would have to clear the work area and restore power to respond to an emergency. In addition, the WMATA escort will periodically check the third rail to confirm it is still de-energized.
 - h. In the event that the work continues through an OCC shift change, it will be the responsibility of the initial OCC supervisor to advise the relief person of the outage and the name of the escort in charge of the work crew.
 - i. In the event that the work continues through the escort's shift change, it will be the responsibility of the initial escort to advise the OCC of the new escort's name. At all times, OCC must be kept informed as to who is in charge and responsible for clearing the work area.

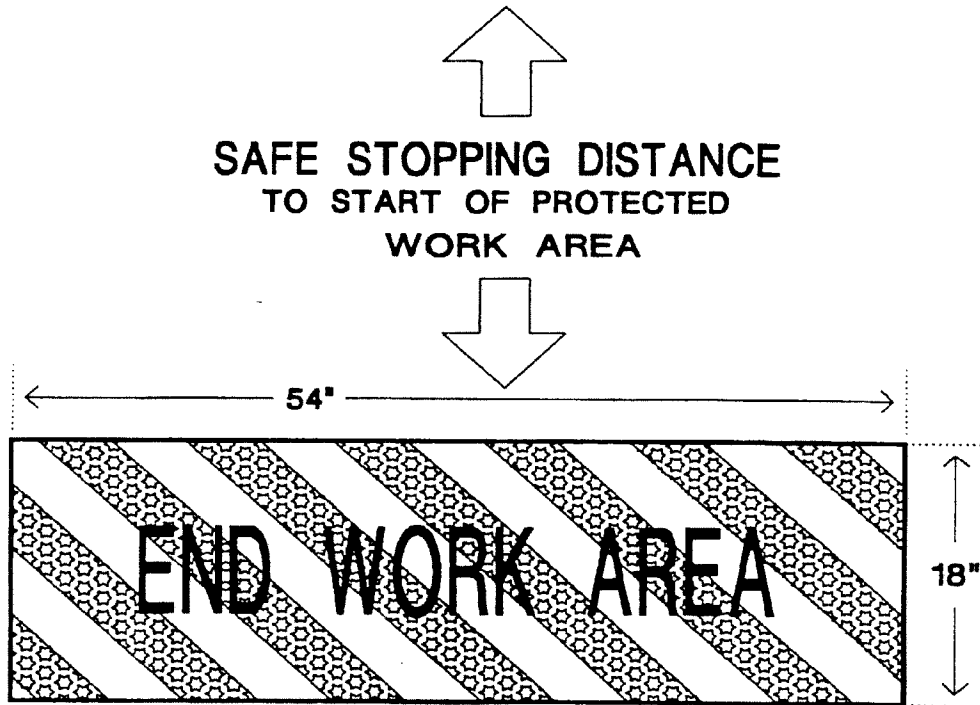
33.5 Restoration:

- a. The WMATA escort will, prior to the scheduled stop time of the outage, advise MOC and OCC that the work is completed and that the work area will be cleared and inspected.
- b. The WMATA escort will, upon completion of the inspection, contact MOC and OCC advising them that the work area has been inspected for re-energization, all personnel and equipment are clear of the track(s) and give OCC clearance to re-energize the third rail in the area.
- c. When OCC receives the clearance from the WMATA escort, and no other work crews are holding the same third rail area out of service, OCC will ensure that announcements are made on their radio net and the MOC net that third rail power is being restored in the work area.
- d. After announcements have been made, OCC will re-energize the third rail in the cleared work area. OCC will record the request to re-energize in the power outage or restoration request log and also the time the restoration was completed.

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ACTUAL WORK AREA

(REFLECTORIZED RUBBER MAT 54in x 18in)

RED LANTERNS

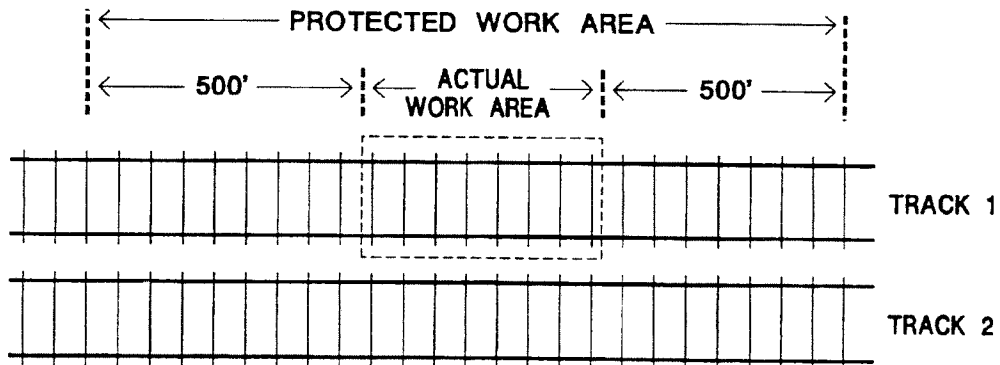


FIGURE-1

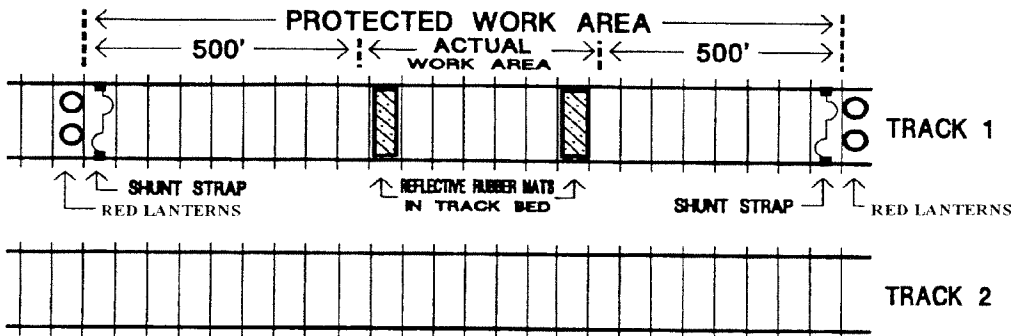


FIGURE-2

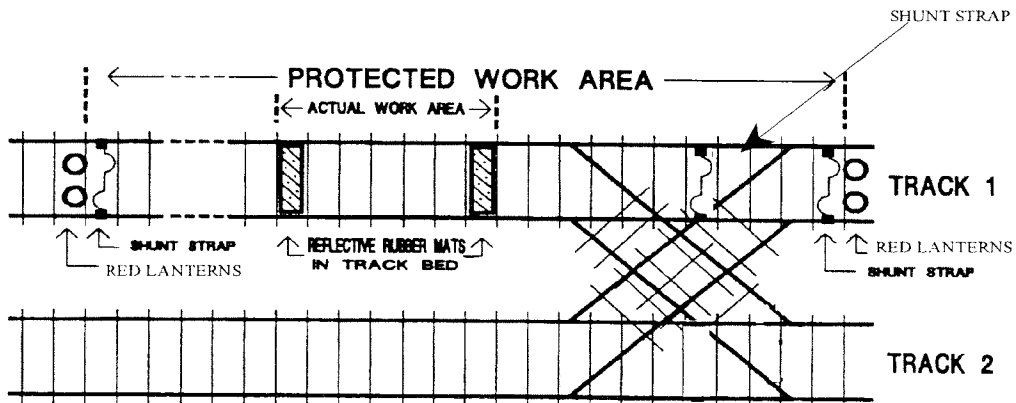


FIGURE-3

Department of Operations
Washington Metropolitan Area
Transit Authority
OPR: Operations Support Branch

OAP 100-9
March 1, 1999

Organization and Administration

1.07 ACCESS TO REVENUE OR START-UP RAILROAD FACILITIES

1. PURPOSE AND SCOPE

The purpose of this Operations Administrative Procedure (OAP) is to provide consistency and guidance to all personnel desiring access to facilities maintained or controlled by organizations associated with the Revenue (Active) or Start-Up (Future Phase) Railroad Systems. It is applicable to all Department of Rail Service (RAIL) personnel, in addition to Design-Builders/Contractors, Consultants and other WMATA employees having a need for such access.

2. RESPONSIBILITY

- A. The Assistant General Manager RAIL (Implementing Authority) is responsible for implementing, and for approving revisions to this OAP.
- B. The Senior Manager, Operations Support Branch, is designated the Reviewing Authority, and as such, is responsible for periodic review of this OAP and for reporting accomplishment of the review by January 31 of each year.

3. POLICIES

- A. The Maintenance Planning and Scheduling Section of the Operations Support Branch shall coordinate all Rail Support Requests received in accordance with paragraph 4.A. below. This coordination activity shall have input from those personnel designated below, or their representatives:
 - 1) RTRA - Operations Control Center (OCC) Superintendent.
 - 2) SMNT - Maintenance Operations Center (MOC) Manager(s).
 - 3) SMNT - Automatic Train Control Branch Superintendent.
 - 4) SMNT - Power Branch Superintendent.
 - 5) SMNT - Communications Branch Superintendent.
 - 6) ENSP - Start-Up Manager.
 - 7) PLNT - Plant Maintenance, General Superintendent.
 - 8) TRST - Track and Structures, General Superintendent.
 - 9) Other WMATA Offices/Branches/Sections, as required.
- B. All coordination activity shall be conducted prior to the General Orders meeting (Wednesday of each week), after which requestors will be advised of approval, disapproval or changes to their request. The Operations Support Branch, Maintenance Planning and Scheduling Section shall maintain records of all submitted Rail Support Requests in the mainframe-based GOTRS (General Orders Track Rights System).

- C. When required, ENOS/ENSP/Start-Up and RAIL (SMNT, RTRA, CMNT, PLNT or TRST) will provide, at the work location, escort(s) and/or support personnel who are completely aware of the nature and extent of the work and shall ensure that it is performed in compliance with the details of the approved request.
- D. The OCC Superintendent and the MOC Superintendent shall, on a daily basis, monitor approved requests as to be able to assist in the resolution of difficulties involving scheduled activities. In addition, they shall be available to review emergency requests for access as they arise.
- E. Requests entered in the "General Orders and Track Rights System" (GOTRS) in accordance with paragraph 4.A. below, provides the routine means for personnel to request:
 - 1) Access to revenue railroad facilities;
 - 2) Access to start-up railroad facilities;
 - 3) Escort or support service;
 - 4) Supervisory or red tag power outages;
 - 5) Certification of hi-rail equipment.
- F. All requests involving facility additions or modifications must be approved by the appropriate General Superintendent in accordance with paragraph 4.E. below.
- G. Emergency requests may be made in accordance with paragraph 4.G. below.
- H. All requests for vehicle access to the revenue or start-up railroad must be made in accordance with paragraph 4.I. below.
- I. Requests for access to the revenue railroad must be made in accordance with Metrorail SOP 19, in addition to the requirements of this OAP.
- J. Requests for access to the start-up railroad must be made in accordance with Rules and Instructions for Conducting Start-Up Activities, in addition to the requirements of this OAP.

4. PROCEDURES

- A. Requests for access to either the revenue railroad facilities or the start-up railroad facilities, electrical power outages, and/or escort/support service by personnel of any Office, must be entered in the "General Orders/Track Rights System" (GOTRS), by the Requestor, not later than Tuesday at 1200 hours of the week preceding the WMATA operating week, which begins Saturday morning at 0001 hours and ends Friday at 2359 hours. A copy (computer screen print) of the Rail Support Request screen is attached for reference (Attachment A).
- B. A General Orders meeting will be conducted each Wednesday at a time and place designated by the RTRA-OCC Superintendent. Only those requests that are properly prepared, coordinated and submitted to the Operations Support Section - Maintenance Planning and Scheduling in accordance with paragraph 4.A. above by the preceding Tuesday at 1200 hours will be considered at the General Orders meeting for implementation for the following week (Saturday through Friday).

- C. Requests for access, once approved, may not be adjusted. Changes may only be accomplished by canceling the old request and entering a new request in GOTRS reflecting the desired version, in accordance with paragraph 4.A. above.
- D. Requests (such as engineering tests) involving special testing or work on the revenue railroad that may affect passengers or revenue service must be supported by prints or drawings and accompanied by a statement of work. They shall be forwarded to the RTRA General Superintendent so as to be received at least ten (10) days prior to the desired start date. These requests must be approved by the RTRA General Superintendent before they will be considered for scheduling.
- E. Access will not be permitted to perform work which has not been coordinated and approved in accordance with Authority policy. Refer to Policy/Instruction (P/I) 2.2/0 and 4.10.0 and OAP 200.4.
- F. Requests involving adjustments to the start-up wayside, the removal of gates or bumping-posts, or those which may infringe on the dynamic clearance envelope shall be accompanied by a thoroughly detailed justification to include prints or drawings and accompanied by a statement of work. All requests involving the start-up railroad must be approved by the Start-Up Manager before they will be considered for scheduling.
- G. Emergency or urgent requests for access or escort/support not addressed by the General Orders planning and scheduling process, should be directed to:

OCC (revenue railroad access)	(202) 962-1970
Start-Up (start-up railroad access)	(202) 962-1080
	(202) 962-2758
MOC (revenue and start-up railroad access):	
Automatic Train Control	(202) 962-1797
Communications	(202) 962-1700
Computer	(202) 962-1790
Automatic Fare Collection	(202) 962-2907
Power	(202) 962-1058

Note: Examples of urgent requests include the repair of the operations, police or fire radio equipment; water main breaks and floods; or the train control room air conditioners. In such cases, the MOC, or appropriate Section Assistant Superintendent shall prepare the necessary forms, to include power switching orders.

- H. Any requestor or WMATA support organization desiring to delay or cancel previously approved and scheduled access/support and/or power outage, MUST call the appropriate MOC section as listed in paragraph 4.G. above. Start-Up Control shall also be notified, as required. All cancellations should be reported in a timely manner.

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- I. Design-Builder/Contractors who wish to use equipment on Metrorail tracks must complete the "Hi-Rail Vehicle Certification" form (Attachment B). All Rail Support Requests involving any vehicle or rail equipment access to the revenue or start-up railroad must be accompanied by an approved "Hi-Rail Vehicle Certification" form, which must be submitted to Start-Up Manager a minimum of ten (10) working days in advance of the week in which access is required.

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ATTACHMENT A
PAGE 1

RCCI100 WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY RCCM100
GENERAL ORDERS AND TRACK RIGHTS SYSTEM
FUNCTION: B BROWSING RAIL SUPPORT REQUEST

REQUEST NO : STATUS: WORK ORDER:
REQUESTOR : WORK PHONE:
ORGANIZATION: HOME PHONE:
WMATA CONTACT :

REQUEST DATE: (TO) TRACK ACCESS : (Y/N)
HOURS FROM : TO : TRACK(S) : &
DAY OF WEEK : CHAINING FROM: + TO +

WORK LOCATION:

G.O. : (Y/N) START-UP : (Y/N) CLEAR IN TEN: (Y/N)
POWER OUTAGE REQUIRED: (N=NONE, R=REDTAG, S=SUPERVISORY)

DESCRIBE NON-WAYSIDE POWER OUTAGE, IF ANY.:

ENTER TO PROCESS OR: PF2/14=PRINT PF3/15=EXIT PF8/20=PAGE 2 PF12/24=RESET

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ATTACHMENT A
PAGE 2

RCCI100 WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY RCCM110
 GENERAL ORDERS AND TRACK RIGHTS SYSTEM
FUNCTION: B BROWSING RAIL SUPPORT REQUEST
REQUEST NO: _____ ESCORT DEPT: CHARGE JOB NO.:
 SUPPORT DEPT: NUMBER PERSONS:
 SUPPORT DEPT: NUMBER PERSONS:
 SUPPORT DEPT: NUMBER PERSONS:

EQUIPMENT ON TRACKS: (Y/N) IF YES, DESCRIBE:

WORK DESCRIPTION:

MEETING LOCATION:

TOOLS/EQUIPMENT:

REMARKS:

ENTER OR PF2/14=PRINT PF3/15=EXIT PF7/19=PAGE 1 PF8/PF20=PAGE 3 PF12/24=RESET

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
DEPARTMENT OF RAIL SERVICE

HI-RAIL VEHICLE CERTIFICATION

Subject: Request for Hi-Rail Vehicle Certification

Requestor: _____

Company: _____ Phone No. _____

Access Area: _____

Vehicle Manufacturer: _____

Vehicle Model: _____ Serial No.: _____

1. Base Line Vehicle Survey (See Attachment) must be submitted.
2. Gross Vehicle Weight: _____
3. Wheel Base: _____
4. Wheel Gauge must be 56-1/2 inches.
5. Weight and position on equipment of material to be moved: _____
6. Wheel Diameter: _____
7. Clearance from ball of rail to lowest vehicle undercarriage point: _____
8. Type of Vehicle Fuel: _____
9. Submit copy of last vehicle exhaust, emission test.

OAP 100-9

Attachment B

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
DEPARTMENT OF RAIL SERVICE
HI-RAIL VEHICLE CERTIFICATION

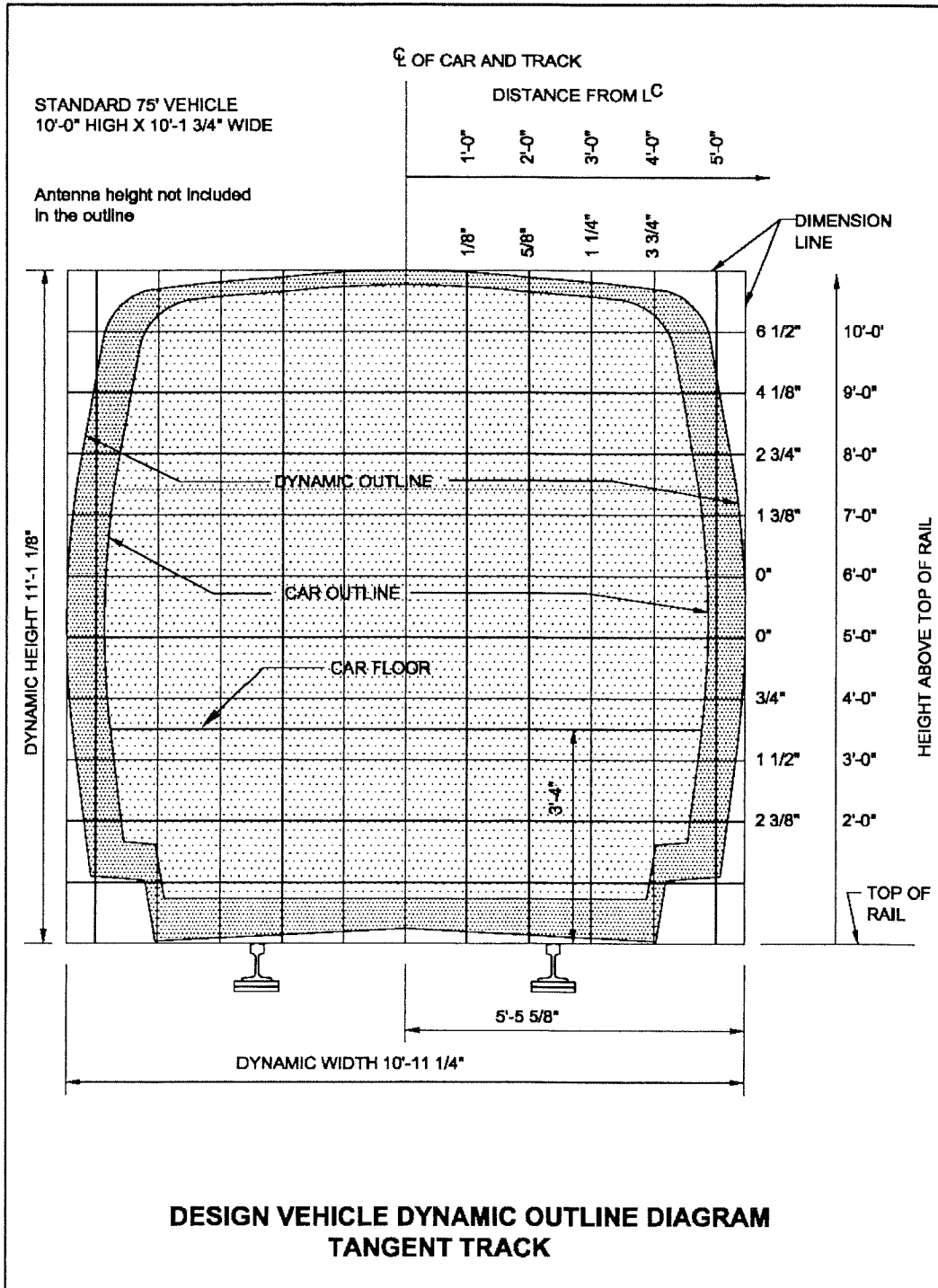
- 10. For multiple-unit equipment, indicate type of connection between prime mover and other units.
- 11. Propulsion Capability - Equipment must possess tractive effort sufficient to move the gross maximum load from a stopped position on a 5% grade in a 750 ft. radius curve.
- 12. Equipment should be equipped with fail-safe brakes (spring-applied power release). If this is not the case, brake system details must be provided. The equipment braking effort should be capable of locking all wheels on dry rail (25% coefficient of adhesion) when fully applied.
- 13. Equipment should have parking brake system capable of holding equipment on a 5% grade.
- 14. Other Information:

_____ Approved

_____ Disapproved

_____ Signature (RAIL)

_____ Date



OAP 100-9
 ATTACHMENT C
 END OF SECTION

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SECTION 01143

USE OF SITE

PART 1 GENERAL

1.01 SUMMARY

This Section specifies restrictions that may affect construction operations including, use of the site, noise and vibration control, historical and scientific specimens, use of explosives, and work on property other than the Authority's.

1.02 RELATED DOCUMENTS

Section 00742, General Conditions - Accident Prevention
Section 00744, General Conditions - Protection of Persons and Property
Section 00787, General Conditions - Indemnification and Insurance Requirements and Special Provisions of Insurance Furnished by Design-Builder
Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements
Section 01141, General Requirements - Summary of Work Requirements: Access to Site
Section 01142, General Requirements - Summary of Work Requirements: Coordination with Occupants and Operations
Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures

1.03 CONSTRUCTION NOISE CONTROL

A. Noise control: The Design-Builder shall take every action possible to minimize the noise caused by its operation. When required by agencies having jurisdiction, noise producing work shall be performed in less sensitive hours of the day or week as directed. Noise produced by the work shall be maintained at or below the decibel levels specified and within the time periods specified.

1. Protection of public and employees: Noise abatement measures and precautions shall be taken in order to reduce exposure to noise. Permissible noise exposure shall be calculated in accordance with the procedures established under the Walsh-Healy Public Contracts Act. Sound levels for public noise exposure due to construction will be measured at the property line of adjacent residential, commercial or industrial property or at the property line of the public right-of-way or 50 feet from the noise source, whichever is greater, when work is in progress in the public right-of-way, while construction work is in progress. Employee noise exposure levels will be measured at the employees' normal work station. In either case sound levels shall not exceed the following:

<u>EXPOSURE PER DAY IN HOURS</u>	<u>SOUND LEVEL IN</u>
<u>dBA</u>	
8	60
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115

Above ground repetitive, high level impact noise will be permitted only between 8:00 A.M. and 9:00 P.M. Repetitive impact noises in the receiving property will not exceed the following dB limitations:

<u>TIME DURATION OF IMPACT NOISE</u>	<u>RESIDENTIALLY ZONED</u>	<u>COMMERCIALLY OR INDUSTRIALLY ZONED</u>
More than 12 minutes in any hour	70	77
Less than 30 seconds of any hour	85	92
Less than three minutes of any hour	80	87
Less than 12 minutes of any hour	75	82

In underground or tunnel construction work, where the above requirements may not be obtained, individual auditory protection shall be provided.

2. Noise restrictions at affected property: In addition to the provisions of Paragraph 1., sound level for noise due to construction activities will be monitored at the property line of property affected acoustically by the Design-Builder's operations and plant. Sound levels for noise from equipment shall be measured at the property line on the A weighting network of a General Purpose sound level meter at slow response. To minimize the effect of reflective sound waves at buildings, measurements may be taken three to six feet in front of any building face.
 - a. Construction equipment: Sound levels for unscheduled, intermittent, short-term noise from equipment shall not exceed the following dBA levels:

RESIDENTIAL PROPERTY

Daily, 7:00 AM to 9:00 PM	75
Daily, 9:00 PM to 10:00 PM	55
Daily, 10:00 PM to 7:00 AM	50

BUSINESS, COMMERCIAL
AND INDUSTRIAL PROPERTY:

Daily, including Sundays and Legal Holidays, 7:00 AM to 9:00 PM	82
Daily, including Sundays and Legal Holidays, 9:00 PM to 7:00 AM	62

- b. Mobile equipment in the public right-of-way: Truck or other powered equipment which moves off the construction site in the public right-of-way and that produces a maximum sound level exceeding the following limits when moving in the public right-of-way shall not be used on this Contract. The sound level limits specified are referenced to a distance of 50 feet from the equipment. Sound levels shall be measured in substantial conformity with the Standards and Recommended Practices established by the Society of Automotive Engineers, Inc., including the latest revisions to SAE J366b and SAE J952b.

- (1) Mobile construction and industrial machinery as defined in Paragraph (c)[1] below:

SOUND LEVEL
LIMITS

Manufactured before July 1, 1975	90 dBA
Manufactured after July 1, 1975	80 dBA
Manufactured after July 1, 1982	77 dBA

- (2) Trucks:

SOUND LEVEL
LIMITS

Manufactured before July 1, 1975	88 dBA
Manufactured after July 1, 1975	83 dBA
Manufactured after July 1, 1982	80 dBA

- c. Noise abatement measures: The Design-Builder shall provide such equipment and sound-deadening devices and take such noise abatement measures that are necessary to comply with the requirements of this Contract, consisting of, but not limited to the following:
- (1) Shields or other physical barriers to restrict the transmission of noise.
 - (2) Soundproof housings or enclosures for noise-producing machinery.
 - (3) Efficient silencers on air intakes for equipment.
 - (4) Efficient intake and exhaust mufflers on internal combustion engines.
 - (5) Lining of hoppers and storage bins with sound-deadening material.
 - (6) Conducting truck loading, unloading and hauling operations so that noise is kept to a minimum.
 - (7) Routing of construction equipment and vehicles carrying spoil, concrete or other materials over streets that will cause the least disturbance to residents in the vicinity of the work. The Authority Representative shall be informed in writing in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES of the proposed haul routes prior to the Design-Builder's securing a permit from the local government.
 - (8) Siting of stationary equipment shall be subject to approval in accordance with SECTION 01520 CONSTRUCTION FACILITIES.
3. Definitions: The following definitions will be used in differentiating mobile equipment from stationary equipment:
- a. Mobile construction equipment: Any automotive vehicle powered by an internal combustion engine or electric drive which is capable of being operated as a vehicle either on the construction site or in the public right-of-way. Under the Maryland Transportation Act, a vehicle means any device, in, on, or by which any individual or property is or might be transported or towed on a highway.
 - (1) Construction equipment is mobile equipment any time it is operated in an automotive mode when performing construction tasks. Such equipment includes compactors, paving machines, front-end loaders, back hoes, scrapers, pavers, ditchers, and trucks.

(2) Some construction equipment while in transit may have the characteristic of mobile equipment, but for the purposes of this definition are not to be so considered. Such equipment includes generators, power shovels, cranes, pile drivers, drilling rigs, concrete mixers, pumps, trash compactors, bar benders, and other similar truck-mounted devices.

b. Stationary construction equipment: Any device tool, or other mechanical system powered by an internal combustion engine, pneumatic engine, or electric motor which does not employ any of the above power sources for automotive propulsion for more than ten minutes out of every working hour while engaged in construction tasks. Examples of such equipment include truck-mounted compressors, generators, power shovels, pile drivers, cranes, drilling rigs, concrete mixers, pumps, trash compactors, bar benders, augers, and other similar truck-mounted devices.

1.04 CONSTRUCTION VIBRATION CONTROL

The Design-Builder shall not cause or permit, beyond the property line of a source, vibration of sufficient intensity to cause another person to be aware of the vibration by such direct means as sensation of touch or visual observation of moving objects. The observer shall be located at or within the property line of the receiving property when vibration determinations are made. Prepare and submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, a plan indicating monitoring locations, including the timing of monitoring measurements to be taken at the construction site boundaries and at nearby residential, commercial and industrial property lines.

1.05 HISTORICAL AND SCIENTIFIC SPECIMENS

Articles of historical or scientific value, including, but not limited to, coins, fossils and articles of antiquity which may be uncovered by the Design-Builder during the progress of the work shall become the property of the Authority. Work in the area where discovered shall cease and such findings shall be reported immediately to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES who will determine the method of removal, where necessary, and the final disposition thereof.

1.06 EXPLOSIVES

A. The use of explosives for the performance of Contract work will not be permitted.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

SECTION 01180

PROJECT UTILITY SOURCES

PART 1 GENERAL

1.01 SUMMARY

This Section specifies the Design-Builder's responsibilities regarding site utilities including its interface with utility companies and agencies.

1.02 RELATED DOCUMENTS

Section 00739, General Conditions - Protection of Existing Vegetation, Structures, Utilities and Improvements

Section 01111, General Requirements - Summary of Work Requirements: Key Design-Builder Functions

Section 01112, General Requirements - Summary of Work Requirements: Design Requirements and Program Criteria

Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures

1.03 UTILITIES AND AGENCIES

The Design-Builder is responsible for coordination, treatment and design of all utilities or properties owned or controlled by utilities or agencies. An active effort must be made by the Design-Builder as early in the design as possible to coordinate with all affected utilities and agencies to determine their current standards. The Design-Builder shall generate a new drawing(s) reflecting the latest standards and code requirements.

1.04 SUBMITTALS

A. The Design-Builder shall submit sets of Drawings and Specifications to those Utilities and Agencies affected by the design as required by the following paragraphs:

1. Drawings, standards and specifications, which have been previously coordinated with the Authority and with private and public utility companies and Agencies, shall be submitted for utility and Agency formal approval subsequent to the incorporation by the Design-Builder of the Utility and Agency review comments and of the Authority's review comments as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. Six paper copies and one electronic copy of the Drawing set and/or Specifications resubmission required to obtain this formal approval shall be provided to the Authority when request is made for final approval by the Utility and Agency.
2. All transmittals and requests to Agencies and Utilities for approvals, reimbursable estimates and other data shall indicate the submittal stage. The Design-Builder shall provide the Authority with six paper copies and one electronic copy of all transmittal letters and other communications and replies thereto as each is sent to or received from a Utility or Agency as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
3. The Utilities and Agencies noted below shall be provided with the following number of copies of review submittals:

- a. (6) copies of each of the composite utility plans,
 - b. (6) copies of each of the appropriate individual utility plans and profiles (including interior potable water, sanitary sewer and mechanical plumbing plans for WSSC),
 - c. (6) copies of all pertinent sections of the specifications,
 - d. (6) copies of index sheets, key plans and general information drawings as appropriate. Key (location) plans for each discipline will not be developed, three or four key plans covering several disciplines each shall be prepared.
4. The Utilities and Agencies listed hereinafter may not be inclusive, and the Design-Builder shall recommend any additional agencies/utility companies as appropriate. The Design-Builder shall determine all affected utilities including but not limited to the following agencies or their successor agencies as general guidelines:
- a. Verizon (D.C., Md.)
 - b. Western Union Telegraph Company (D.C. Relocation of Telegraph Lines).
 - c. Washington Gas (D.C. Relocation of Gas Lines; Md.).
 - d. Baltimore Gas and Electric (Md. ROW).
 - e. PEPCO (D.C. Relocation of Electric Lines, ROW, Permanent Connections to System; Md. Permanent Connections to System;).
 - f. NOT USED
 - g. WSSC (Montgomery Co. & Prince George's Co.).
 - h. District of Columbia Water and Sewer Authority (D.C.).
 - i. Comcast (Prince George's Co.).
 - j. NOT USED
 - k. District Cablevision (D.C.).
 - l. Montgomery Cable TV (Montgomery Co. Relocation of Cable Lines).
 - m. Metrovision of Prince George's County (Prince George's Co.).
 - n. Plantation Pipeline Company (D.C., Md. ROW).
 - o. Transcontinental Gas Pipeline Corp. (Montgomery Co. Relocation of Lines around WMATA ROW)
 - p. NOT USED
 - q. Williams Telecommunications Group.
 - r. U.S. Sprint Communications Company.
 - s. American Telephone & Telegraph Co. (D.C.; Md.; Va. Relocation of Phone Lines).

- t. MCI Communications.
 - u. Columbia Gas Transmission Corp.
 - v. Lightnet (Prince George's Co. Relocation of Cable Lines).
 - w. U.S. Army Engineer District (D.C.).
 - x. NOT USED
 - y. Police Alarm and Call Boxes.
 - z. Any other identified utility owner (cable, fuel lines, etc.) whose facility will be affected by the construction.
5. Confirmation of approval by the affected Utility or Agency of the treatment, design and standards must accompany the submittal to the Authority of the Final Design Drawings and Final Design Specifications as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

PART 2 PRODUCTS

2.01 APPROVED PRODUCTS

All products to be utilized on any utility shall be as approved by that utility.

PART 3 EXECUTION

3.01 DESIGN, CONSTRUCTION AND MAINTENANCE OF UTILITY FACILITIES

- A. All work performed by the Design-Builder on any utility, if any, shall be performed in accordance with the requirements of that utility and the full knowledge of the Authority Representative.
- B. Indicate in the Design Drawings where utilities will perform design, construction and maintenance of their facilities in relation to this Contract. Provide the engineering design as specified for facilities owned by utilities including service connections, facility modifications and relocations as applicable.
- C. Provide the Utilities with detailed Shop Drawings for utility connections and special facilities during construction.

END OF SECTION

THIS PAGE NOT USED

SECTION 01250

CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

This Section specifies procedures for making clarifications and proposals for change, and changes to the contract.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions
Section 00800, Supplementary Conditions
Division 01, General Requirements

1.03 GENERAL

- A. Specific approval must be received from the Authority prior to doing any work which may be considered to be a change to the Contract and for which an equitable adjustment may be requested under Section 00753, CHANGES provisions of this Contract.
- B. Authority Request for Additional Work - NOT USED
- C. Should the Authority determine it to be in their best interest to delete portions of the work from the Contractor's scope, the Design-Builder will be requested to give a credit to the Authority, stating the amount of the equitable adjustment. The offer for the credit shall be documented and directed to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, who, upon approval at the appropriate level, will issue a contract modification.

1.04 TIME AND MATERIALS WORK FOR THE CONSTRUCTION EFFORT

- A. In the event equitable adjustment pursuant to Section 00753, CHANGES provisions of the Contract cannot be agreed to in a timely manner, the Authority reserves the right to order work on a time and materials basis as specified in Section 00755, ACCOUNTING AND RECORD KEEPING. When work is ordered under this Section and notwithstanding the provisions of other Sections, compensation for the work shall be determined as hereinafter provided and shall constitute the total compensation to be paid for the changes to the work. The methods, labor, materials and equipment used in the performance of such work shall be subject to the approval of the Authority.
- B. Work performed by or for the Design-Builder: labor, materials, services and equipment shall be furnished by the Design-Builder or by a subcontractor or by others on behalf of the Design-Builder. The Design-Builder will be paid therefor as hereinafter provided, except where agreement has been reached to pay in accordance with Section 1.04 C. below.
 - 1. Labor: The cost of labor used in performing the work, whether the employer is the Design-Builder, subcontractor, or other forces, will be the sum of the following:
 - a. The gross actual wages paid including income tax withholding but not including any employer payments to or on behalf of workmen for health and welfare, pension, vacation,

insurance, and similar purposes.

- b. To the actual gross wages, as defined in Section B.1.a above, will be applied a percentage based upon current applicable labor rates concerning payments made to or on behalf of workmen other than actual wages, which percentage shall constitute full compensation for all payments other than actual gross wages as defined in Section B.1.a above and subsistence and travel allowance as specified in Section B.1.c below. The Design-Builder shall compute a separate percentage for each craft or a composite percentage for all crafts, if so approved by the Authority. All computed percentages shall be submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES to the Authority Representative for approval within 30 days after start of construction work or as directed by the Authority Representative prior to any time and materials work being performed.
 - c. Subsistence and travel allowance paid to such workmen if required by collective bargaining agreements. The charges for labor shall include all classifications through foremen when engaged in the actual and direct performance of the work. They shall not include charges for such overhead personnel as assistant superintendents, superintendents, office personnel, timekeepers and maintenance mechanics.
2. Materials: The cost for materials required for the accomplishment of the work will be delivered cost to the purchaser without mark-up, whether Design-Builder, subcontractor or other forces, from the supplier thereof, except as the following are applicable:
- a. If a cash or trade discount by the actual supplier is offered or available to the purchaser, it shall be credited to the Authority notwithstanding the fact that such discount may not have been taken.
 - b. If materials are procured by the purchaser by any method which is not a direct purchase from and a direct billing by the actual supplier to such purchaser, the cost of such materials, including handling, shall be deemed to be the price to the actual supplier as determined by the Authority Representative.
 - c. If the materials are obtained from a supply or source owned wholly or in part by the purchaser, payment therefor will not exceed the price paid by the purchaser for similar materials furnished from said source on Contract items or the current wholesale price for such materials delivered to the job site, whichever price is lower.
 - d. The cost of such materials shall not exceed the lowest current wholesale price at which such materials are available in the quantities concerned, delivered to the job site, less any discount as provided in Section 1.04 B.2.a. above.
 - e. If the Design-Builder does not furnish in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES satisfactory evidence of the cost of such materials from the actual supplier thereof, the cost shall then be determined in accordance with Section 1.04 B.2.d. above.
 - f. The Design-Builder shall not be compensated for indirect costs and profit on Authority-furnished materials.
3. Equipment: The Design-Builder shall be paid for the use of equipment in accordance with the Contract. The Design-Builder shall furnish in accordance with Section 01330, DESIGN AND

CONSTRUCTION SUBMITTAL PROCEDURES all data which might assist the Authority in the establishment of such rates.

- a. Operators of equipment will be paid under Section 1.04 B.1. above.
 - b. Small tools (defined as equipment less than \$2,000 in acquisition costs) are computed at a maximum of five percent of direct base labor wages.
4. Subcontracts: The cost for subcontract work at any tier will be the actual cost to the Design-Builder/subcontractor for work performed by a subcontractor as computed in accordance with Sections 1.04 B.1. through 3. above. For the purposes of this article, subcontractor is defined as an individual, partnership, corporation, association, joint venture or any combination thereof, who contracts with the Design-Builder to perform work or labor or render service on or about the work. The term subcontractor shall not include those who supply materials only. When work paid for on a time and materials basis is performed by forces other than the Design-Builder's organization, the Design-Builder shall reach agreement with such other forces as to the distribution of the payment made by the Authority for such work and no additional payment therefor will be made by the Authority by reason of performance of the work by a subcontractor or by others.
5. To the totals, completed as indicated in Sections 1.04 B.1. through 4., shall be added field office overhead as follows:
- a. If the costs determined above do not exceed \$50,000 and the adjustment in time for Contract performance is ten days or less, the markup shall be computed in accordance with Section 1.05 below.
 - b. In all other cases, the most recent audited daily field office overhead rate will be used.
6. Home Office General and Administrative (G&A) costs will be determined using the most recent audited rate at the time the work was accomplished. A fixed rate of 3 percent will be used in the absence of an audited rate.
7. Profit will be negotiated as provided in Section 1.08 below.
8. A percentage for Design-Builder's bond, not to exceed one percent, may be added.
- C. Special items of work: If the Authority Representative and the Design-Builder, by agreement, determine that either: an item of time and materials work does not represent a significant portion of the total Contract price, or such item of work cannot be performed by the forces of the Design-Builder or the forces of any of its subcontractors, or it is not in accordance with the established practice of the industry involved to keep the records which the procedure outlined in Section 1.04 B. above would require, charges for such special time and materials work item may be made on the basis of invoices for such work without complete itemization of labor, materials and equipment rental costs. To such invoiced price, less a credit to the Authority for any cash or trade discount offered or available, whether or not such discount may have been taken, will be added a negotiated amount not to exceed five percent of the discounted price, in lieu of the negotiated lump sum not to exceed the percentages provided for in Section 1.04 B. above.
- D. Records: The Design-Builder shall maintain its separate records in such a manner as to provide a clear distinction between the direct costs of work paid for on a time and materials basis and the cost of other operations.

1. The Design-Builder shall prepare, and furnish to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, the original and six copies and one electronic copy of report sheets of each day's work paid for on a time and materials basis the day after such work was performed. The daily report sheet shall itemize the materials used, and shall cover the direct cost of labor and the charges for equipment rental, whether furnished by the Design-Builder, subcontractor or other forces, except for charges described in Section 1.04 C. above. The daily report sheet shall provide names or identifications and classifications of workmen, the hours worked, and also the size, type and identification number of equipment, and hours operated.
 2. Material charges shall be substantiated by valid copies of vendor's invoices. Such invoices shall be submitted with the daily report sheets, or if not available, they shall be submitted with subsequent daily report sheets in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. Should said vendor's invoices not be submitted within 60 days after the date of delivery of the material or 15 days after acceptance of the work, whichever comes first, the Authority reserves the right to establish the cost of such materials at the lowest current wholesale prices at which such materials are available in the quantities concerned delivered to the location of the work less any discounts provided in Section 1.04 B.2.a. above.
 3. Said daily report sheets shall be signed by the Design-Builder or its authorized agent.
 4. The Authority Representative will compare the Authority's records with the Design-Builder's daily report sheets, make any necessary adjustment, and compile the costs of work paid for on a time and materials basis on daily time and materials work report forms furnished by the Authority. When these daily reports are agreed upon and signed by both parties, they shall become the basis of payment for the work performed, but shall not preclude subsequent adjustment based on a later audit. The use of any specific Authority form, such as Form C-113, to segregate change order costs does not, in and of itself, invoke the provisions of this Section 1.04 or other provision of this Contract.
- E. Payment: Payment as provided in Section 1.04 B. and C. above shall constitute full compensation to the Design-Builder for performance of work paid for on a time and materials basis and no additional compensation will be allowed therefore.
- 1.05 EQUITABLE ADJUSTMENT FOR MINOR CONTRACT MODIFICATIONS FOR THE CONSTRUCTION EFFORT
- A. When the Authority and Design-Builder agree to an additive or deductive amount for a modification to this Contract made pursuant to this Contract when the fair and reasonable price in aggregate amount does not exceed \$50,000, and further agree to an adjustment in the time for Contract performance resulting from said modification which increases or decreases the completion date 10 or less calendar days, the equitable adjustment in Contract amount shall consist of the sum of the following:
1. Direct labor, material and equipment costs as agreed to by the Authority and Design-Builder (small tools, defined as equipment less than \$2,000 in acquisition costs, are included in equipment costs and computed at a maximum of five percent of direct base labor wages.)
 2. Job Office Overhead costs, the sum of which shall be limited to a maximum of 10 percent of direct labor costs, including fringe benefits, but excluding FICA, FUTA, and State

Unemployment Insurance (SUI); a maximum of 10 percent of direct material costs; a maximum of five percent of direct equipment costs (including small tools); and a maximum of five percent of subcontract costs.

3. Home Office General and Administrative (G&A) costs are computed using the most recent audited rate, or a fixed rate of three percent in the absence of an audited rate.
 4. Profit will be determined in accordance with the guidelines specified in Section 1.07 below.
- B. In using the above rates, the following shall apply:
1. Payroll Tax (FICA, FUTA & SUI) amounts are added immediately after direct and indirect costs are totaled.
 2. Subcontractors' indirect costs and profit shall be computed in the same manner as above.
 3. Indirect costs shall not be duplicated in direct costs.
 4. When the Contract time is increased, the change in Contract amount for direct and indirect costs computed by application of the above rates includes costs of impact and extended performance due to the time extension and no further consideration of costs arising from the specific modification and cited pending change orders (PCO's) will be given. The Design-Builder shall not receive both a percentage and a daily rate markup for job office overhead costs when a time extension to the Contract Performance Period is recognized.
 5. Bond costs will be allowed at actual cost without markup.
- C. Equipment Rates shall be determined from prior Authority audits. In the absence of audited rates for equipment owned or controlled by the Design-Builder, hourly rates shall be computed in the same fashion as described in 1.08 D.

1.06 COST OR PRICING DATA

- A. The Design-Builder shall submit to the Authority Representative, either actually or by specific identification in writing in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, the original and six copies and an electronic copy of cost or pricing data under the conditions described in this Paragraph and certify that, to the best of the Design-Builder's knowledge and belief, the cost or pricing data submitted is accurate, complete and current as of the date of execution, which date shall be as close as possible to the date of agreement on the negotiated price of the Contract modification. The cost or pricing data shall be submitted at the time the Design-Builder submits its proposal for the pricing of any modification to this Contract, whether or not cost or pricing data was required in connection with the initial pricing of the Contract, when the modification involves aggregate increases and/or decreases in costs plus applicable profits expected to exceed \$100,000, or less at the discretion of the Authority.
- B. The submittal of certified cost or pricing data shall not be required if the price is based on adequate price competition, established catalog or market prices of commercial items sold in substantial quantities to the general public, or prices set by law or regulation. The Design-Builder agrees that the terms "adequate price competition" and "established catalog or market prices of commercial items sold in substantial quantities to the general public" shall be determined by the Authority in accordance with the guidelines as set forth in Subpart 15.8 of the Federal Acquisition Regulations

(48 CFR 15.8).

- C. Cost or pricing data consists of all facts existing up to the time of agreement on price which prudent buyers and sellers would reasonably expect to have a significant effect on the price negotiations for the modification. The definition of cost or pricing data embraces more than historical accounting data; it also includes, where applicable, such factors as subcontractor, supplier and vendor quotations, nonrecurring costs, changes in construction methods, unit cost trends such as those associated with labor efficiency and any management decisions which could reasonably be expected to have a significant bearing on costs under the proposed modification and the Contract work. Cost or pricing data consists of all facts which can reasonably be expected to contribute to sound estimates of future costs as well as to the validity of costs already incurred. Cost or pricing data, being factual, is that type of information which can be verified. Because the certificate pertains to cost or pricing data, it does not make representations as to the accuracy of the Design-Builder's judgment on the estimated portion of future costs or projections. The certificate does however, apply to the data upon which the Design-Builder's judgment is based.

1.07 PAYMENT FOR USE OF EQUIPMENT

- A. The following methods of determination of equipment costs shall apply to all adjustments to Contract prices arising under the provisions of the Contract except for Section 00730, TERMINATION FOR CONVENIENCE OF THE AUTHORITY provisions thereunder.
- B. Allowable ownership and operating expense for construction plant and equipment in sound workable condition, owned by the Design-Builder, Joint Venture, Partnership, organizations under common control, and any equipment under lease purchase or sale-lease back agreements, will be paid for at hourly rates applicable to the performance period, published in the Rental Rate Blue Book for Construction Equipment (Blue Book) by PRIMEDIA Information, Inc., by applying the following formula: the Regular Hourly Rate shall be 75 percent of the sum of the monthly rate (area adjustment map not used) divided by 176 and the estimated operating cost per hour. Regular Hourly Rate shall be full compensation for equipment ownership and operating expenses and shall include the cost of fuel, oil, lubricants, supplies, spare parts, repairs and maintenance, major overhauls, mechanics and servicing labor, depreciation, storage, insurance, interest, taxes, record keeping and all incidentals. The cost of equipment operators is not included. For forward pricing, the Blue Book rates in effect at the time of negotiations shall apply. For retrospective pricing, the Blue Book rates in effect at the time the work was performed shall apply. Manufacturers ratings and manufacturer approved modifications shall be used to classify equipment for the determination of the Regular Hourly Rate.

The hourly rates are calculated as shown in the following example:

	Regular Hourly Rate	Multi-Shift Hourly Rate	Standby Hourly Rate
Monthly \$	\$6,070.00	\$6,070.00	\$6,070.00
Divided by	176	176	176
Monthly \$	\$34.49	\$34.49	\$34.49
Estimated	18.20	18.20	18.20
Subtotal	52.69	52.69	52.69
Rate	75%	75%	75%
Subtotal	39.52	39.52	39.52
Status	100%	60%	40%
Total Rate	\$39.52	\$23.71	\$15.81

1. For Design-Builder owned equipment as identified in Paragraph B., the first eight (8) hours, or fraction thereof, usage in any one day shall be paid for at the Regular Hourly Rate and any additional time in excess of eight (8) hours, shall be considered to be an additional shift, or fraction thereof, and shall be paid for at 60 percent of the Regular Hourly Rate. Standby time, if authorized by the Authority Representative, will be paid for at 40 percent of the Regular Hourly Rate. Standby time shall be limited to the regular eight hour shift and shall not exceed 40 hours in a week. Any usage time less than 30 minutes shall be considered to be one half hour.
2. For third party rented equipment the Authority will accept rental rates actually paid and substantiated by certified reproduced copies of invoices or bills. Such invoices or bills shall indicate the amount of operating expenses and/or operator wages and fringes, if any, included in the rental rate. In no case shall the bare rental rate per hour (operating expense, and/or operator wages and fringes not included) exceed the appropriate Regular Hourly Rate. Where required, the operating costs per hour will be agreed upon between the Design-Builder and the Authority using operating costs per hour from the Blue Book for the same or similar equipment.
3. When approved by the Authority Representative, use of equipment not listed in the Blue Book shall be permitted. An equitable hourly rate for such equipment shall be established by the Authority Representative based on Design-Builder furnished cost data and basic information concerning the equipment submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. Information required to determine rates includes, but is not limited to, manufacturer, year, size, model, serial number, capacity, and weight. This information shall be furnished to the Authority Representative prior to the use of the equipment. Authority shall be granted audit access to verify information related to or pursuant to this Section.
4. The Regular Hourly Rate does not include "move-in" and "move-out" costs.
5. These equipment rates shall apply to equipment in sound workable condition. The equipment shall be of approved size and capacity to provide normal output or production required for the work to be done. Equipment not meeting these requirements may be used only with the Authority Representative's approval and at agreed, reduced rates. Usage time or standby time will not be allowed while equipment is inoperative due to breakdown and such equipment shall be removed from the jobsite at the direction of the Authority Representative.

C. Items of equipment with an acquisition cost of \$2,000 or less shall be considered as small tools.

D. Equipment costs that are paid under the equipment use rate shall not be duplicated in the Design-Builder's other direct or indirect costs.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

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SECTION 01260

DISPUTES REVIEW BOARD PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

This Section is inserted into the Contract by mutual agreement of the parties, and specifies the processes relating to the use of a Disputes Review Board.

1.02 RELATED DOCUMENTS

Section 00732, General Conditions, Dispute Resolution
Section 00832, Supplementary Conditions, Disputes Review Board Requirements
Three-Party Agreement

1.03 FORMATION OF A BOARD

A Disputes Review Board (DRB) shall be established when the parties to this contract can not resolve disputes or issues by negotiations or mutual agreement. The DRB shall consist of one member selected by the Authority, one member selected by the Contractor, and a third member, who shall be the chairperson, selected by the first two members. The selection of qualified DRB members shall be made in accordance with the Authority's Disputes Review Board Rules and Procedures, as amended.

1.04 RULES AND PROCEDURES

- A. All DRB members shall have substantial experience with the type of work involved in this Contract and in the interpretation of construction contract documents. The goal in selecting the chairperson is to complement the experience of the first two members, thus furnishing technical as well as administrative expertise that will facilitate the DRB's operations.
- B. The specific qualifications and requirements for membership on the DRB shall be as follows:
1. The candidate member shall have commensurate formal/technical education and experience in one or more of the fields of construction, engineering, or architecture.
 2. Except for payment of services as a DRB member, excluding fee-based consulting services on other projects, or for roles identical or similar to DRB membership, [1] no voting DRB member shall have a) employment with, an ownership interest in, or existing business or financial relationship with, any party to the Contract including designers and other consultants; or b) a financial interest in the Contract; and [2] no voting member shall have been employed by any party to the contract within one year prior to award of the contract.
 3. No voting DRB member shall have been or be involved directly or indirectly, in the management or administration of the Contract, or have had any prior involvement with the

Contractor (or a company with a substantial role with the Contractor) or in the Washington Metropolitan Area Transit Authority's Rail Capital Construction Program of a nature that could compromise her/his ability to impartially review disputes.

4. During the term of membership on the DRB, no discussion of or agreement for employment after the Contract is completed shall occur or be made between any DRB member and any party to the Contract.
- C. Before their appointments are made, the first two DRB candidate members shall submit complete disclosure statements for review and acceptance by the Contracting Officer and the Contractor. Each statement shall include [a] resume of experience and education; [b] a detailed description of all past, present, and planned future relationship(s) to the Authority's Rail Capital Construction Program or with any party involved in the Contract, including any fee-based consulting services on any other projects; and [c] certification that the prospective member meets the qualifications set forth above. The chairperson shall supply such a disclosure statement to the first two DRB members and to the Contracting Officer and the Contractor before his/her appointment as chairperson is approved and finalized.

1.05 SELECTION OF MEMBERS

- A. WHEREAS, the BOARD is composed of three members. Each party selects one member, and these two members select the third member who is designated as the "Chairman" of the DRB.
- B. The third member of the DRB shall be an impartial and qualified chairperson who shall be selected and mutually agreed upon by the first two members within 15 calendar days after the first two members' appointments are finalized. If the two designated DRB members cannot agree on a chairperson within the 15-day period, the chairperson shall be selected within 10 calendar days thereafter by mutual agreement of the Contracting Officer and the Contractor.
- C. The Contracting Officer and the Contractor shall negotiate with each of the three members of the DRB on the terms and conditions of salary and reimbursable costs for travel, conference facilities, clerical services, mailings, and copying. All costs are to be initially borne by the Design-Builder for payment purposes. The Authority will pay the Contractor for 50 percent of the incurred cost of the DRB up to the allowance specified in the Contract Modification (to be issued). If the agreed cost exceeds the allowance specified on the Contract Modification, the Authority will reimburse the Contractor 50% of the cost over the Contract Modification amount.

Fees for each member of the DRB shall be commercially reasonable and shall be no greater than the fees charged to the DRB member's most favored customer for similar work. Billing procedures and the fees for travel, per diem and reimbursable items shall be prudent and consistent with practices given most favored customers.

- D. Each voting DRB member shall be appointed for the life of the Contract. Forty-five calendar days prior to the yearly anniversary of the appointment of the chairperson, the Contracting Officer and the Contractor shall review the performance of the DRB, individually and as a group. Either the Contracting Officer or the Contractor may elect to replace any voting member of the DRB, except that in the case of the chairperson, both the Contracting Officer and the Contractor must agree

on replacement. Action to appoint a replacement must start immediately and follow the same procedure as for initial appointment, except that the appointment must be made prior to the yearly anniversary date of the appointment of the chairperson.

- E. If an election by either party to replace a member is not made in a timely manner, the DRB shall continue for another 12-month period before any replacement is made. If a member of the DRB cannot continue or voluntarily seeks to leave the DRB, the new member shall be appointed in the same manner in which the original appointment had been made.
- F. Any DRB member to be replaced shall, in conjunction with the remaining DRB members, complete consideration of any dispute pending before the DRB at the time the decision to replace is made. The DRB shall make appropriate rules to handle such disputes during the transition period. In the case of an incapacitated member, or of a member who voluntarily leaves the DRB, all disputes will be put in abeyance until the replacement DRB member has been appointed.

1.06 OPERATION OF THE BOARD

- A. The DRB shall formulate its own rules of operation which shall be provided in writing to the Authority Representative and the Contractor. The entire process may be kept flexible and any portion of the process may be changed to adapt to individual circumstances presented by a particular dispute. The DRB may initiate on its own or in consultation with the Authority Representative and the Contractor new rules or modifications to existing rules, whenever the DRB deems it appropriate.
- B. The DRB members shall keep abreast of industry developments and the progress of the work. The Authority Representative and the Contractor shall copy the DRB on periodic progress reports that have been jointly signed by the Authority Representative and the Contractor or special written progress reports no less often than once a month.
- C. The DRB members may, at their discretion, visit the job site as often as it deems necessary.

1.07 HEARING PROCEDURES

- A. DRB hearings shall be conducted at the jobsite, the Authority offices, or in the Washington Metropolitan Area.
- B. The DRB may request the Authority Representative and the Contractor to produce documents and/or exchange documents prior to any hearing. The DRB may also request the Authority Representative and the Contractor to produce documents and/ or witnesses at a hearing. Either party's failure to comply with the DRB's request may be taken into consideration by the DRB in reaching a decision.
- C. The DRB has the authority to conduct hearings and reach decisions in the manner the DRB deems most appropriate. The DRB has the authority to impose appropriate rules and procedures for the conduct of its hearings. However, such rules and procedures should be informal and, except for the conduct of an orderly hearing, should not exclude any member from the Authority's or Contractor teams.

- D. The DRB chairperson shall be responsible for directing the course of the hearings. The DRB shall follow its own rules of presentation and shall not be bound by the judicial rules of evidence. Documents and testimony concerning the dispute shall be presented in the order, manner, and degree of detail the DRB deems most efficient and probative. Each party shall be allowed to make a brief initial presentation and to rebut any factual assertion by another party until the DRB determines that all aspects of the dispute have been covered adequately. The DRB may limit the presentation of any documents or testimony the DRB deems not relevant or redundant. In rare circumstances the DRB chairperson may require that the testimony of certain or all individuals be given under oath. The DRB chairperson shall administer the oath.

1.08 FINDINGS AND RECOMMENDATIONS

- A. The DRB shall meet in private at the conclusion of the dispute hearing. All deliberations by the DRB shall be kept confidential except for the findings and recommendations. The DRB shall make a concerted effort to reach a unanimous decision. The DRB shall base its findings and recommendations on the Contract provisions and documents, law, statutes and regulations deemed by the DRB to be applicable, considering all facts and circumstances of the dispute. The DRB's findings and recommendations are to be set forth in the following format:

DISPUTES REVIEW BOARD FINDINGS AND RECOMMENDATIONS

I. INTRODUCTION

This Article shall contain the following information:

- Name, Number, and Notice-to-Proceed Date of Contract
- Dispute Title and Specific Number
- Dispute Hearing Conclusion Date and Location
- Attachment Number(s) or Exhibits, if any
- General Scope of the Contract
- General Contract Background information, as appropriate to facilitate the parties' understanding

II. STATEMENT OF DISPUTE

This Article shall include a description of the dispute(s) presented by claimant and/or counter-claimant. It should set forth each element of the relief requested (e.g., adjustment to Contract time and/or price) and the basis of each claim and difference advanced by the parties. In general this Article should be a brief summation of the dispute, and the basis for bringing forward the dispute and the basis on which the initial claim was denied.

III. FINDINGS AND ANALYSIS

This Article shall include the DRB's findings on (a) each element of the entitlement constituting an adjustment in Contract price, (b) each element of time constituting an adjustment in Contract time, and (c) each element of any other relief requested by the parties. This Article shall provide the analysis of and justification for the following Article IV,

RECOMMENDATIONS, and shall include references to all contractual, statutory or other applicable authority supporting the DRB's findings. This Article shall also address the DRB's conclusion as to the relative merits of each parties' position. Nothing in the foregoing shall be construed as the DRB being expected to produce a legal brief or detailed estimate of cost and time. However, this Article shall be detailed enough to provide both parties with sufficient information to act on the DRB's recommendation(s) contained in the following Article IV.

IV. RECOMMENDATION(S)

This Article shall contain the DRB's specific recommendation(s) for resolution of the dispute. The recommendation(s) shall be consistent with the findings and analysis in Article III, FINDINGS AND ANALYSIS.

V. DISSENTING OPINION

This Article shall contain any dissent to the findings and recommendations, in whole or in part. The dissenter shall be identified. Any dissent shall explain the dissenting member's reasons for disagreeing with the findings and recommendations, in whole or in part, made by the majority of the DRB.

- B. Within 60 calendar days after the close of the hearing, the DRB shall issue draft findings and recommendations, to the Authority and the Contractor. Within 14 calendar days after receipt of the draft findings and recommendations each party shall independently notify the DRB in writing of any calculation or other errors or omissions in the draft. Within 14 calendar days after receipt of the parties' responses to the draft, the DRB shall forward its final findings and recommendations to the Authority and the Contractor simultaneously.

1.09 ADMINISTRATIVE CLOSING

Either party may reject the recommendation(s) of the DRB issued pursuant to Article 1.08 of this Section all or in part in the resolution of a dispute or disputes. If the Contractor rejects the DRB recommendation, the Contractor shall request a final decision of the Contracting Officer pursuant to General Provisions Article 11, DISPUTES. The request for a final decision shall be accompanied by a full explanation as to basis for the rejection of the DRB recommendation(s). In the event of a rejection by the Authority, the Contracting Officer shall support the basis of the rejection by findings of fact which shall provide a full explanation for the basis of rejection, subject only to appeal as provided by General Provisions Article 11, Disputes.

END OF SECTION

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SECTION 01290

PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

This Section specifies procedures for submitting applications for payment.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions
Section 00800, Supplementary Conditions
Division 01, General Requirements

1.03 DETERMINATION OF PROGRESS

- A. Independent of progress payments pursuant to payment provisions of the Contract in Section 00749, METHOD OF PAYMENT, progress schedules prepared under the requirements of the Contract in Section 01322, CONTRACT PROGRESS REPORTING, shall provide as schedules progress for only 50 percent of the estimated invoiced cost of materials or equipment delivered to the site but not incorporated in the work as of the time of the scheduled delivery thereof.
- B. In determining progress accomplished, the Authority will allow as an element of work accomplished, i.e., progress toward completion, only 50 percent of the invoiced cost of materials or equipment delivered to the site but not incorporated in the construction up to the time the materials or equipment are actually incorporated in the work.

1.04 BASIS OF PAYMENT

The basis of payment will be the Total Base Proposal Price, and including, if applicable, any Options exercised, which shall constitute complete compensation for performance of all work required by the Contract.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION

3.01 PROGRESS PAYMENT PROCEDURES

- A. The mutually agreed to Progress Report as specified in Section 01322, CONTRACT PROGRESS REPORTING shall be the basis for progress payments to the Design-Builder.
- B. The Design-Builder shall submit the original and necessary paper copies as directed and an electronic copy of the approved final monthly update of the Initial 90-Day Schedule or the Monthly Progress Report as specified in Section 01322, CONTRACT PROGRESS REPORTING and of the approved QA/QC Manager's Statement of Compliance Quality Certification for Payment Verification stating that the Quality System has effectively ensured that the items requested for payment have been designed or constructed to meet the design requirements, or have been inspected and tested as required to comply with Contract requirements including those of the Quality Management System as specified in Section 01470, QUALITY SYSTEM and Section 01113, SYSTEMS INTEGRATION, reflecting the outcome of the Preliminary and Formal Progress Status Report Review Meetings as specified in Section 01312, PROGRESS MEETINGS, along with the Monthly Progress Payment Schedule within seven calendar days after the last day of the Design-Builder's last pay period of the month. Upon receipt of the Monthly Progress Status Report, the Authority will approve the processing of the Monthly Progress Payment.

- C. The approved final monthly update of the Initial 90-Day Schedule or the Monthly Progress Report and Quality Certification shall include the following:
1. The Monthly Design Progress Report or CPM Status Progress Report specified in Section 01322, CONTRACT PROGRESS REPORTING as applicable.
 2. QA/QC Manager's Statement of Compliance Quality Certification for Payment Verification as specified in Section 01470, QUALITY SYSTEM.
- D. The supporting narrative shall include the following:
1. A description of activities in progress as of the data date with originally scheduled start dates, actual start dates, percent complete, and projected completion dates noted for each activity.
 2. A description of activities completed during the report period with the originally scheduled and actual start dates and the scheduled and actual completion dates noted for each activity.
 3. A description of activities planned to start during the next report period with the originally scheduled and planned start dates for each activity noted.
 4. A discussion of activities which are behind schedule including the reasons for the delay and the corrective actions planned or implemented to get back on schedule.
 5. A list of approved revisions to the approved Schedules with the reason for each revision/change noted.
 6. The status of the Contract Milestone Dates.
 7. A listing of Actual or Potential Problems, their causes, and impact on any critical path/activity, and proposed solutions.
- E. When so directed, the Design-Builder shall revise/change the approved Monthly Progress Report(s) to reflect changes in the Design-Builder's planned sequence of work or to reflect scope of work, and or time changes included in any Contract modification(s). All such revisions/changes will be shown only after approval by the Contracting Officer.
1. If it becomes apparent that minor logic changes and or activity additions to the approved Monthly Progress Reports could be advantageous to one or both parties, the Design-Builder may propose such changes and/or additions. If the Authority approves, the Design-Builder shall submit a revision/change to the Monthly Progress Reports in the same form and format as the originally approved Monthly Progress Reports, including a narrative explanation of the changes/revisions, and a tabulation of estimated monthly and cumulative earnings to completion of the Contract.
 2. If the Design-Builder's Monthly Progress Report does not, based on the Authority's decision, accurately reflect the value and status of the work completed to date and is not in accordance with the Contract requirements, progress payment will not be made until a correct report has been submitted and approved.
- F. Final Payment Request shall be submitted in accordance with Section 00749, METHOD OF PAYMENT, Section 01770, CLOSEOUT PROCEDURES and Section 01780, CLOSEOUT SUBMITTALS.

END OF SECTION

SECTION 01310

PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies general administrative, procedural and coordination requirements for the project including:

1. Updated Comprehensive Project Management Plan
2. General Project Coordination Procedures
3. Coordination Drawings
4. Project Interface Management
5. Administrative and Supervisory Personnel
6. Correspondence

1.02 RELATED DOCUMENTS

Section 00204, Instructions to Proposers - Proposal Format, Procedures and Evaluation Factors, and Instructions;

Section 00321, Information Available to Proposers - Geotechnical Information

Section 00371, WMATA Construction Safety and Environmental Manual Requirements

Section 00381, Safety and Security Certification Program Plan Requirements

Section 00391, System Safety Program Plan Requirements

Section 00491, Proposal Forms and Supplements - Technical Proposal As Finally Accepted;

Section 00700, General Conditions;

Section 00800, Supplementary Conditions;

Section 01110, General Requirements - Summary of Work Requirements: Summary of Work;

Section 01111, General Requirements - Summary of Work Requirements: Key Design-Builder Functions;

Section 01112, General Requirements - Summary of Work Requirements: Design Requirements and Program Criteria;

Section 01113, General Requirements - Summary of Work Requirements: Systems Integration;

Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements;

Section 01250, General Requirements - Price and Payment Procedures: Contract Modification Procedures;

Section 01260, General Requirements - Price and Payment Procedures: Disputes Review Board if applicable;

Section 01290, General Requirements - Price and Payment Procedures: Payment Procedures;

Section 01312, General Requirements - Administrative Requirements: Project Meetings;

Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures;

Section 01410, General Requirements - Quality Requirements: Regulatory Requirements;

Section 01420, General Requirements - Quality Requirements: References;

Section 01470, General Requirements - Quality Requirements: Quality System;

Section 01520, General Requirements - Temporary Facilities and Controls: Temporary Construction Facilities.

Section 01780, General Requirements - Execution Requirements: Closeout Submittals.

Safety Rules and Procedures Manual

Metro rail Safety Rules and Procedures Handbook

1.03 PROJECT MANAGEMENT PLAN

The Design-Builder shall prepare a Comprehensive Updated Project Management Plan (PMP) that describes its approach to the Design, Construction and Systems Installation and Integration work. The updated PMP shall follow the outline submitted with its Technical Proposal as specified in Section 00204 and as finally accepted in Section 00491, which corresponds to revision 0 of the PMP, and expand the information contained in that Initial PMP. The updated PMP shall include the addition of appropriate charts, narratives, Plans and other requested information to describe the organization, relationships and responsibilities of project management. The original, six paper copies and one electronic copy of the Updated PMP shall be submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, 10 calendar days after Award. Some of the components of the comprehensive PMP are more fully described in Section 00321, GEOTECHNICAL INFORMATION, Section 00701, DEFINITIONS, Section 00707, PERMITS AND RESPONSIBILITIES, Section 00708, RESPONSIBILITY OF THE DESIGN-BUILDER FOR DESIGN-RELATED SERVICES, Section 00722, QUALITY CONTROL/QUALITY ASSURANCE, Section 00744, PROTECTION OF PERSONS AND PROPERTY, Section 00753, CHANGES, Section 00844, SAFETY SUPERINTENDENCE REQUIREMENTS, Section 01110, SUMMARY OF WORK, SECTION 01111, KEY DESIGN-BUILDER FUNCTIONS, Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION, Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS, Section 01250, CONTRACT MODIFICATION PROCEDURES, Section 01260, DISPUTES REVIEW BOARD if applicable, Section 01290, PAYMENT PROCEDURES, Section 01410, REGULATORY REQUIREMENTS, Section 01420 REFERENCES, Section 01470, QUALITY SYSTEM,

and Section 01520, TEMPORARY CONSTRUCTION FACILITIES. The PMP shall be revised for major changes in organization or approach to the work as necessary during the progress of the work and specifically for safety program plans as specified in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS and for quality management plans as specified in Section 01470, QUALITY SYSTEM.

- A. Updated Overview/Executive Summary: Provide a narrative detailed Overview of the Project Control and Management System to be utilized for this Project. Identify critical areas, method of problem resolution, lines of communications and responsibility. Detail the overall management strategy for accomplishing all aspects of the required work. The Design-Builder shall demonstrate understanding of the management techniques required for proper implementation and control of the work.
- B. Updated Organization: Provide a project organizational chart including a definition of the responsibilities shown therein. Show how this project management structure fits into the corporate management structure. Show the limits of authority and lines of authority of personnel to be assigned to the Contract. Include information regarding the positions they will fill and the percentage of time they are expected to devote to the work. In addition, identify who is responsible for project staffing, coordination with the Authority, jurisdictional inspectors/authorities and others, integrating design and construction aspects of the work, etc. Define who makes all major decisions pertaining to the overall project, including project staffing for design and construction management and who makes all day-to-day decisions. Identify who is the: Architect of Record, Structural Engineer of Record, Civil Engineer of Record, Electrical Engineer of Record, Mechanical Engineer of Record, and Systems Engineer of Record.
- C. Updated Project and Program Management and Control:
1. Subcontractor Management: Provide a narrative of procedures for coordinating, managing and controlling the work and the work of subcontractors: Identify who is responsible. Identify who reviews and approves subcontractor designs. Identify who reviews and approves subcontractor submittals. Identify who inspects and accepts subcontractor construction/installation work. Identify who reviews, verifies and approves subcontractor requests for equitable adjustment in subcontract price and period of performance. Identify who coordinates with the Authority, jurisdictional inspectors/authorities and others. Identify persons responsible for the procurement of construction materials and Systems equipment to be installed and for securing construction equipment to be utilized for the construction/installation, and include plans and procedures to ensure timely delivery of materials to achieve project schedule.
 2. Quality Management: Quality Control/Quality Assurance - provide a narrative description of the quality control/assurance organization for this Contract including numbers, qualifications, duties, responsibilities and authority of personnel, as well as, a description of the methods by which the applicable quality requirements of the Contract will be regulated, maintained and monitored. In addition, describe your proposed Quality Control/Quality Assurance (QC/QA) Plans and Quality Program, and the responsible component of each organization involved in this work. Indicate how interfaces between various quality control organizations will be accomplished to ensure compliance with the overall quality control requirements. Identify who monitors all design and construction work for compliance with QC/QA Plans and supervises the design and construction QC/QA Staff. Identify who approves submittals. Identify who performs inspections and documents material/equipment testing. Identify who is responsible for managing and implementing the QC/QA Plans and maintaining contact with the Authority's Representative for the purpose of providing up-to-date, accurate design and construction status with emphasis given to deviations from the Contract Documents. Refer to Section 00722, QUALITY CONTROL / QUALITY ASSURANCE and Section 01470, QUALITY SYSTEM for a

detailed description of required quality management plans including Quality Plan and Proposed Interim Inspection and Test Plans and other quality requirements.

3. **Systems Integration Management:** Identify who is responsible for preparing the Systems Integration Plans. Identify who oversees Systems integration and who is responsible for coordinating the work of the Systems trades. Refer to Section 01113, SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM for a detailed description of system integration management plans including Systems Inspection and Test Plans, Integrated System Test Plan and other Systems Integration requirements.
 4. **Safety Program Management:** Provide the following information regarding your proposed safety program management for this Contract: Narrative of the proposed project safety program that complies with the attachments to the Project Manual; i.e., the WMATA Construction Safety and Environmental Manual as specified in Section 00371, and the Safety and Security Certification Program Plan as specified in Section 00381 and the System Safety Program Plan as specified in Section 00391; and also with the System Safety Certification Program of the Safety Rules and Procedures Manual. Describe who is responsible for enforcement of the safety program. Refer to Section 01114, SAFETY AND ENVIRONMENTAL REQUIREMENTS and Section 00744, PROTECTION OF PERSONS AND PROPERTY for a detailed description of safety plans and requirements and Section 00844, SAFETY SUPERINTENDENCE REQUIREMENTS for a description of Safety Superintendence.
 5. **DBE Program Management if applicable:** Identify who is responsible for assuring that the DBE Program if applicable is in accordance with Authority policy as specified in Section 00453 and 49 CFR Part 23 and that the goals are being met. Refer to SECTION 00453, DBE DATA for a detailed description of DBE requirements and Section 00872 for percentage of DBE participation required, if applicable.
 6. **Design and Construction Management:** Provide description of the design and construction support and project engineering services for furnishing required drawings and other submittals. Identify persons responsible for preparing and approving design drawings, specifications, calculations, working drawings, shop drawings, operation and maintenance manuals, as-built drawings, as-built specifications, etc. Refer to SECTION 01111, KEY DESIGN-BUILDER FUNCTIONS, Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, and Section 01113, SYSTEMS INTEGRATION for a detailed description of Design and Construction Management requirements.
- D. **Temporary Facilities:** Identify who is responsible for janitorial services, trash and snow removal, recycling and equipment repair/maintenance for the Authority Representative's Site Facility and for maintenance of parking areas associated with the AR's Site Facility, temporary access roads and storage/laydown areas as specified in Section 01520, TEMPORARY CONSTRUCTION FACILITIES.
- E. **Contract Administration:** Identify who is responsible for the management of pending change and change orders and payment requests as specified in Section 00753, CHANGES, Section 01250, CONTRACT MODIFICATION PROCEDURES, Section 01260, DISPUTES REVIEW BOARD if applicable and Section 01290, PAYMENT PROCEDURES and of VECP's as specified in Section 00721, VALUE ENGINEERING INCENTIVE.
- F. **Permit and Regulatory Compliance:** Identify who coordinates with the Authority, jurisdictional authorities and others for obtaining permits, approvals, etc. from the entities specified in Section 01410, REGULATORY REQUIREMENTS and Section 01420 REFERENCES and the permits and approvals described in Sections 00321, 00701, 00707, 00708, 01110, 01111, and 01114.

1.04 COORDINATION

- A. Coordinate Design-Build activities included in various Sections of the Specifications to ensure efficient and orderly design and installation of each part of the Work. Coordinate planning, design and construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation. Coordination extends to and includes the interfaces between this and other contracts and existing facilities within the system.
- B. The Design-Builder shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each subcontractor shall coordinate its operations with other operations included in different Sections that depend on each other for proper installation, connection, and operation.
1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 2. Coordinate installation of different components with other subcontractors to ensure maximum accessibility for required maintenance, service, and repair.
 3. Make adequate provisions to accommodate items scheduled for later installation.
 4. All work under this Contract shall be performed generally in accordance with the construction sequence and staging and maintenance of traffic requirements shown on the approved detailed plans of the work following a logical sequence developed by the Design-Builder as specified in Section 01530, TEMPORARY CONSTRUCTION and in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.
 5. The Design-Builder shall conduct its work in a manner that will minimize interference with the operations of other contractors involved in the performance of related work.
 6. The Design-Builder's particular attention is directed to the fact that both vehicular traffic and pedestrian traffic must be continuously maintained and remain unimpeded at all times throughout the duration of the work at the site(s) as specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.
 7. A method of staging shall be developed that specifically complies with all requirements pertaining to the maintenance of both vehicular and pedestrian traffic onsite and the use of all approved working and storage/laydown areas. The staging plan shall incorporate and comply with all limitations imposed elsewhere in this Project Manual, and six paper copies and one electronic copy of the staging plan shall be submitted to the Authority Representative for approval, working drawings including comprehensive sequence and staging plans in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. No work shall be started prior to approval by the Authority as specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.
 8. The Design-Builder's particular attention is directed to the fact that both vehicular and pedestrian traffic must be maintained on the various existing streets within and adjacent to the project site at all times during the duration of the Contract. The Design-Builder is responsible for coordinating access to the site from the public roadways, including, but not limited to, the delivery of all materials by the Design-Builder to the site from public roads. All such use of

public roadways shall be coordinated with the jurisdictional authority(ies). The staging plan shall incorporate and comply with all limitations imposed elsewhere in this Project Manual, and shall be submitted to the Authority Representative for review, and shall also be submitted to the jurisdictional agency(ies) of the area(s) where the work is to be performed, for their (its) approval, working drawings including comprehensive sequence and staging plans in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. No work shall be started prior to approval by the jurisdictional agency(ies) as specified in Section 01530, TEMPORARY CONSTRUCTION and in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.

- C. As necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings. Prepare similar memoranda for Authority Representative and separate subcontractors if coordination of their Work is required.
- D. The Design-Builder shall coordinate its design and construction activities, through the Authority Representative, with governmental, public and private agencies and others. Such coordination shall include acquiring permits and approvals and attending conferences as may be authorized and required by the Authority. The Design-Builder shall prepare and submit to the Authority Representative within five working days, six paper copies and one electronic copy of a memorandum of record of all such conferences attended. The Design-Builder shall promptly bring to the attention of the Authority Representative, by written notice, any betterments or other work considered to be a change requested by private and public agencies and property owners that have not already been authorized by the Authority.
- E. Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other subcontractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Design-Builder's cost-loaded schedules and updates as described in Section 01322, CONTRACT PROGRESS REPORTING.
 - 2. Installation and removal of temporary facilities and controls as described in Section 01500.
 - 3. Delivery and processing of submittals as described in Sections 01330, 01780 and 01820 and elsewhere in this Project Manual.
 - 4. Meetings, as described in Section 01312, PROJECT MEETINGS.
 - 5. Safety, as described in Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS and Safety Management as described in Section 00844.
 - 6. Quality Management as described in Section 01470, QUALITY SYSTEM.
 - 7. Systems Integration as described in Section 01113.
 - 8. Project closeout activities as described in Section 01770, CLOSEOUT PROCEDURES and Section 01780, CLOSEOUT SUBMITTALS .

1.05 CORRESPONDENCE

- A. All correspondence shall be referenced to the Authority Contract number.

- B. Three copies of matters relating to the Contract, change proposals, billings and other matters shall be addressed and sent to the Authority Representative.
- C. Three copies of matters relating to the technical performance of the work and the schedule thereof shall be sent to the Design-Professional and the Authority Representative.
- D. Three copies of correspondence between the Design-Builder and third parties shall be sent to the Authority Representative.
- E. Copies of all correspondence are to be retained by the Design-Builder and forwarded to the Authority Representative as a complete correspondence file at the completion of the Contract as specified in Section 01780, CLOSEOUT SUBMITTALS.

1.06 SUBMITTALS

- A. Project Management Plan: As outlined elsewhere in this Section.
- B. Coordination Drawings / Composite Drawings: Prepare and submit the original and six copies and one electronic copy of Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities. Prepare and submit the original and six copies and one electronic copy of Composite Drawings, showing the work of all disciplines, where clearance, coordination, and conflicts among different disciplines may occur. The Coordination Drawings and/or Composite Drawings shall be submitted, in conjunction with the relevant submission to the Authority for use during its review and approval of submittals as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
 - 1. Indicate relationship of components shown on separate Shop Drawings.
 - 2. Indicate required installation sequences.
 - 3. Refer to Division 15 and Division 16 for specific coordination drawing requirements for mechanical, electrical and systems installations.
- C. Staff Names: Submit the original, six paper copies and one electronic copy of a list of principal staff assignments, including Superintendent and other personnel in attendance at Project site at least 30 calendar days prior to the start of any construction work. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

3.01 PERSONNEL

- A. Provide administrative and supervisory personnel as required for proper performance of the Work and additional special personnel required for coordination of operations with subcontractors as

needed. The Design-Builder shall provide personnel for the positions specifically identified by the Authority in this Contract as required Key Personnel (see Section 00204, PROPOSAL INSTRUCTIONS AND EVALUATION FACTORS) and in addition, any other personnel essential for performance of the work as identified by the Design-Builder (see the Design-Builder's TECHNICAL PROPOSAL AS FINALLY ACCEPTED, Section 00491), and for any other positions the Design-Builder deems necessary for the successful execution during performance of the Contract work. The Design-Builder shall confirm the Key Personnel in the verification submittal as specified in 01111, KEY DESIGN-BUILDER FUNCTIONS. Also see Section 00710, PROJECT MANAGEMENT, SUPERINTENDENCE AND KEY PERSONNEL and Section 01111, KEY DESIGN-BUILDER FUNCTIONS for responsibilities of Key Personnel.

- B. If any subcontractor or person employed by the Design-Builder appears to the Authority to be incompetent or careless or to act in a disorderly or improper manner, that person's services in connection with the work shall be immediately terminated upon request by the Authority Representative and that person shall not again be employed on the Work.

END OF SECTION

SECTION 01312
PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to:
1. Pre-Award Conference
 2. Pre-Design-Build Conference
 3. Design Review Meetings
 4. Pre-Activity Meetings
 5. Progress Meetings
 6. Progress Status Report Reviews
 7. Systems Integration Progress Meetings
 8. Change Meetings
- B. During the term of this Contract, the Design-Builder shall attend meetings and conferences with officials of the Authority, governmental agencies or others interested in the work as may be directed by the Authority Representative. A record of all such meetings or conferences shall be made by the Design-Builder who is responsible for preparing a memorandum stating the place and time of the meeting, the names and identification of those present, and a brief description of the matters discussed and the agreements reached. Comprehensive meeting minutes memoranda shall be prepared immediately after the meeting and original and six copies and one electronic copy shall be submitted within ten (10) calendar days to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

1.02 RELATED DOCUMENTS

Section 00200, Instructions for Procurement

Section 00700, General Conditions

Section 00800, Supplementary Conditions

Section 01111, General Requirements - Summary of Work Requirements: Key Design-Builder Functions

Section 01112, General Requirements - Summary of Work Requirements: Design Requirements and Program Criteria

Section 01113, General Requirements - Summary of Work Requirements: Systems Integration

Section 01290, General Requirements - Price and Payment Procedures: Payment Procedures

Section 01310, General Requirements - Administrative Requirements: Project Management and Coordination

Section 01322, General Requirements - Administrative Requirements: Contract Progress Reporting

Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures

Section 01470, General Requirements - Quality Requirements: Quality System

1.03 PRE-AWARD CONFERENCE

- A. The Authority requires that a pre-award conference with the successful proposer be held prior to the actual award of the Contract. The purpose of the meeting would be to review the successful proposer's understanding of the Contract Documents, contractual requirements prior to award, and the successful proposer's capabilities, financial standing, and past experience.
- B. The pre-award conference will be held in the Washington Metropolitan Area and shall be chaired by the Authority and attended by representatives of the Authority, the successful proposer, and its key personnel nominated for assignment to the Contract, the Design Professional, the Construction Firm, and including major subcontractors if so requested by the Authority. Concerned parties shall each be represented by persons thoroughly familiar with and authorized to conclude matters relating to the work described in the Contract Documents.
- C. Agenda discussion items for the meeting may include, but are not limited to, the following:
 - 1. Requirements for acceptability of payment and performance bonds.
 - 2. Requirements for DBE participation.
 - 3. Verification of qualifications of key individuals and subcontractors. The Design-Builder shall not substitute any key personnel and subcontractors identified in its Technical Proposal As Finally Accepted without the written approval of the Authority. The Design-Builder shall provide the Authority with any information as may be reasonably requested regarding any substitution and any proposed substitute will share similar or better qualities than the person or firm substituted for.
 - 4. Requirements for quality assurance/control.
 - 5. Percentage of construction work to be performed by Design-Builder's forces.
 - 6. Verification of successful proposer's experience with similar work, including previous Authority contracts, scheduling capabilities and financial standing.
 - 7. Understanding of work described in the Contract Documents and the physical constraints associated with the work.
- D. Representations and commitments made by the successful proposer or its subcontractors shall be construed as binding to the Contract.

1.04 PRE-DESIGN-BUILD CONFERENCE

- A. The Authority will schedule a pre-design-build conference and organizational meeting in the Washington Metropolitan Area with the Design-Builder ten calendar days after the issuance of the Notice of Award. The purpose of the meeting will be to review the parties' responsibilities and personnel assignments and to submit the required submittals to the Authority. The Authority will publish an agenda at least one week prior to the meeting.
- B. The pre-design-build conference shall be chaired by the Authority and attended by representatives of the Authority, the Design-Builder and its Key Personnel nominated for assignment to the Contract, including the Design Professional, the Construction Firm, and major subcontractors, manufacturers, suppliers and other concerned parties. Concerned parties shall each be represented by persons thoroughly familiar with and authorized to conclude matters relating to the Work described in the Contract Documents if so requested by the Authority.

- C. Agenda discussion items for the meeting may include, but are not limited to, the following:
1. DBE participation and certifications.
 2. Site security.
 3. Required Pre-Design-Build Conference Meeting Submittals: Updated Key Personnel, firms and subcontractors identifications and qualifications; Initial Project Management Plan; Overview/Executive Summary; Organizational Chart; Program Management and Control Plan including Interim Quality Management Plan, Interim Systems Integration Plan, Interim Health and Safety Plan, Interim Design and Construction Management Plan, Temporary Facilities Plan, Contract Administration Plan, and Permit and Regulatory Requirements Plan; Project Approach; Description of Compliance with Project Requirements; Executed Contract Agreement; Power of Attorney Form; Power of Execution Form; Performance Bond Form; Payment Bond Form; Insurance Certificates; and Preliminary Required Submittals List.
 - a. Designation of responsible personnel verification: The Design-Builder shall provide confirmation that the Key Personnel identified by the Authority in Section 00203 as applicable or Section 00204 and these and any other personnel and subcontractors essential for performance of the work as identified by the Design-Builder in its Final Proposal Revision (FPR) are assigned to the Work. The Design-Builder shall not substitute any key personnel and subcontractors identified without the written approval of the Authority. The Design-Builder shall provide the Authority with any information as may be reasonably requested regarding any substitution and any proposed substitute will share similar or better qualities than the person or firm substituted for.
 4. Work sequencing.
 5. Procedures for processing design decisions and approvals.
 6. Procedures for processing Applications for Payment.
 7. Authority Design Criteria and other Project Requirements including requirements for ADA Facilities Accessibility Checklist submittals and certification of ADAAG regulations compliance submittals during design process by the Design-Builder.
 8. Authority Construction Guidelines including requirements for certification of ADAAG regulations compliance submittal at completion of construction by the Design-Builder, and emphasizing the fact that project is subject to FTA audit for ADAAG compliance.
 9. Submittal of Shop Drawings, Working Drawings, Product Data, Samples, Certification, and Documentation.
 10. Preparation and submittal of Record Documents and Operations & Maintenance Manuals.
 11. Use of the premises.
 12. Office, Work and Storage areas.
 13. Equipment deliveries and priorities.
 14. Safety procedures and administration of the overall safety program.
 15. Quality Assurance and Quality Control Requirements.
 16. First aid.
 17. Housekeeping.
 18. Working hours.

19. Codes and permits.
 20. Other Required Submittals.
 21. Approvals required before construction proceeds.
 22. Mobilization plan.
 23. Equipment and manpower availability.
 24. Systems Integration plans.
- D. The Design-Builder shall record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from the meeting.

1.05 DESIGN REVIEW COMMENT MEETINGS

- A. The Authority will schedule a design review comment meeting in the Washington Metropolitan Area with the Design-Builder after receipt of preliminary, intermediate, pre-final and final levels of design as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Authority review and comment on these Design Specifications and Design Drawings. The purpose of these meetings will be to discuss and clarify the Authority's design review comments and the Design-Builder's written responses to the review comments.
- B. The design review comment meeting shall be chaired by the Authority and attended by representatives of the Authority, the Design-Builder and its Key Personnel assigned to the Contract, including the Design Professional and other concerned parties. Concerned parties shall each be represented by persons thoroughly familiar with and authorized to conclude matters relating to the Work described in the Design Specifications and Design Drawings if so requested by the Authority.
- C. The Design-Builder shall record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting. The Design-Builder shall initiate whatever actions are necessary to incorporate the agreed to required changes and additions into the Design Drawings and Design Specifications.

1.06 PRE-ACTIVITY MEETINGS

- A. The Design-Builder will conduct pre-activity meetings at the site prior to the start of construction activities that require special coordination or for those activities that are deemed to require a separate meeting because of the technical nature of the installation. The Key Personnel, subcontractors, representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with their materials and installations that have preceded or will follow and the Authority shall attend the meeting. The parties shall each be represented by persons thoroughly familiar with and authorized to conclude matters relating to the Work described in the approved Final Design Drawings and Final Design Specifications Issued for Construction.
- B. The Design-Builder shall inform the Authority in advance of the date, time, location and topics for review and discussion at each pre-activity meeting. The Design-Builder shall ensure that other attendees are properly notified. Topics that may require pre-activity meetings include, but are not limited to the following:
 1. Precast Concrete Installation as applicable,
 2. Systems Equipment Installation as applicable,
 3. Items that require connection to existing Authority equipment or systems as applicable,
 4. Other pre-installation meetings as may be called by the Design-Builder, or the Authority.

- C. Agenda discussion items for the meeting may include, but are not limited to, the following:
1. Approved Final Design Drawings and Final Design Specifications Issued for Construction.
 2. Options, if any.
 3. Purchases.
 4. Deliveries.
 5. Shop Drawings, Working Drawings, Product Data, Quality Control Samples, Certifications and Documentation.
 6. Possible conflicts.
 7. Compatibility problems.
 8. Time schedules.
 9. Weather limitations.
 10. Manufacturers' recommendations.
 11. Compatibility of materials.
 12. Temporary facilities.
 13. Space and access limitations.
 14. Governing regulations.
 15. Safety.
 16. Inspection and testing requirements.
 17. Required performance results.
 18. Recording requirements.
 19. Protection.
 20. QA/QC.
 21. ADAAG compliance.
- D. Work shall not proceed if the meeting cannot be successfully concluded. The Design-Builder shall initiate whatever actions are necessary to resolve impediments to performance of Work and schedule a follow-up meeting with the Authority at the earliest date.
- E. The Design-Builder shall record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.07 PROGRESS MEETINGS

- A. The Design-Builder shall conduct Progress meetings in the Washington Metropolitan Area weekly at regularly scheduled times convenient for all parties involved. Progress meetings are in addition to specific meetings held for other purposes, such as coordination and special pre-installation meetings. A two week work plan shall be developed by the Design-Builder prior to the start of the meeting as specified in Section 01322, CONTRACT PROGRESS REPORTING and will be discussed during the planning portion of the agenda. Additionally, discussions will address administrative and technical issues of concern, determining resolutions, and development of

deadlines for resolution within allowable time frames. The Authority Representative or designee shall attend all progress meetings.

- B. The Design-Builder shall determine, together with the Authority Representative, who should attend the meeting in addition to representatives of the Authority, the Design-Builder, and those subcontractors, suppliers, or other entities critical to the current progress or involved in planning, coordination or performance of future activities that are part of the Work. The parties shall each be represented by persons thoroughly familiar with and authorized to conclude matters relating to the work described in the approved Final Design Drawings and Final Design Specifications Issued for Construction.
- C. Agenda discussion items shall include, but are not limited to, review of minutes of the previous progress meeting prepared by the Design-Builder. The Design-Builder shall publish an agenda at least 10 calendar days prior to the meetings and submit to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL and will document issues of significance including submittals, schedules, quality control/assurance, safety, problems encountered, and the assignment of responsibilities for future action. Agenda items may include other items of significance that could affect progress such as:
1. Design-Builder's design and/or construction schedule.
 2. Interface requirements.
 3. Time.
 4. Sequences.
 5. Deliveries.
 6. Off-site fabrication problems.
 7. Access.
 8. Site utilization.
 9. Updated Submittals List and Submittals.
 10. Requests for Information.
 11. Non-Compliance Notices.
 12. Temporary facilities and services.
 13. Hours of Work.
 14. Resource allocation.
 15. Hazards and risks.
 16. Housekeeping.
 17. Quality and Work standards.
 18. Safety issues.
 19. Change Orders.
 20. Documentation of information for payment requests.
 21. ADAAG compliance.

- D. The Design-Builder shall record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.08 PROGRESS AND QUALITY STATUS REPORT REVIEWS

- A. The Initial 90-Day Schedule or the Monthly Progress Report, including Design Progress and Bar Graph or CPM Schedules and Cash Flow Curves as applicable, based on the phase of the work in progress, as specified in Section 01322, CONTRACT PROGRESS REPORTING, are to be updated on at least a monthly basis after the last day of the Design-Builder's last pay period for the month to ensure the incorporation of all approved changes made to the sequence of work and any change notices issued by the Authority. Job progress shall specifically include actual start and completion dates for all activities completed during the report period, actual start dates and percent complete for activities started but not completed during the report period, estimated start dates for activities scheduled to start during the next period, approved changes in durations of any activity, and separate tabulation of monthly earnings, including a cumulative tabulation of monthly earnings to date shall be provided. In computing the monthly earnings, no value will be allowed for partially completed activities. The Schedule may need to be supplemented with a narrative to explain unusual circumstances. Preliminary status report meetings will be held in the Washington Metropolitan Area prior to the submittal of the Design-Builder's final monthly update of the Initial 90-Day Schedule or the Monthly Progress Report. The purpose of the meetings is a review to determine the status of each activity in relation to the Design-Builder's draft monthly update of the Initial 90-Day Schedule or the Monthly Progress Report and any deficiencies based on the Quality System as specified in Section 01470, QUALITY SYSTEM, in order to develop an informal agreement on pay items. This meeting shall be attended by the Design-Builder's Design Professional and Construction Firm and the Authority Representative.
- B. The draft monthly update of the Initial 90-Day Schedule or the Monthly Progress Report shall again be updated to incorporate all changes agreed to during the Preliminary Status Report Meetings. A certification stating that the Quality System has effectively ensured that the items of work completed have been designed or constructed to meet the design requirements, and have been inspected and tested as required to comply with Contract requirements including those of the Quality Management System as specified in Section 01470, QUALITY SYSTEM shall be provided. Formal Status Report Meetings will be held in the Washington Metropolitan Area prior to the submittal of the Design-Builder's Application for Payment. The purpose of the meetings is to review and develop a formal joint agreement on the final monthly update of the Initial 90-Day Schedule or the Monthly Progress Report, job progress, pay items and quality certification. This meeting shall be attended by the Design-Builder's Design Professional and Construction Firm and the Authority Representative and shall be held five (5) working days after the Preliminary status report meeting.
- C. The Design-Builder shall submit the approved final monthly update of the Initial 90-Day Schedule or the Monthly Progress Report and the approved certificate stating that the Quality System has effectively ensured that the items requested for payment have been designed or constructed to meet the design requirements, or have been inspected and tested as required to comply with Contract requirements including those of the Quality Management System, reflecting the outcome of the Preliminary and Formal Progress Status Report Review Meetings, along with the Monthly Progress Payment Schedule as specified in Section 01290, PAYMENT PROCEDURES.

1.09 SYSTEMS INTEGRATION PROGRESS MEETINGS

- A. Systems Integration Progress Meetings shall be held by the Design-Builder monthly in the Washington Metropolitan Area starting 10 calendar days after receipt of the Design-Builder written responses to the Authority's design review comments on the 30% Systems Integration Design. The purpose of these meetings will be to clarify the comments, update WMATA personnel on the systems integration issues, resolve interface definitions or systems integration issues and exchange ideas and information. Meeting intervals can be revised by the Authority Representative, if he deems it appropriate.

- B. The agenda for the progress meetings shall be similar to the progress review meeting agenda and shall be built based upon the previous meetings issues. The Design-Builder shall publish an agenda at least one week prior to the meetings and shall provide comprehensive minutes of the meetings within 10 calendar days after such meeting.
- C. It is important that any and all interface problems are identified at the earliest possible opportunity. The Design-Builder shall provide a list of problem interfaces along with an assessment of the project impact and potential resolutions at each progress meeting.

1.10 CHANGE MEETINGS

- A. Separate meetings will be held in the Washington Metropolitan Area by either the Authority or the Design-Builder, on an ad hoc basis, to discuss and resolve change order issues as they arise during the course of design and construction.
- B. This meeting shall be attended by the Design-Builder, Authority Representative or designee, and those subcontractors, suppliers, or other entities critical to the resolution of any open issues. The parties shall each be represented by persons thoroughly familiar with and authorized to conclude matters relating to the work described in the initial Contract Documents and in the Final Design Specifications and Final Design Drawings Issued for Construction.
- C. The Design-Builder shall record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

SECTION 01321
CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.01 SUMMARY

This section describes the requirements for taking and submitting construction photographs.

1.02 RELATED DOCUMENTS

Section 01322, General Requirements - Administrative Requirements: Contract Progress Reporting
Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures
Divisions 2 through 16, Standard and Technical Specifications Requirements

1.03 PHOTOGRAPHS

After construction operations have started at the site, the Design-Builder shall have an average of ten color photographs taken each month until completion of the work. The actual number and location of views to be taken each month shall be as directed by the Authority Representative or designee.

PART 2 PRODUCTS

2.01 DELIVERABLES

- A. Digital Photographs shall be submitted to the Authority in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, in an electronic format on CD's. Digital photographic files shall be capable of producing standard commercial quality photographs, eight inches by ten inches in size. Each file shall consist of one page containing one photograph. Each page shall contain the following information arranged as shown:

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

Project: _____ Contract No.: _____
Design-Builder: _____
Photograph No. _____ Date: _____
Description: _____

- B. Submit photographs with the Monthly Report as described in Section 01322, CONTRACT PROGRESS REPORTING.

PART 3 EXECUTION [Not Applicable]

END OF SECTION

THIS PAGE NOT USED

SECTION 01322

CONTRACT PROGRESS REPORTING

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies the requirements for Monthly Progress Reports, and the development and maintaining of progress schedules and work plans for both the design and construction of the Project.
- B. The Design-Builder shall carefully monitor the progress of the Work during design and construction and provide the Authority with Monthly Progress Reports detailing the progress of that work.
- C. The approved schedules shall be used by the Design-Builder to ensure adequate planning, scheduling, management and execution of the work, and to enable the Authority to evaluate work progress and progress payments. These approved schedules shall not be revised without the prior approval or direction of the Authority Representative. Schedules shall include the following, as applicable: Initial 90-Day Schedule; Design Progress, or Cost-Loaded CPM Schedule as applicable; Monthly Updates of the Schedules; 90-Day Rolling Schedule; and Two-Week Work Plan.

1.02 RELATED DOCUMENTS

Section 00753, General Conditions: Changes
Section 00749, General Conditions: Method of Payment
Section 00788, General Conditions: Liquidated Damages
Section 01110, General Requirements - Summary of Work Requirements: Summary of Work
Section 01113, General Requirements - Summary of Work Requirements: Systems Integration
Section 01290, General Requirements - Price and Payment Procedures: Payment Procedures
Section 01312, General Requirements - Administrative Requirements: Project Meetings
Section 01321, General Requirements - Administrative Requirements: Construction Photographs
Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures
Section 01470, General Requirements - Quality Requirements: Quality System

1.03 GENERAL: MONTHLY PROGRESS REPORTS

- A. The Monthly Progress Reports shall include a narrative report, schedules information, and construction photographs as follows:
 - 1. A narrative description of work accomplished, work activities planned for the upcoming reporting period, problem areas and actions intended by the Design-Builder to mitigate the problem areas, work that is being performed out of sequence with accepted schedules, status of change orders, notices of potential claims, status of submittals, and status of Design-Builder procurement items.
 - 2. Schedules, including: the Initial 90-Day Schedule; the Design Progress; the Cost-Loaded CPM Schedule; the Monthly Update of the Schedules as appropriate; and a 90-day Rolling Schedule; and a Two-Week Work Plan as applicable. Schedules shall clearly identify the critical path(s).
 - 3. Cash flow curves indicating graphically the total percentage of Contract value and the total dollar value scheduled to be in place on early finish, late finish, and actual finish on a monthly and cumulative basis.

4. A complete list of scheduled submittal dates for each review submittal and design completion. Submittal dates for each phase of the design as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and for each phase of Systems integration as specified in Section 01113 SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM shall be listed.
 5. A summary of meetings or conferences held or attended during the report period as specified in Section 01312, PROJECT MEETINGS and elsewhere in the Contract Documents.
 6. A listing of actions or decisions required of the Authority or its Consultants with an indication of the date by which such action or decision is required to avoid any adverse impact on the design schedule.
 7. Utility/Agency coordination and approvals report. Include telephone conversation and dates of contact made with each agency/utility.
 8. Construction Photographs, as described in Section 01321, CONSTRUCTION PHOTOGRAPHS.
- B. The supporting narrative shall include the following:
1. A realistic approach to meeting the Contract completion date required by the Contract.
 2. A discussion of the critical path and the most critical activities in meeting the required completion dates.
 3. A listing of holidays and special non-working days planned during the Contract duration.
 4. A separate tabulation of estimated monthly and cumulative planned earnings. The monetary values shall be generally consistent with the proposal item breakdown.
- C. The Monthly Progress Report Request for Payment submittal is described in Section 01290, PAYMENT PROCEDURES.

1.04 UPDATED INITIAL NINETY-DAY SCHEDULE

- A. Revision 0 of the Initial 90-Day Schedule shall be submitted with the Technical and Cost Proposals. Any changes and additions shall be incorporated into the Initial 90-Day Schedule and submitted within 10 calendar days after Award. The 90-day schedule is the Design-Builder's plan for planning, managing, executing and for recording completed work during the first 90 days of the Project. All approved activities in the 90-day schedule shall be incorporated into the Schedule.
- B. The schedule shall be time-scaled and may be submitted in either bar chart or Critical Path Method (CPM) format. The schedule shall include the requirements listed in Part 1.05 F. below.
- C. Work items defined in the schedule shall not exceed 20 work days in duration.
- D. The submittal shall be accompanied by a written narrative that describes the schedule and the approach to the work that the Design-Builder intends to employ during the initial ninety-day period of the Contract.
- E. The 90-day schedule will be cost-loaded and will be used to process the progress payments for

the first three months following NTP until the Cost-Loaded CPM Schedule is approved.

1.05 UPDATED COST-LOADED CPM SCHEDULE

- A. Revision 0 of a calendar time scaled CPM network diagram schedule covering the complete project shall be submitted with the Technical and Cost Proposals. Any changes and additions shall be incorporated into the CPM Schedule and submitted within 60 calendar days after NTP. A Cost-Loaded CPM Schedule, acceptable to the Authority Representative, shall be in place prior to the third Partial Payment Invoice being submitted. The original logic of the initial 90-day schedule shall be incorporated into the Cost-Loaded CPM Schedule, unless identified changes are submitted and approved by the Authority Representative. The final Construction Planning Schedule plus related documents showing the order in which the Design-Builder proposes to carry on the construction work, the dates on which it will start the several major features, including procurement of materials, plant and equipment, and the contemplated dates for completing same shall be submitted with the Final Design Drawings and Final Design Specifications level of submittal specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTALS.
- B. The schedule must meet all of the Project Milestones listed under Section 00725, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE and Section 00825, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE REQUIREMENTS.
- C. A schedule showing the work completed in less than the Contract time, which is found practical and approved by the Authority Representative, shall be considered to have float. The float shall be the time between the scheduled completion of the work and the Contract completion date. Float shall not be for the exclusive benefit of either the Authority or the Design-Builder. Float shall be a resource available to both parties.
- D. A schedule found to be impractical by the Authority Representative for any reason shall be revised by the Design-Builder and resubmitted.
- E. The schedule shall be prepared utilizing the Precedence Diagram Method (PDM) of CPM scheduling technique. The 90-Day schedule shall be cost-loaded and will be used to process the progress payments for the first three months following NTP until the complete Cost-Loaded CPM Schedule is approved.
- F. The schedule shall show clearly the sequence and interdependence of activities and shall list specifically:
 - 1. Interim milestone completion dates. Phasing and staging of the work as specified shall be prominently identified.
 - 2. Procurement, fabrication, delivery, installation, and testing of major materials and equipment.
 - 3. Submittals and Authority Representative review of shop drawings, working drawings and material samples.
 - 4. Interfacing, coordination, and dependencies with preceding, concurrent, and follow-on contractors.
 - 5. Manpower, material, and equipment restrictions, if any.
 - 6. Delivery of the Authority-furnished equipment, if any.

7. Inspection of the work including punch list and acceptance.
8. Work to be performed by other agencies which affect the schedule.
9. Acquisition of permits.
10. Resources necessary to accomplish the work for that activity including, but not limited to, specific equipment, manpower and material requirements.
11. The costs of the work for each activity.
12. The graphic network diagram shall be composed of two parts: a table of activity data; and a time-scaled graphic network diagram and shall include the following:
 - a. A Table of Activity Data in columnar format with the pertinent data for each activity in the row corresponding to that activity's placement in the schedule. The minimum required data is: Activity ID, Activity Description, Early Start date, Early Finish date, Late Start date, Late Finish date, Total Float, Planned Duration, the monetary value in whole dollars for that activity, man-days applicable to each activity and any lag/lead time. The Authority Representative may require additional data such as total shifts or other resource data. An activity numbering system will be utilized which assigns a unique activity identification number to each activity. No two activities shall bear the same activity number or description. Activity descriptions shall be brief but shall convey the scope of the work described. Unusual abbreviations shall be explained in a legend. If an activity includes work to be done by a Disadvantaged Business Enterprise (DBE), that fact shall be identified in the activity description by inclusion of an appropriate parenthetical entry, e.g., Install West Footing Reinforcing Steel (DBE1) with DBE properly identified in the legend. Percentages shall generally not be used in activity descriptions, e.g., Pour West Footing (0 – 50 percent) is not acceptable.
 - b. A time-scaled graphic network diagram showing logical relationships and constraints formatted in accordance with the following requirements: a bar (node) representing the duration of each work activity scaled to the planned duration with arrows (relationship lines) defining predecessor and successor relationships. Each bar shall contain the following information positioned above, below or adjacent to it in a consistent and legible manner: activity description; abbreviated start and finish dates (the day of the month in which the event occurs) and the activity duration. Lag time in whole project units (e.g. work days) shall be displayed on each relationship line where it occurs. The use of lag must be minimized and restricted to only those situations where it is not possible to properly define the start or finish of an activity by the use of a normal Finish-to-Start, Start-to-Finish, Start-to-Start or Finish-to-Finish relationship. Negative Lag shall not be used.
13. Monetary value of each activity indicated in the Schedule shall be identified in a Table of Activity Data following the description. The allocation of monetary values assigned to activities shall be subject to approval and will contain, as close as can reasonably be determined, all labor, equipment, material and subcontractor cost plus its proportional share of all indirect costs. The total of all values allocated to the individual work activities shall equal the total contract value. Should the Design-Builder intend to deliver materials and receive payment under the Materials-on-Site provision of the contract, with the approval of the Authority Representative, the following will be incorporated into the schedule:
 - a. A materials-on-site (MOS) delivery activity will be incorporated into the schedule in logical sequence with the associated installation activity. The cost allocated to the installation

activity will be reduced by the approved MOS activity amount. The activity description will contain the MOS designation and an MOS activity code will be assigned.

- b. The monetary value assigned to that MOS activity will be arrived at by considering only those materials the monetary values of which are to be excluded from the monetary values of the installation activities to which they relate. The monetary value of the delivery activity will equal the projected invoiced values of materials, as restricted above and in other relevant provisions of the Contract, to be delivered to the site. The Design-Builder shall submit a separate, detailed breakdown of the projected total of all MOS activities.
- G. Individual schedule activities shall not exceed 20 work days in duration, except certain procurement, delivery and/or material-on-site activities, which may exceed 20 work days with the approval of the Authority Representative. Activities exceeding 20 work days in duration shall be subdivided.
- H. Schedule activities shall be sufficiently described to include what is to be accomplished and identified by the applicable work areas. Activities shall be grouped to assist in the understanding of the activity sequence. Group activities by category of work, work area and/or responsibility. Activity durations shall be expressed in whole days. Work that is to be performed by subcontract shall be clearly defined.
- I. The schedule diagram shall indicate a clearly defined critical path which shall be prominently distinguished.
- J. A written narrative shall accompany the schedule submittal describing the Design-Builder's approach and methods for completion of the work. The narrative shall be adequate for the Authority Representative to understand the schedule and specifically identify the use of lag time.
- K. Submit the calendar(s) used to calculate the CPM schedule, including: (i) the proposed number of work days per week; (ii) the planned number of shifts per day; (iii) the number of hours per shift; and (iv) all non-work days.
- L. In addition to the initial Cost-Loaded CPM Schedule, the Design-Builder shall submit for approval a summarized schedule depicting the entire Cost-Loaded CPM Schedule in graphical, time-scaled format that clearly identifies the Design-Builder's work areas, activities and planned logic for completion of the work. The summarized schedule shall be hammocked activities or otherwise summary bars of logically-grouped activities, of approximately 300-500 activities total.

1.06 MONTHLY UPDATES OF THE COST-LOADED CPM SCHEDULE

- A. At least once each month, the Design-Builder shall submit an updated schedule showing the progress of the work to date and anticipated activities to be worked on.
- B. The Cost-Loaded CPM Schedule shall not be revised to include additional activities, deleted activities, revised activity durations, revised network logic, or any other changes to the schedule, without approval of the Authority Representative. Only actual progress, completion dates, and anticipated future progress shall be incorporated in a schedule update.
- C. If according to the current updated Cost-Loaded CPM Schedule, the Design-Builder is sixty or more days behind the Contract completion date of any milestone, or the schedule contains sixty or more work days of negative float, considering all granted time extensions, the Design-Builder shall submit a Recovery Schedule, showing a practical plan to complete the work within the

contract time. The Design-Builder shall execute some or all of the following remedial actions: (i) increase construction labor in such quantities and crafts as necessary to eliminate the backlog of work; (ii) increase the number of working hours per shifts, shifts per working day, working days per week, the amount of construction equipment or any combination to eliminate the backlog of work. The Authority may withhold progress payments until a revised schedule, acceptable to the Authority Representative, is submitted by the Design-Builder.

- D. Any revisions to the planned sequence, activity durations, interdependency of activities and any other change to the schedule shall be submitted separately for review. Written notification and explanation for the proposed changes and separately revised CPM network schedule and reports shall accompany the submittal. Changes shall not be incorporated into the current schedule until the submittal has been accepted by the Authority Representative. A Baseline Schedule, i.e., the current schedule excluding any schedule changes, shall be submitted along with the proposed schedule changes for the Authority Representative's review and approval.
- E. After all Contract work items are complete, and as a condition of final payment, the Design-Builder shall submit an "as-built" Contract Schedule showing actual start and finish dates for all work activities and milestones, based on the accepted monthly updates. These schedule submittals shall be in tabular and in time-scaled PDM plot formats. In addition to the retainage specified in Section 00749, METHOD OF PAYMENT, the amount specified in Section 01780, CLOSEOUT SUBMITTALS will be withheld until approved as-built computer printouts and network diagrams are delivered to the Authority Representative.
- F. The Design-Builder is responsible for maintaining the as-built schedule data according to the field records and submit to the Authority Representative on the monthly basis.

1.07 NINETY-DAY ROLLING SCHEDULE

- A. A schedule depicting activities occurring in the upcoming ninety day period in greater detail than specified in the Initial Ninety-Day and subsequent Schedules. The logic shall generally follow the logic of the approved Schedule.
- B. The schedule shall be time scaled and may be submitted in either bar chart or Critical Path Method (CPM) format.
- C. Activities shall be ten work days or less in duration with particular focus on design, procurement and associated activities to be performed in this time frame.
- D. The Ninety-Day Rolling Schedule shall be updated and submitted monthly for review and approval by the Authority Representative.

1.08 TWO-WEEK WORK PLAN

- A. A schedule in a calendar time-scaled bar chart format depicting the Design-Builder's intended work activities for the upcoming two-week period shall be submitted on a weekly basis and due on the first working day of each week. Each activity lasting one day in duration shall be prominently noted.
- B. Any deviations, including but not limited to sequences of work, timing, and durations of activities, from the Initial Ninety-Day or subsequent Schedule shall be noted and explained in writing.
- C. The form of submittal may be a medium smaller than specified in 1.10 of this Section; however, the format shall not be less than 8-1/2 x 11 inches in size.

1.09 MONTHLY DESIGN PROGRESS REPORT

- A. A description of design progress in the previous month, and a look ahead to the completion of design work.
- B. Identify all design submittals issued to the Authority and the status of the submittals.
- C. Identify all design submittals to be issued to the Authority for review and/or approval within the next 60 days.

1.10 SUBMITTALS

- A. Refer to the Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES for submittal procedures and quantities and also for the additional Scheduling Information submittals required along with the various levels of design review submissions.
- B. The Monthly Progress Status Report shall be submitted in a medium no larger than 11 inches by 17 inches nor any smaller than 8-1/2 x 11 inches in size.
- C. The Cost-Loaded CPM Schedule, as specified under section 1.05, shall be submitted on sheets no smaller than 22 inches wide by 34 inches long nor larger than 34 inches wide by 44 inches long.
 - 1. CPM terminology, definitions and conventions as required herein shall be consistent with the technical portions of the Associated General Contractor's Manual titled Construction Planning & Scheduling.
 - 2. The schedule must be generated in Primavera Project Planner (P3) for Windows version 3.0 or the latest version available. As an exception and with approval of the Authority Representative, the Design-Builder may be permitted to submit data that has been generated utilizing other scheduling software. These schedules must be submitted in an electronic form that can be directly read by P3 and results in no loss of data or restrictions of scheduling or analysis capabilities. If an alternative software is approved, the Design-Builder may be required to provide, at no additional cost to the Authority, up to three current, licensed copies of that software for the Authority's use and provide the necessary manuals and training for Authority staff to achieve proficiency with the software. Design-Builder provided scheduling software must operate on an IBM-compatible personal computer, Windows95 operating system or later.
 - 3. All schedules and reports are to be prepared and submitted in electronic format on CD-ROM labeled with the Contract number, Contract name, Design-Builder's name, data date, run date and any access codes or file designators listed.
- D. Schedule submittals shall include the following and shall be submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES:
 - 1. Rev 0 Preliminary Initial 90-Day Schedule Draft submitted with Technical Proposal as specified in Section 00204 as applicable - one reproducible and six copies and one set of electronic media.
 - 2. Rev 0 Cost-Loaded CPM Schedule Draft submitted with Technical Proposal as specified in Section 00204 as applicable - one reproducible and six copies and one set of electronic

media.

3. Updated Initial 90-Day Schedule - one original reproducible and six full size copies of the network diagram together with six copies of Narrative and one set of electronic media for both.
 4. Monthly Updates of Design Schedule if applicable - original and six copies of the reports specified under Section E. (below) and one set of electronic media.
 5. Monthly Narrative Report - original and six copies and one set of electronic media.
 6. Updated Cost-Loaded CPM Schedule - one reproducible and six full size copies of the network diagram together with six copies of Narrative and one set of electronic media for both.
 7. Monthly Updates of Cost-Loaded CPM Schedule - original and six copies of the reports specified under Section E. (below) and one set of electronic media.
 8. 90-Day Rolling Schedule - original and six copies and one set of electronic media.
 9. Two-Week Work Plan - original and six copies and one set of electronic media.
 10. Construction Photographs - as specified in Section 01321, CONSTRUCTION PHOTOGRAPHS
 11. "As-Built" Contract Schedule as specified in Section 01780 CLOSEOUT SUBMITTALS - original and six (6) copies and one set of electronic media.
- E. At a minimum number of work days, the Authority Representative will review and return the Design-Builder's schedule submittal with comments according to the following schedule from the date of receipt:

Initial Ninety-Day Schedule	-	Seven Days
Cost-Loaded CPM Schedule	-	Fifteen Days
Ninety-Day Rolling Schedule	-	Seven Days
Two-Week Work Plan	-	One Day

The Design-Builder shall make all corrections to the schedule requested by the Authority Representative and resubmit the schedule for approval. If the Design-Builder does not agree with the Authority Representative's comments, the Design-Builder shall provide written notice of disagreement within five work days from the receipt of the Authority Representative's comments for the Cost-Loaded CPM Schedule. Authority Representative's comments to the Initial Ninety-Day Schedule, Ninety-Day Rolling Schedule and Two-Week Work Plans for which the Design-Builder disagrees shall be resolved in a meeting held for that purpose, if necessary. Resubmittals shall conform to the same requirements as original submittals.

- F. The Cost-Loaded CPM Schedule submittal, all subsequent schedule updates, and time extension requests shall also include the following computer generated reports:
1. Successor Report: This report shall contain all activities shown on the graphic network diagram listed in ascending order of activity ID based on successor relationships.

2. Predecessor Report: This report shall contain all activities shown on the graphic network diagram listed in descending order of activity ID based on their predecessor relationships.
3. Float Report: This report shall contain all activities shown on the graphic network diagram listed in order of ascending total float values and, where float values are equal, in chronological order of the early start date.
4. Late Finish Report: This report shall contain all activities as shown on the graphic network diagram listed in chronological order of the late finish date.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION

3.01 GENERAL

- A. Schedules shall represent a practical plan to complete the work within the Contract time, and shall convey the Design-Builder's intent in the manner of prosecution and progress of the work.
- B. The scheduling and execution of the project work in accordance with the Project Requirements of the Project Manual and Attachments to the Project Manual are the responsibility of the Design-Builder.
- C. The submittal of schedules shall be understood to be the Design-Builder's representation that the schedule meets the requirements of the Contract Documents and that the work will be executed in the sequence and duration indicated in the schedule.
- D. All schedule submittals are subject to review and acceptance by the Authority Representative. The Authority retains the right to withhold progress payments until the Design-Builder submits a schedule, payment schedule and updates acceptable to the Authority Representative.
- E. The approved Cost-Loaded CPM Schedule shall be used as the basis for periodic progress payments to the Design-Builder.

3.02 PAYMENT

The Design-Builder shall submit the original reproducible and six paper copies and an electronic copy of the approved final updated Cost-Loaded CPM Schedule and Monthly Progress Report reflecting the outcome of the Formal Progress Status Report Review specified in Section 01312, PROJECT MEETINGS along with its Application for Payment as specified in Section 01290, PAYMENT PROCEDURES. No invoice will be processed if there is not an agreed update in place.

3.03 PROJECT SCHEDULER

- A. To prepare the project schedules, the Design-Builder shall engage the services of a scheduler who is skilled in the time and cost application of scheduling using PDM network techniques for heavy-construction projects, the cost of which is included in the Design-Builder's bid or price proposal and whose qualifications are listed in Section 00491, TECHNICAL PROPOSAL AS FINALLY ACCEPTED and as confirmed in the Key Personnel verification submittal as specified in Section 01111, KEY DESIGN-BUILDER FUNCTIONS.
- B. The Design-Builder's scheduler may or may not be an independent consultant; however, the scheduler shall be available to the Design-Builder and Authority Representative to address

schedule questions and shall attend all Periodic Progress Review and Schedule meetings convened by the Authority Representative.

- C. In the event that the project scheduler is not found to be competent or to have sufficient relevant experience, WMATA will request that the project scheduler be removed from the project pursuant to Section 00710, PROJECT MANAGEMENT, SUPERINTENDENCE AND KEY PERSONNEL. In that event, the Design-Builder shall submit a resume of the new candidate for consideration within 10 calendar days.

3.04 REQUESTS FOR TIME EXTENSIONS

- A. The Design-Builder is responsible for submitting a written request for any extensions of Contract time within the time specified by the Contract. Requests not submitted in writing, without the required documentation, and not submitted in 30 calendar days will not be considered.
- B. The request shall include documentation with written justification for the extension of time, supporting evidence, and specific references to the Contract for which the basis of the request is being made.
- C. The request shall also include a calendar time-scaled CPM network schedule analysis and reports specified in Section 1.05, Cost-Loaded CPM Schedule, depicting the time impact basis of the request with the affected areas prominently highlighted. The Cost-Loaded CPM Schedule to be used in determining the time extension request shall be the current and accepted schedule at the time of the event.
- D. If the Authority Representative finds that the Design-Builder is entitled to an extension of time of any completion date under the provisions of the Contract, the Authority Representative's determination of the total number of days extension will be based upon the current analysis of the currently approved Cost-Loaded CPM Schedule and upon data relevant to the extension. Extensions of time for performance under any and all of the provisions of the Contract will be granted only to the extent that equitable time adjustments for the activity or activities affected exceed the total float along the paths involved of the most critical path to project completion.
- E. The Design-Builder shall submit a CPM fragnet with enough details to depict the causes, duration, and logic relationship and impact of the current schedule activities. The quantum of delay impact on contract completion or interim milestone(s) must be determined for time extension.
- F. Critical delays, i.e., delay which may affect the activities on the current critical path, will be contemporaneously discussed and mutually agreed by all the parties involved. In case the quantum of delays or impact cannot be resolved, the background, issues, work performed, as well as start and finish dates of delays shall be well-documented in chronological order. The Authority Representative's determination of merit for time extension(s) will be awarded after the Authority Representative finds entitlement to the Design-Builder's request and only after the alleged delays are demonstrated to impact the most critical path(s). Data furnished by the Design-Builder shall be used as a basis in the findings of the Authority Representative.
- G. A complete As-Built Schedule which has enough details to depict delay and demonstrate cause-effect delay impact shall be submitted at the end of the project as specified in Section 01780, CLOSEOUT SUBMITTALS, and will be utilized in the event of unresolved time-related issues.

END OF SECTION

SECTION 01330

DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for Design and Construction submittals required for performance of the Work. Refer to the WMATA Standard and Technical Sections for specific construction submittal requirements. This Section excludes various administrative submittals and closeout and training submittals specified elsewhere, but includes the following:
1. Required Submittals List and Submittal Log.
 2. Design Specifications - 60%, 90% and 100%.
 3. Design Drawings - 60%, 90% and 100%.
 4. Design Computations.
 5. Building and Utility Plans and Topographic Data.
 6. Estimated Material Quantities.
 7. Design Certifications.
 8. Product Data.
 9. Shop Drawings.
 10. Working Drawings.
 11. Samples.
 12. Construction Certifications.
 13. Documentation.
 14. Design-Builder's Reports.
 15. Licenses, Permits, and Approval Letters from Government and Utility Agencies.
 16. Overviews, Procedures, Plans and Reports.
 17. Site Specific Work Plan (SSWP) - See Section 01142.
- B. Refer to other Sections of the Contract for administrative submittal and closeout and training submittal requirements.

- C. Generally, the Design-Builder shall submit the original and six paper copies and one electronic copy for all required submittals, unless otherwise specified.

1.02 RELATED DOCUMENTS

All Divisions of the Project Manual and the Project Drawings.

1.03 GENERAL SUBMITTAL PROCEDURES

- A. The Design-Builder shall provide a Preliminary Required Schedule of Submittals List as described in Section 00720, SUBMITTALS and Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA for all sections of the Project Manual and for all Project Drawings developed from the requirements identified in the Contract Documents. The Preliminary Submittal List shall be submitted for Authority approval at the Pre Design-Build Conference as specified in Section 01312, PROJECT MEETINGS to be held ten (10) calendar days after Award of Contract, and after approved, shall subsequently be updated through discussions with the Authority during weekly progress meetings or through special meetings as may be required. . As the design progresses, the Design-Builder shall separate items of the work that require Authority approval as directed by the Authority Representative into a separate Submittal List.

1. Within 60 days of NTP, the Design-Builder shall submit for approval the original and six paper copies and one electronic copy of a Contract Documents Submittals Log as described in Section 00720, SUBMITTALS, created in a Corel Office 2000 data base, consisting of all Design Drawings, Design Specifications, design calculations, analyses and reports to be prepared by the Design-Builder. The log shall also list all versions of a document, only one version of a document may be effective at any one time. The Log shall function to keep a history of each document and its evolutionary status. The Contract Documents Submittals Log shall provide the following information:
 - a. Contract Document Title /Number.
 - b. Document Serial Number.
 - c. Nature/Reason for Change.
 - d. Version Number/Change Commentary.
 - e. Reference specification(s).
 - f. Effective Date.
 - g. Anticipated Submittal Date.
 - h. Responsible Party.
 - i. Tested/Inspected By: Quality Control/Quality Assurance; third party agency; subcontractor or supplier QC representative.
 - j. Status (as a minium):
 - (1) Effective.

(2) Draft.

(3) Archived.

k. Approved By: Authority Representative or Project Representative.

l. Remarks.

B. PROFESSIONAL REGISTRATION - NOT USED - Specified elsewhere.

C. The Designer of the Design-Builder Team shall be responsible for the review and approval of all Contract-related submittals prior to forwarding to the Authority those submittals the Authority has reserved the right to review and comment or review and approve and for maintenance of records of submittals.

D. All Authority reviews, whether for design or construction submittals, shall be solely for the purposes stated in Section 00719, AUTHORITY REVIEWS and Section 00720, SUBMITTALS. The Design-Builder shall make submittals sufficiently in advance of schedule requirements to permit for checking and appropriate action. Time critical submittals (those whose lack of acceptance would cause delay to the project) shall be scheduled on the CPM schedule, showing appropriate durations and review sequences.

E. Submittals that the Authority reserves the right to review and approve will be returned to the Design-Builder with one of the following approval codes:

1. Code 1: Approved Without Condition or Comment.

2. Code 2: Approved As Corrected, Resubmittal Not Required. The Design-Builder shall comply with any changes, conditions or comments on the submittal.

3. Code 3: Disapproved. The entire submittal is disapproved and shall be resubmitted.

F. The Design-Builder shall be responsible for and bear all cost of damages which may result from the ordering of material from or proceeding with any part of the work prior to the approval of specified or directed submittals. The Authority's approval will be general and shall not be construed as relieving the Design-Builder of the responsibility for any errors including details, dimensions and materials as specified in Section 00719.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION

3.01 DESIGN SUBMITTALS

A. Design Submittal Reviews: The Authority will complete its review of submittals within twenty-one (21) calendar days unless otherwise specified, and provide written review comments and marked-up drawings and specifications to the Design-Builder. Within ten (10) calendar days after receipt of the Authority review comments, the Design-Builder shall deliver to the Authority Representative the original and six paper copies and one electronic copy of written responses to all comments detailing the proposed technical modifications required to comply with the comments or reasons

why the Design-Builder recommends that they not comply. The Design-Builder shall meet with the Authority to discuss the review comments as specified in Section 01312, PROJECT MEETINGS. A resubmittal by the Design-Builder will be required when the design has not been developed to the level specified. Within ten (10) calendar days after the Design Review Comment Meeting, the Design-Builder shall deliver to the Authority Representative the original and six paper copies and one electronic copy of the meeting minutes documenting decisions on comments made in the meeting. The Design-Builder shall incorporate all revisions and additions agreed to at the Design Review Comment Meeting and shall deliver the original and six paper copies and one electronic copy of the appropriate design documents to the Authority Representative for approval for adherence to the Project Requirements within fourteen (14) calendar days after the review meeting.

- B. Specifications, Drawings, and other submittals shall be submitted for review in accordance with the requirements stated in this PART 3 EXECUTION and the approved Design-Builder's Design Progress Schedule. A submittal is not complete until all of the elements have been received by the Authority and the level of completion of the several disciplines is substantially as presented in the approved design activity schedule. Review and approval by the Authority will not relieve the Design-Builder from its responsibility for accuracy of submittals, for conformity of submittals to the Project Requirements, for prosecution and completion of the Contract in accordance with the Contract Documents and Final Design Specifications and Final Design Drawings, and for compatibility of described product with contiguous products and the rest of the systems that they impact. Authority review and approval of a separate item will not constitute review and approval of an assembly in which the item functions.
1. The Design-Builder shall prepare electronic copies of the Design Specifications text files in current WordPerfect file format version.
 2. If available, the Authority will furnish to the Design-Builder without charge one (1) set of CD ROM disks in an AutoCAD (.DWG) file format of the original Project Drawings including any amendments, and including if applicable Standard Drawings and Informational Layout and Detail Drawings and Authority As-Built Record Drawings from prior contracts, and if available, one (1) set of CD ROM disks of the Project Manual including any amendments and the WMATA CAD Manual in current WordPerfect version, except for the applicable publications referenced in the technical provisions. If the Drawings are not available in electronic format, then full-sized or half-sized Mylars or other reproducible medium will be provided. Additional documents will be furnished on request at the cost of reproduction.
 3. If drawing reproducibles were initially provided by the Authority, the Design-Builder, if it desires to, may use the reproducible medium to prepare AutoCAD (.DWG) file format Design Drawings, in addition to the other requirements of this Section. The original reproducibles of Project Drawings, including if applicable Standard Drawings and Information and Authority Record Drawings from prior contracts, shall be returned to the Authority not later than 10 calendar days after their receipt from the Authority.
 4. The Design-Builder shall prepare Design Drawings, including if applicable Standard Drawings and Informational Layout and Detail Drawings and Authority Record Drawings from prior contracts, on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. The latest version of both the AutoCAD (.DWG) and .pdf file formats of the type and quality specified herein shall be the standard formats for all Design, Shop, Working and As-Built Drawings that are to be forwarded to the Authority for approval.

5. Please note that all Design Drawing (and also including all Shop, Working and As-Built Drawings prepared during construction) line work shall be shown in AutoCAD drawings on designated layers in accordance with the information listed below. Images shall be clear, sharp and readily legible. The Authority reserves the right to have drawing(s) resubmitted until the Authority Representative approves the legibility of the drawing contained in the file. For updates to Design, Shop, Working and As-Built Drawings, drafting quality shall match the original documents in line weights, symbols and lettering style and size.
6. The Design-Builder shall utilize the latest version of WMATA's CAD Manual, which is based on the NIBS's National CAD Standard publication, consisting of the AIA's CAD Layer Guidelines, the CSI's Uniform Drawing System Modules 1 - 8 and the U.S. DOD CADD/GIS Technology Center's Plotting Guidelines of the U.S.C.S., and includes unique Authority symbols, conventions and layering standards for the preparation of required Drawing submittals during both the design phase and the construction phase of the Project. WMATA's CAD Manual is an Attachment to this Project Manual.

C. Design Reviews:

1. Submit the following for approval for conformance with the Requirements as specified below. Where design submittal level and contents are defined in individual Specification Sections, those percentages for level of completion shall be used. However, submittal contents shall include both the requirements specified in individual Specification Sections and in this Section. If a conflict occurs, the individual Specification Sections requirements shall take precedence, except that "issued for construction" submittals shall always be required. Includes all elements listed in Section 00100.
 - a. 60% Intermediate level of design review: The Design-Builder shall submit the Design Drawings of all disciplines that are required for the completion of the Project including layouts, installations, typical circuits, schedules of equipment and complete flow diagrams developed sufficiently to indicate the intended level of completion, and shall also submit the Intermediate Design Specifications in CSI format. The Specifications in may be in draft form, but otherwise complete, including Standard and Technical Specifications Sections edited for the Contract, and developed text for specifications generated by the Design-Builder. The Design Drawings shall be in sufficient detail to define the design of all major elements, substantially complete and checked. In addition, the 60% design package shall contain the original and six paper copies and one electronic copy of the following also for the Authority Representative/Project Representative's review:
 - (1) Notification of Variations in Project Requirements if applicable in Intermediate submittal letter of transmittal as described in Section 00720, SUBMITTALS.
 - (2) Complete list of all Intermediate Design Drawings, Intermediate Design Specifications and other material being submitted.
 - (3) Disposition of 30% Comments - Not Used
 - (4) Test, acceptance and verification criteria and/or procedures for the product being supplied as specified in Section 01111, KEY DESIGN-BUILDER FUNCTIONS and Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
 - (5) Updated Overview of the Quality Management System: Include any adjustments made

to Finalized Design Control Plan; Inspection and Testing Plans and Reports including Quality Manual, Plans, Reports and Procedures; Document Control Procedures; Subcontracting and Purchasing Procedures; Process Control Procedures; Inspection, Measuring and Test Equipment Procedures; Reporting, Review and Disposition of Non-Conforming Product Procedures; Control of Quality Records Procedures; and Internal Quality Audit Procedures. Also include QA/QC Records; Summary of Management Review Findings and Corrective Actions; Audit Results; Status Reports; QA/QC Manager's Statement of Compliance Quality Certification for Payment Verification Certificate; and Certifications. The above shall be as specified in General Requirements Section 01111, KEY DESIGN-BUILDER FUNCTIONS, Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION; Section 01310, PROJECT MANAGEMENT AND COORDINATION; and Section 01470, QUALITY SYSTEM.

- (6) Systems Integration - Not Used. See Section 01113 for requirements.
- (7) Resumes for Design Review Team reviewers and a signed certificate indicating that each member of the Design Review Team has reviewed the Intermediate documents and found them proper; Reports substantiating design analyses and calculations as required in accordance with accepted industry practice to support the basis of Intermediate design and development of Intermediate Design Drawings; All checked Intermediate design computations, indexed and bound (Coordinate and elevation listings shall be provided in AutoCAD compatible format); Reports substantiating Intermediate design analyses and calculations as required in accordance with accepted industry practice to support the basis of design and development of Intermediate Design Drawings; Intermediate design documentation including any jurisdictional approval letters received from governmental agencies (approvals applied for, but not received, should be indicated and the reasons for not receiving such approvals given) and any permits for maintenance of traffic, environmental, geotechnical, stormwater management, sediment and erosion control, grading, pavement and markings, forest conservation, wetlands mitigation, right-of-entry, forest stand delineation, reforestation, afforestation, landscaping, and buildings and other structures as applicable; Intermediate ADAAG Design Compliance Certification; Intermediate ADA Facilities Accessibility Checklist; and Records of Intermediate design reviews and design change requests as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
- (8) Statement by the Design Professional who signed the drawings that the Intermediate drawings and specifications conform to applicable architectural, engineering, Systems and Authority requirements and to the appropriate jurisdictional regulations as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA and Section 01470, QUALITY REQUIREMENTS.
- (9) Drawing set and/or Specifications transmittals and other communications and replies thereto as each is sent to or received from a Utility or Agency since the Preliminary level review submittal including transmittal letters and requests for approvals, reimbursable estimates and other data; confirmation of approval by the affected Utility or Agency of the treatment, design and standards; written statement indicating those items of utility work which must be completed prior to construction, and those which must be completed within six months after start of construction as applicable; and of all utility plans and all materials collected by or issued to the Design-Builder, as specified in Section 01180, PROJECT UTILITY SOURCES.

- (10) Latest approved version of Construction Planning Schedule plus related documents as specified in Section 01322, CONTRACT PROGRESS REPORTING.
- (11) Design survey field notes as applicable as specified in Section 01721, LAYOUT OF WORK AND FIELD ENGINEERING.
- (12) Building plans and topographic data and all materials collected by or issued to the Design-Builder.
- (13) Intermediate report listing specific actions which are required by others to enable construction to proceed on schedule. Give particular attention to those items of construction indicated in the Contract Documents and Intermediate Design Drawings and Intermediate Design Specifications to be performed by others.
- (14) Product data including cut sheets to demonstrate compliance with the Contract Documents and Intermediate estimated quantities for all types of materials to be incorporated into the project. This shall include civil, structural, architectural, electrical, mechanical, Systems and all other items to be permanently installed in the project.
- (15) Completed stormwater management, paving and restoration plans as applicable.
- (16) Electrical plans and calculations as applicable and as follows:
- (a) Electrical plans showing: lighting and equipment layout; layout of raceways, manholes, trenches and conduits for alternating current (A.C.) power; conduit and wire schedule showing number, type, size, routing and voltage; panelboard, transformer and circuit breaker schedules; stray current bonding and cathodic protection; cable support and equipment mounting details; provisions for circuit breakers to permit selective tripping; automatic lighting control.
 - (b) Complete design computations, including assumptions and back-up data, for the following: illumination levels; voltage drop on feeders; summary of connected and demand load on each panelboard and feeder; sizing of all equipment short circuit calculations; breaker coordination study of selective tripping; and resistance of grounding mat.
 - (c) Power feeder and ductbank if required: After coordination with local electrical utility company on design of power feeder for installation by local electrical utility company, a statement of final approval of electric power service ductbank entrance to rapid transit facilities by the supplying utility company.
- (17) System plans and schedules showing all conduit ductbank and cable trench routing as applicable.
- (18) Mechanical plans and calculations as follows:
- (a) Mechanical plans showing heating and ventilation, air-conditioning systems including control and air flow diagrams; complete equipment schedules; fire suppression, drainage and plumbing systems.
 - (b) Complete design computations, including any assumptions and back-up data,

covering heating and ventilation, air-conditioning systems, fire suppression system, exiting calculations and any other special systems. Computations are to include equipment selection with a minimum of three manufacturers listed, complete with model numbers along with appropriate performance data, curves, dimensions, etc. Equipment selection is to include verification that equipment will fit in space available and retain adequate accessibility for maintenance.

- (19) Civil, Architectural and Structural plans and calculations as applicable including list of control monuments that could be destroyed or disturbed during construction, complete design computations, including any summary and back-up data, covering sitework, foundation and superstructure.
- (20) A letter from electrical, mechanical and Systems subcontractors as applicable stating that their design represents the intermediate level submission and that, at a very minimum, items identified in Design-Builder's Quality Control/Quality Assurance Plan have been complied with.
- (21) Product data including cut sheets to demonstrate compliance with the Contract Documents and Preliminary estimated quantities for all types of materials to be incorporated into the project. This shall include civil, structural, architectural, electrical, mechanical, Systems and all other items to be permanently installed in the project.
- b. 90% pre-final level of design review for details of what was included in the previous submittals (Pre-Final Design Drawings and Pre-Final Design Specifications in CSI format Review and Approval): The Design-Builder shall submit the Design Drawings of all disciplines that are required for the completion of the Project with cut sheets and shall also submit the Pre-Final Design Specifications in CSI format. The 90% submittal shall include basically complete and checked revised drawings and specifications of all disciplines. In addition, the 90% design package shall contain the original and six paper copies and one electronic copy of the following also for the Authority Representative/Project Representative's review:
- (1) Notification of Variations in Project Requirements if applicable in Pre-Final submittal letter of transmittal as described in Section 00720, SUBMITTALS.
 - (2) Complete list of all Pre-Final Design Drawings, Pre-Final Design Specifications and other material being submitted.
 - (3) Written disposition of the 60% comments by the Design-Builder certifying that all previous comments from the Authority and its Design Professional have been resolved and/or incorporated in the design.
 - (4) Pre-Final Test, acceptance and verification criteria and/or procedures for the product being supplied as specified in Section 01111, KEY DESIGN-BUILDER FUNCTIONS and Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
 - (5) Pre-Final Updated Overview of the Quality Management System: Include any adjustments made to Finalized Design Control Plan; Inspection and Testing Plans and Reports including Quality Manual, Plans, Reports and Procedures; Document Control Procedures; Subcontracting and Purchasing Procedures; Process Control

Procedures; Inspection, Measuring and Test Equipment Procedures; Reporting, Review and Disposition of Non-Conforming Product Procedures; Control of Quality Records Procedures; and Internal Quality Audit Procedures. Also include QA/QC Records; Summary of Management Review Findings and Corrective Actions; Audit Results; Status Reports; QA/QC Manager's Statement of Compliance Quality Certification for Payment Verification Certificate; and Certifications. The above shall be as specified in General Requirements Section 01111, KEY DESIGN-BUILDER FUNCTIONS, Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION; Section 01310, PROJECT MANAGEMENT AND COORDINATION; and Section 01470, QUALITY SYSTEM.

- (6) Systems Integration - Not Used. See Section 01113 for requirements.
- (7) Resumes for Design Review Team reviewers and a signed certificate indicating that each member of the Design Review Team has reviewed the Pre-Final documents and found them proper; Reports substantiating design analyses and calculations as required in accordance with accepted industry practice to support the basis of Pre-Final design and development of Pre-Final Design Drawings; All checked Pre-Final design computations, indexed and bound (Coordinate and elevation listings shall be provided in AutoCAD compatible format); Reports substantiating Pre-Final design analyses and calculations as required in accordance with accepted industry practice to support the basis of design and development of Pre-Final Design Drawings; Pre-Final design documentation including any jurisdictional approval letters received from governmental agencies (approvals applied for, but not received, should be indicated and the reasons for not receiving such approvals given) and any permits for maintenance of traffic, environmental, geotechnical, stormwater management, sediment and erosion control, grading, pavement and markings, forest conservation, wetlands mitigation, right-of-entry, forest stand delineation, reforestation, afforestation, landscaping, and buildings and other structures as applicable; Pre-Final ADAAG Design Compliance Certification; Pre-Final ADA Facilities Accessibility Checklist; and Records of Pre-Final design reviews and design change requests as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
- (8) Statement by the Design Professional who signed the drawings that the Pre-Final drawings and specifications conform to applicable architectural, engineering, Systems and Authority requirements and to the appropriate jurisdictional regulations as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA and Section 01470, QUALITY REQUIREMENTS.
- (9) Drawing set and/or Specifications transmittals and other communications and replies thereto as each is sent to or received from a Utility or Agency since the Intermediate level review submittal including transmittal letters and requests for approvals, reimbursable estimates and other data; confirmation of any approvals by the affected Utility or Agency of the treatment, design and standards (approvals from all utilities and agencies must be acquired by the Design-Builder prior to the Final Design Level submittal); and of all utility plans and all materials collected by or issued to the Design-Builder, as specified in Section 01180, PROJECT UTILITY SOURCES.
- (10) Latest approved version of Construction Planning Schedule plus related documents as specified in Section 01322, CONTRACT PROGRESS REPORTING.
- (11) Pre-Final design survey field notes as applicable as specified in Section 01721,

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- (12) Building plans and topographic data and all materials collected by or issued to the Design-Builder.
- (13) Pre-Final report listing specific actions which are required by others to enable construction to proceed on schedule. Give particular attention to those items of construction indicated in the Contract Documents and Pre-Final Design Drawings and Pre-Final Design Specifications to be performed by others.
- (14) Pre-Final product data including cut sheets to demonstrate compliance with the Contract Documents and Pre-Final estimated quantities for all types of materials to be incorporated into the project. This shall include civil, structural, architectural, electrical, mechanical, Systems and all other items to be permanently installed in the project.
- (15) Completed stormwater management, paving and restoration plans as applicable.
- (16) Electrical plans and calculations as applicable and as follows:
- (a) Electrical plans showing: lighting and equipment layout; layout of raceways, manholes, trenches and conduits for alternating current (A.C.) power; conduit and wire schedule showing number, type, size, routing and voltage; panelboard, transformer and circuit breaker schedules; stray current bonding and cathodic protection; cable support and equipment mounting details; provisions for circuit breakers to permit selective tripping; automatic lighting control.
 - (b) Complete design computations, including assumptions and back-up data, for the following: illumination levels; voltage drop on feeders; summary of connected and demand load on each panelboard and feeder; sizing of all equipment short circuit calculations; breaker coordination study of selective tripping; and resistance of grounding mat.
 - (c) Power feeder and ductbank: After coordination with local electrical utility company on design of power feeder for installation by local electrical utility company, a statement of final approval of electric power service ductbank entrance to rapid transit facilities by the supplying utility company.
- (17) System plans and schedules showing all conduit ductbank and cable trench routing as applicable.
- (18) Mechanical plans and calculations as follows:
- (a) Mechanical plans showing heating and ventilation, air-conditioning systems including control and air flow diagrams; complete equipment schedules; fire suppression, drainage and plumbing systems.
 - (b) Complete design computations, including any assumptions and back-up data, covering heating and ventilation, air-conditioning systems, fire suppression system, exiting calculations and any other special systems. Computations are to include equipment selection with a minimum of three manufacturers listed,

complete with model numbers along with appropriate performance data, curves, dimensions, etc. Equipment selection is to include verification that equipment will fit in space available and retain adequate accessibility for maintenance.

- (19) Civil, Architectural and Structural plans and calculations as applicable including list of control monuments that could be destroyed or disturbed during construction, complete design computations, including any summary and back-up data, covering sitework, foundation and superstructure.
- (20) A letter from electrical, mechanical and Systems subcontractors as applicable stating that their design represents the pre-final level submission and that, at a very minimum, items identified in Design-Builder's Quality Control/Quality Assurance Plan have been complied with.
- c. 100% final level of design review for what the Designer will submit to the jurisdictional authorities during the permitting/approval process (Final Design Drawings and Final Design Specifications in CSI format Review and Approval): The 100% design package shall be a complete set of checked revised Construction Documents for all disciplines including Final Design Drawings with cut sheets and Final Design Specifications in CSI format, progressed to the 100% level and incorporating all of the WMATA's comments from the earlier submittals. In addition, the 100% design package shall contain the original and six paper copies and one electronic copy of the following also for the Authority Representative/Project Representative's review:
- (1) Notification of Variations in Project Requirements if applicable in Final submittal letter of transmittal as described in Section 00720, SUBMITTALS.
 - (2) Complete list of all Final Design Drawings, Final Design Specifications and other material being submitted.
 - (3) Written disposition of the 90% comments by the Design-Builder certifying that all previous comments from the Authority and its Design Professional have been resolved and/or incorporated in the design.
 - (4) Final Test, acceptance and verification criteria and/or procedures for the product being supplied as specified in Section 01111, KEY DESIGN-BUILDER FUNCTIONS and Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
 - (5) Final Updated Overview of the Quality Management System: Include any adjustments made to Finalized Design Control Plan; Inspection and Testing Plans and Reports including Quality Manual, Plans, Reports and Procedures; Document Control Procedures; Subcontracting and Purchasing Procedures; Process Control Procedures; Inspection, Measuring and Test Equipment Procedures; Reporting, Review and Disposition of Non-Conforming Product Procedures; Control of Quality Records Procedures; and Internal Quality Audit Procedures. Also include QA/QC Records; Summary of Management Review Findings and Corrective Actions; Audit Results; Status Reports; QA/QC Manager's Statement of Compliance Quality Certification for Payment Verification Certificate; and Certifications. The above shall be as specified in General Requirements Section 01111, KEY DESIGN-BUILDER FUNCTIONS, Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION; Section 01310, PROJECT MANAGEMENT AND COORDINATION; and Section 01470, QUALITY SYSTEM.

- (6) Final Updated Systems Integration and Testing Plans, Procedures and Records as applicable: Include any adjustments made to Systems Integration Procedure and Systems Operations Description including Interface Control Document; Interface Matrix; Systems Interface Report; Description of Route Operations or WMATA operating system as applicable; Integration Procedure; Fully Populated Systems Integration Database; All Systems, Interfaces and Schedule Impact Identification Update; All Coordination Effort Identification; Interfaces on Critical Path Identification; WMATA Reliability, Availability and Safety Goals Identification and Compliance; Detailed Layout and Interface Identification and Consolidated Drawings; and Emergency Procedures, Integration Design Technical Documentation; Operations Procedures for All Interfaces; Proposed Standards; Manuals; Flow Charts; Operation Procedures; Verification Procedures; Test Procedures; Performance Demonstration Plan and Procedures; and Acceptance Testing Plan as specified in General Requirements Section 01111, KEY DESIGN-BUILDER FUNCTIONS; Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION, Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS, Section 01310, PROJECT MANAGEMENT AND COORDINATION, Section 01470, QUALITY SYSTEM, Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING.
- (7) Resumes for Design Review Team reviewers and a signed certificate indicating that each member of the Design Review Team has reviewed the Final documents and found them proper; Reports substantiating design analyses and calculations as required in accordance with accepted industry practice to support the basis of Final design and development of Final Design Drawings; All checked Final design computations, indexed and bound (Coordinate and elevation listings shall be provided in AutoCAD compatible format); Reports substantiating Final design analyses and calculations as required in accordance with accepted industry practice to support the basis of design and development of Final Design Drawings; Final design documentation including all jurisdictional approval letters received from governmental agencies and all permits for maintenance of traffic, environmental, geotechnical, stormwater management, sediment and erosion control, grading, pavement and markings, forest conservation, wetlands mitigation, right-of-entry, forest stand delineation, reforestation, afforestation, landscaping, and buildings and other structures as applicable; Final ADAAG Design Compliance Certification; Final ADA Facilities Accessibility Checklist; and Records of Final design reviews and design change requests as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
- (8) Statement by the Design Professional who signed the drawings that the Final drawings and specifications conform to applicable architectural, engineering, Systems and Authority requirements and to the appropriate jurisdictional regulations as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA and Section 01470, QUALITY REQUIREMENTS.
- (9) Drawing set and/or Specifications transmittals and other communications and replies thereto as each is sent to or received from a Utility or Agency since the Pre-Final level review submittal including transmittal letters and requests for approvals, reimbursable estimates and other data; confirmation of all approvals by the affected Utility or Agency of the treatment, design and standards; written statement indicating those items of utility work which must be completed prior to construction, and those which

must be completed within six months after start of construction as applicable; and of all utility plans and all materials collected by or issued to the Design-Builder, as specified in Section 01180, PROJECT UTILITY SOURCES.

- (10) Latest approved version of Construction Planning Schedule plus related documents as specified in Section 01322, CONTRACT PROGRESS REPORTING.
 - (11) Final design survey field notes as specified in Section 01721, LAYOUT OF WORK AND FIELD ENGINEERING.
 - (12) Building plans and topographic data and all materials collected by or issued to the Design-Builder.
 - (13) Final report listing specific actions which are required by others to enable construction to proceed on schedule. Give particular attention to those items of construction indicated in the Contract Documents and Final Design Drawings and Final Design Specifications to be performed by others.
 - (14) Final product data including cut sheets to demonstrate compliance with the Contract Documents and Final estimated quantities for all types of materials to be incorporated into the project. This shall include civil, structural, architectural, electrical, mechanical, Systems and all other items to be permanently installed in the project.
- d. Issued For Construction (Review and Approval): In some cases, construction may commence before the complete 100% Final Design Drawings and Specifications are produced and issued to the Authority for consideration. In such cases, an additional submittal shall be required of the Design-Builder consisting of all Design Drawings, Design Specifications, and other materials needed to review and approve the work that the Design-Builder intends to construct. Such submittals shall include composite drawings, showing the various disciplines of work involved, where appropriate. Secure WMATA approval for conformance to the Project Requirements before construction for fabrication of any work indicated by a required design submittal.
- e. Other Design Reviews: The Authority retains the right to review and approve for conformance to the Project Requirements any other submittals that it deems necessary during the Design Phase of this Contract. In addition, the Design-Builder shall provide all other submittals to the Authority that are specified in the Project Manual beyond those referenced above and as listed on the approved Schedule of Submittals.
2. The number of sets of Design Drawings and Design Specifications to be submitted by the Design-Builder for approval shall be as indicated below:
- a. Intermediate and Pre-Final Reviews:
 - (1) The Design-Builder shall prepare electronic copies of the Design Specifications text files in current WordPerfect file format version. The Design-Builder shall, unless otherwise directed, submit the original, one electronic copy and six sets of paper copies of Design Specifications to the Authority Representative using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative.

- (2) The Design-Builder shall prepare separate sets of electronic Design Drawings on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. The Design-Builder shall prepare separate sets of electronic Design Drawings on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. The latest version of both the AutoCAD (.DWG) and .pdf file formats of the type and quality specified shall be the standard formats for all Design Drawings submitted for approval. All line work shall be shown in AutoCAD drawings on designated layers in accordance with CAD layering guidelines specified in the WMATA CAD Manual Attachment to this Project Manual. Images shall be clear, sharp and readily legible. When forwarding to the Authority those Design Drawing submittals, the Authority reserves the right to have drawing(s) resubmitted until the Authority Representative approves the legibility of the drawing contained in the file. The Design-Builder shall, unless otherwise directed, submit the original half-size reproducible, electronic copies as specified above and six half-size sets of black ink on white paper copies of all Design Drawing submittals to the Authority Representative using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative.
3. For delivery of the Final Design Documents, the original full-size and half-size reproducible of Final Design Drawings and original Final Design Specifications shall be checked in accordance with the approved Design-Builder's Quality Plan, bear the professional registration seal, and be signed and camera ready for reproduction.
- a. The number of sets of Final Design Drawings and Final Design Specifications to be submitted by the Design-Builder for approval will be as indicated below:
- (1) Final delivery of documents:
- (a) The original Final Design Specifications along with the Specifications cover shall be printed on bond and ready for reproduction: One set unbound.
- (b) Copies of the Final Design Specifications: Six bound copy sets.
- (c) The original full-size reproducible Final Design Drawings (22 inches by 34 inches): One set.
- (d) The original half-size reproducible Final Design Drawings (11 inches by 17 inches): One set.
- (e) Copies of the full-size Final Design Drawings: One bound blackline print set.
- (f) Copies of the half-size Final Design Drawings: Six bound blackline print sets.
- b. The Final Design Specifications and the Final Design Drawings will be reviewed by the Authority Representative as specified below and, if necessary, comments will be given to the Design-Builder for resolution. Any original Drawings or Specifications that require revision will be returned to the Design-Builder. The Design-Builder shall re-submit the revised Drawings and Specifications for approval for conformance to the Project Requirements in the quantities as listed above.
- c. Electronic Media Drawing Files: Following acceptance of the Final Design Drawings and

Final Design Specifications, the Design-Builder shall prepare the final Electronic Media Drawing Files as previously specified for all approved Final Design Drawings and Final Design Specifications, and submit to the Authority Representative using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative, six (6) sets each of Drawings in both an AutoCAD (.DWG) file format and in a .pdf file format on CD-ROM electronic media and one (1) separate set of Specifications in WordPerfect current file format version on CD-ROM electronic media. All CD-ROM disks shall be labeled with file name, operating system, file format, and contract number.

3.02 CONSTRUCTION SUBMITTALS

- A. Authority Review: The Design-Builder shall be responsible for the review and approval of all Contract-related submittals prior to forwarding to the Authority those submittals the Authority has reserved the right to review and comment or review and approve. The Authority explicitly reserves the right to review and approve for conformance to the Project Requirements the Construction items identified below. Such approval (or disapproval) shall be given to the Design-Builder within no less than twenty-one (21) calendar days after receipt by the Authority unless otherwise specified. The Design-Builder shall incorporate any comments or corrections and deliver a revised submittal to the Authority within fourteen (14) calendar days following receipt of such by the Design-Builder unless otherwise specified. Review and approval by the Authority will not relieve the Design-Builder from its responsibility for accuracy of submittals, for conformity of submittals to and for prosecution and completion of the Contract in accordance with the Contract Documents and Final Design Specifications and Final Design Drawings, and for compatibility of described product with contiguous products and the rest of the systems that they impact. Authority review and approval of a separate item will not constitute review and approval of an assembly in which the item functions.
1. Construction Review:
- a. S&I Yard Improvements and S&I Shop Expansion Facility:
- (1) Factory visit to pre-caster to approve fabrication of insulated architectural pre-cast concrete panels, if proposed.
 - (2) Working Drawings.
 - (3) Shop, Schematic and Installation Drawings, manufacturer's literature, product data and product substitution requests.
 - (4) Samples.
 - (5) Certifications.
 - (6) Documentation including calculations and miscellaneous documentation.
 - (7) Licenses, Permits, and Approval Letters from Government and Utility Agencies.
- b. Other Construction Reviews: The Authority retains the right to review and approve for conformance to the Requirements any other submittals that it deems necessary during the Construction Phase of this Contract. In addition, the Design-Builder shall provide all other submittals to the Authority that are specified in the Project Manual beyond those

referenced above and as listed on the approved Schedule of Submittals.

- c. **Start of Construction:** The Design-Builder shall not start construction until the Authority has approved the Design for that Element for conformance to the Requirements, except by the express consent of the Authority. The Construction for any Design Element will not be approved until the balance of the Design is advanced to a stage where in the judgment of the Authority the Design Element can be adequately evaluated.
- d. **Performance of Inspections and Tests by the Design-Builder:** The Design-Builder shall perform all inspection and testing as specified in Section 01470 QUALITY SYSTEM, Section 01113, SYSTEMS INTEGRATION, Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING and with the procedures in the Design-Builder's approved Quality Control/Quality Assurance (QC/QA) Plan and in the approved Systems Integration Plan as specified in Section 01470 QUALITY SYSTEM and Section 01113, SYSTEMS INTEGRATION . QA/QC Plan and Systems Integration Plan shall include Testing and Inspections in accordance with jurisdictional agencies and utility companies.

3.03 CONSTRUCTION SHOP DRAWINGS

- A. Initially and as work progresses, Shop Drawings shall be submitted to the Designer for approval prior to forwarding to the Authority for approval.
- B. The Design-Builder shall prepare separate sets of electronic Shop Drawings on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. The latest version of both the AutoCAD (.DWG) and .pdf file formats of the type and quality specified in this Project Manual shall be the standard formats for all Shop Drawings submitted for approval for conformance to the Requirements. All line work shall be shown in AutoCAD drawings on designated layers in accordance with CAD layering guidelines specified in the WMATA CAD Manual Attachment to this Project Manual. Images shall be clear, sharp and readily legible. When forwarding to the Authority those Shop Drawing submittals the Authority has reserved the right to review and comment or review and approve, the Authority reserves the right to have drawing(s) resubmitted until the Authority Representative approves the legibility of the drawing contained in the file. Also, the Design-Builder shall, unless otherwise directed, submit one set of full-size and six sets of half-size black ink on white paper copies of all Shop Drawing submittals the Authority has reserved the right to review and approve to the Authority Representative using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative.
- C. Shop Drawings shall be complete, detailed and dimensioned and shall include the following:
 - 1. Fabrication, erection, layout and setting drawings.
 - 2. Complete list of materials.
 - 3. Schedules.
 - 4. Manufacturer's drawings.
 - 5. Wiring and control diagrams and utility connections and special facilities as specified in Section 01180, PROJECT UTILITY SOURCES, as applicable.

6. Catalog cuts or entire catalogs: Six originals.
 7. Descriptive literature.
 8. Performance and test data.
 9. Drawings prepared by the Design-Builder for permanent structures, equipment and systems designed by it to comply with the Specifications.
 10. Additional requirements specified in the technical specifications.
- D. Drawings and schedules shall be checked and coordinated with the work of all trades involved before they are submitted for approval by the Designer and shall bear the Designer's stamp of approval as evidence of such checking and coordination. Drawings or schedules submitted to the Authority without this stamp of approval may be returned to the Design-Builder for resubmittal. Where specified to be certified by a professional engineer, certification of shop drawings shall comply with such requirements of the WORKING DRAWINGS article.
- E. Maximum size of each full-size sheet shall be 22 inches by 34 inches and maximum size of each half-size sheet shall be 11 inches by 17 inches. Each full-size shop drawing shall have a blank area 3-1/2 inches by 3-1/2 inches, located adjacent to the title block. The title block in the lower right hand corner shall display the following:
1. Number and title of the drawing.
 2. Date of drawing or revision.
 3. Name of project.
 4. Name of Design-Builder and subcontractor submitting the drawing.
 5. Clear identification of contents and location of the work.
 6. Title and number of Specifications section.
- F. Drawings for work on utility facilities, streets and other facilities which are constructed for owners other than the Authority shall be coordinated so that the information required by these owners is included on the Shop Drawings for their facilities.
- G. If drawings show variations from the Contract requirements because of standard shop practice or for other reasons, the Design-Builder shall describe such variations in its letter of transmittal as specified in Section 00720, SUBMITTALS. The Design-Builder shall submit the original and six paper copies and one electronic copy of the submittal transmittal letter. If acceptable, the Authority Representative may approve such variations, subject to a proper adjustment in the Contract. If the Design-Builder fails to describe such variations it shall not be relieved of the responsibility for executing the work in accordance with the Contract, even though such drawings have been approved for conformance to the Requirements.
- H. If the drawings or schedules as submitted include such variations and show a departure from the Contract requirements, which the Authority Representative finds to be in the interest of the Authority and to be so minor as not to involve a change in the Contract price or time for performance, the Authority Representative may approve the drawings.

- I. One set of full-size black ink on white paper copies of all Shop Drawings will be returned to the Design-Builder. Each of the approved Shop Drawings will be identified as having received such approval by being so stamped and dated. Shop Drawings not approved will be stamped NOT APPROVED and will have required corrections shown. If disapproved, resubmittals shall be in the formats and quantities as specified in B. above. Additions and corrections resulting from Authority review comments shall be incorporated by the Design-Builder. On resubmittals the Design-Builder shall direct specific attention, in writing or on resubmitted Shop Drawings, to revisions other than the corrections requested by the Authority Representative on previous submittals. If the Design-Builder considers corrections indicated on the Drawings to constitute a change to the Contract Documents, notice as required under the CHANGES Section 00753 of the General Conditions shall be given to the Contracting Officer through the Authority Representative.
- J. When the Shop Drawings have been completed to the satisfaction of the Authority Representative, the Design-Builder shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Authority Representative.
- K. After written approval of the Shop Drawings by the Designer, or after written approval of the Shop Drawings by the Authority Representative for submittals the Authority has reserved the right to review and approve, the Design-Builder shall supply the Authority Representative with one set each of Shop Drawings in both an AutoCAD (.DWG) file format and in a .pdf file format on CD-ROM electronic media, one set of full-size paper prints and six sets of half-size paper prints of the approved Shop Drawings if the Drawings have been approved subject to certain revisions prior to commencing such work.
- L. Before the date of final substantial completion, the Builder shall furnish to the Designer for approval prior to forwarding to the Authority Representative for approval, Record Shop Drawings, all clearly revised, completed and brought up to date, showing permanent construction as actually made. Record Shop Drawings shall be provided in both an AutoCAD (.DWG) file format and a .pdf file format on CD-ROM electronic media as specified in Section 01780 CLOSEOUT SUBMITTALS of these General Requirements. Also, the Design-Builder shall, submit one set of full-size and six sets of half-size black ink on white paper copies of all Shop Drawings to the Designer for approval prior to forwarding to the Authority Representative for approval.
- M. Once the Record Shop Drawings are approved, the Builder shall submit six separate sets each of Drawings in both an AutoCAD (.DWG) file format and in a .pdf file format on CD-ROM electronic media and one set of full-size and one set of half-size reproduces of all approved Record Shop Drawings to the Designer for approval prior to forwarding to the Authority Representative for approval as specified in Section 01780 CLOSEOUT SUBMITTALS of these General Requirements using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative.

3.04 CONSTRUCTION WORKING DRAWINGS

- A. When used in the Specifications, the term Working Drawings shall be considered to mean: the Design-Builder's plan for temporary structures such as decking, temporary bulkheads, support of excavation, support of utilities, groundwater control systems, and forming and falsework; for underpinning; and for such other work as may be required for construction which but do not become an integral part of the completed project.
- B. Working Drawings and calculations as submitted shall be certified by a professional engineer registered in the area where the work will be performed and shall convey, or be accompanied by,

information sufficient to completely explain the structure, machine or system described and its intended manner of use.

- C. Initially and as work progresses, Working Drawings shall be submitted to the Designer for approval prior to forwarding to the Authority for approval for conformance to the Requirements. The Design-Builder shall prepare separate sets of electronic Working Drawings on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. The latest version of both the AutoCAD (.DWG) and .pdf file formats of the type and quality shall be the standard formats for all Working Drawings submitted for approval. All line work shall be shown in AutoCAD drawings on designated layers in accordance with CAD layering guidelines specified in the WMATA CAD Manual Attachment to this Project Manual. Images shall be clear, sharp and readily legible. When forwarding to the Authority those Working Drawing submittals the Authority has reserved the right to review and approve, the Authority reserves the right to have drawing(s) resubmitted until the Authority Representative approves the legibility of the drawing contained in the file. Also, the Design-Builder shall, unless otherwise directed, submit one set of full-size and six sets of half-size black ink on white paper copies of all Working Drawing submittals the Authority has reserved the right review and approve to the Authority Representative using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative.
- D. Drawings shall be checked and coordinated with the work of all trades involved before they are submitted for approval by the Designer and shall bear the Designer's stamp of approval as evidence of such checking and coordination. Drawings or schedules submitted to the Authority for approval without this stamp of approval may be returned to the Design-Builder for resubmittal.
- E. One set of full-size black ink on white paper copies of all Working Drawings will be returned to the Design-Builder. Each of the approved Working Drawings will be identified as having received such approval by being so stamped and dated. Working Drawings not approved will be stamped NOT APPROVED and will have required corrections shown. If disapproved, resubmittals shall be in the formats and quantities as specified in C. above. Additions and corrections resulting from Authority review comments shall be incorporated by the Design-Builder. On resubmittals the Design-Builder shall direct specific attention, in writing or on resubmitted Working Drawings, to revisions other than the corrections requested by the Authority Representative on previous submittals. If the Design-Builder considers corrections indicated on the Drawings to constitute a change to the Contract Documents, notice as required under the CHANGES article of the General Conditions shall be given to the Contracting Officer through the Authority Representative.
- F. When the Working Drawings have been completed to the satisfaction of the Authority Representative, the Design-Builder shall carry out the temporary construction in accordance therewith and shall make no further changes therein except upon written instructions from the Authority Representative.
- G. After written approval of the Working Drawings by the Designer, or after written approval of the Working Drawings by the Authority Representative for submittals the Authority has reserved the right to review and approve, the Design-Builder shall supply the Authority Representative with one set each of Working Drawings in both an AutoCAD (.DWG) file format and in a .pdf file format on CD-ROM electronic media, one set of full-size paper prints and six sets of half-size paper prints of the approved Working Drawings if the Drawings have been approved subject to certain revisions prior to commencing such work.
- H. Before the date of final substantial completion, the Builder shall furnish to the Designer for approval prior to forwarding to the Authority Representative for approval, Record Working Drawings, all

clearly revised, completed and brought up to date, showing temporary construction as actually performed as specified in Section 01780 CLOSEOUT SUBMITTALS of these General Requirements . Record Working Drawings shall be provided in both an AutoCAD (.DWG) file format and a .pdf file format on CD-ROM electronic media. Also, the Builder shall, submit one set of full-size and six sets of half-size black ink on white paper copies of all Working Drawings to the Designer for approval prior to forwarding to the Authority Representative for approval.

- I. Once the Record Working Drawings are approved, the Builder shall submit six (6) separate sets each of Drawings in both an AutoCAD (.DWG) file format and in a .pdf file format on CD-ROM electronic media and one set of full-size and one set of half-size reproducibles of all approved Record Working Drawings to the Designer for approval prior to forwarding to the Authority Representative for approval as specified in Section 01780 CLOSEOUT SUBMITTALS of these General Requirements using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative.
- J. Temporary Construction and Construction Sequence and Staging Working Drawings including Temporary Decking are more fully described in Section 01530, TEMPORARY CONSTRUCTION and in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.
- K. Temporary utility connections and special facilities Working Drawings are more fully described in Section 01510, TEMPORARY UTILITIES.

3.05 CONSTRUCTION SAMPLES

- A. The Design-Builder shall submit samples for approval for conformance to the Requirements as specified or as directed and shall be delivered to the Design Professional as specified in the Final Design Specifications or Final Design Drawings or as directed by the Authority. The Design-Builder shall prepay shipping charges on samples. Materials or equipment for which samples are required shall not be used in the work until approved.
- B. Each sample shall be labeled as follows:
 - 1. Name of project.
 - 2. Name of Design-Builder and subcontractor.
 - 3. Material or equipment represented.
 - 4. Place of origin.
 - 5. Name of producer and brand, if any.
 - 6. Location in project. Samples of finish materials shall have additional markings identifying them under the schedules.
- C. The Design-Builder shall mail, under separate cover, a letter to the Authority Representative submitting each shipment of samples as specified in Section 00737, MATERIALS, WORKMANSHIP AND EQUIPMENT, and containing the information required in Paragraph B. above. Design-Builder shall also enclose a copy of this letter with the shipment. Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify Contract requirements. Substitutions will not be permitted unless

they are considered to be in the best interests of the Authority and are requested in accordance with the Contract Documents.

- D. Approved samples not destroyed in testing shall be sent to the Design Professional. Approved samples in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in the work shall match the approved samples. Samples which fail testing or are not approved will be disposed of, unless the Design-Builder requests, at the time of submittal, that they be returned to the Design-Builder at its expense.
- E. Failure of any material to pass the specified tests will be sufficient cause for refusal to consider, under this Contract, further samples of the same brand or make of that material. The Authority Representative reserves the right to disapprove any material or equipment which previously has proved unsatisfactory in service.
- F. Samples of various materials on site, stored or in place, may be taken by the Authority for testing. Samples failing to meet Contract requirements will automatically void approvals of items tested. The Design-Builder shall replace such materials or equipment to meet Contract requirements, or there shall be a proper adjustment of the Contract price as determined by the Contracting Officer.
- G. Samples which do not meet specified requirements will be rejected. Retesting of additional samples will be made at the expense of the Design-Builder.

3.06 CONSTRUCTION CERTIFICATIONS

- A. The Design-Builder shall submit the original and six paper copies of certification and an electronic copy for approval, unless otherwise specified.
- B. The Design-Builder shall submit the following certificates:
 - 1. Certification that construction complies with ADAAG regulations as specified in Section 01780, CLOSEOUT SUBMITTALS.
 - 2. Certificates to demonstrate proof of compliance with requirements specified in the technical specifications for each of the following:
 - a. Products and materials.
 - b. Functioning and testing of equipment and systems.
 - c. Qualifications of personnel, manufacturers, fabricators and installers.
 - d. Each certificate shall be signed by an official authorized to certify on behalf of the issuing organization and shall bear the name and address of the Design-Builder, the project name and location; if for a material, quantity and date(s) of shipment or delivery to which the certificates apply shall be indicated.
- C. Certification shall not be construed as relieving the Design-Builder from furnishing satisfactory material, if, after tests are performed on selected samples, the material is found not to meet the specified requirements.
- D. Certified test reports:

1. Submit original and number and type of copies as specified above.
2. Unless otherwise specified, testing shall be conducted by an independent testing agency that certifies that it complies with the recommended requirements of ASTM E329.

3.07 CONSTRUCTION DOCUMENTATION

- A. The Design-Builder shall provide the original and six paper copies and an electronic copy for approval of each of the following when so specified in the technical specifications and as follows:
1. Test reports of previous testing. Where specified in the technical specifications, the Design-Builder may in lieu of testing submit certified test reports of previous testing of such items under similar Authority contracts. The inclusion of a previously approved product only signifies that at one time the manufacturer made a product which met specification requirements. It does not relieve the Design-Builder of its responsibility for furnishing supplies that meet all specification requirements or for performing specified inspections and tests for such material.
 - a. Include the following:
 - (1) Certification that materials meet or exceed specified test requirements.
 - (2) Name and address of testing laboratory.
 - (3) Dates of tests to which reports apply.
 - (4) Certification that materials provided are the same as those tested.
 2. Calculations: Certified by a professional engineer registered in the area where the work will be installed.
 3. Miscellaneous documentation: Specified items such as delivery tickets, batch tickets and bills of materials.

3.08 AS-BUILT CONTRACT DRAWINGS PROVIDED DURING CONSTRUCTION

- A. As-built Contract Drawings provided during construction: The term As-built Contract Drawings prepared by or through the Design-Builder reflect all known changes from the approved Design-Builder provided Final Design Drawings Issued for Construction, including as applicable revisions and additions to Standard Drawings and As-built Information and Record Drawings from previous Authority projects initially provided by the Authority. During construction, the Design-Builder shall maintain a record set of all Drawings annotated to show any changes incorporated as work progresses. All line work shall be shown in AutoCAD drawings on designated layers in accordance with CAD layering guidelines specified in the WMATA CAD Manual Attachment to this Project Manual. Information shall include, but not be limited to, the following:
1. Depths of various elements of foundations in relation to survey data.
 2. Horizontal and vertical locations of underground electrical and utility facilities referenced to survey data. Unless otherwise specified, verify measurements within a 12-inch tolerance. Verify storm and sanitary sewer pipe inverts within 0.01 foot.
 3. Location of interior utilities and appurtenances concealed in construction, referenced to visible and accessible features of the structure.

4. Field changes of dimensions and detail.
 5. Changes accomplished by change orders.
- B. Construction left in place, such as temporary support systems and concrete outside neat lines of permanent structures, including notes defining types and locations of items.
- C. Before the scheduled date of final substantial completion, the Design-Builder shall submit approved as-built drawings for the completed work as specified in Section 01780 CLOSEOUT SUBMITTALS.

3.09 ADMINISTRATIVE SUBMITTALS AND CONSTRUCTION CLOSEOUT AND TRAINING SUBMITTALS

- A. Authority Review: The Design-Builder shall be responsible for the review and approval of all Contract-related submittals prior to forwarding to the Authority those submittals the Authority has reserved the right to review and comment or review and approve. The Authority explicitly reserves the right to review and approve the Administrative items identified below. Such approval (or disapproval) shall be given to the Design-Builder within no less than twenty-one (21) calendar days after receipt by the Authority unless otherwise specified. The Design-Builder shall incorporate any comments or corrections and deliver a revised submittal to the Authority within fourteen (14) calendar days following receipt of such by the Design-Builder unless otherwise specified. Review and approval by the Authority will not relieve the Design-Builder from its responsibility for accuracy of submittals, for conformity of submittals to and for prosecution and completion of the Contract in accordance with the Contract Documents and Final Design Specifications and Final Design Drawings.
- B. Administrative Submittals Review: Submit the original and six paper copies and one electronic copy of:
1. Cost or Pricing Data as specified in Section 00201, GENERAL INSTRUCTIONS Section 00756, AUDIT - PRICE ADJUSTMENTS, Section 00757, CERTIFICATE OF CURRENT COST OR PRICING DATA, Section 00758, PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA - PRICE ADJUSTMENTS, Section 00760, SUBCONTRACTOR COST OR PRICING DATA; and Section 01250, CONTRACT MODIFICATION PROCEDURES.
 2. Signed Contract as specified in Section 00521, DESIGN-BUILD CONTRACT FORM, Section 00611, BOND REQUIREMENTS and Section 00726, COMMENCING THE WORK.
 3. Power of Attorney as specified in Section 00541, POWER OF ATTORNEY, Section 00611, BOND REQUIREMENTS and Section 00726, COMMENCING THE WORK.
 4. Power of Execution as specified in Section 00542, POWER OF EXECUTION, Section 00611, BOND REQUIREMENTS and Section 00726, COMMENCING THE WORK.
 5. Performance Bond as specified in Section 00611, BOND REQUIREMENTS, Section 00612, PERFORMANCE BOND and Section 00726, COMMENCING THE WORK.
 6. Payment Bond as specified in Section 00611, BOND REQUIREMENTS, Section 00613, PAYMENT BOND and Section 00726, COMMENCING THE WORK.
 7. Contract Closeout Certificates including ADAAG Construction Compliance, Affidavits, Written Descriptions, Releases, and Warranties and Guarantees as specified in Section 00620,

CERTIFICATES and Section 01780, CLOSEOUT SUBMITTALS.

8. Notification of discrepancy in the figures in the Project Drawings if applicable; RFI's if work to be performed is not sufficiently detailed or explained in the Project Requirements if applicable; notification of all errors, omissions, inconsistencies if applicable; notification of conflicts among the requirements and criteria either indicated in the Project Manual and/or Project Drawings or required by local, state or federal jurisdictions or utilities that affect the scope, cost or quality of this work or other defects including inaccuracies in the Project Requirements with options to resolve if applicable as specified in Section 00703, GENERAL REQUIREMENTS, DRAWINGS AND SPECIFICATIONS and Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
9. Pre-Design and Design Review Meetings Minutes as specified in Section 00704, INTENT OF CONTRACT and Section 01312, PROJECT MEETINGS.
10. Resumes of Design-Builder Substitutions of Key Personnel if applicable as specified in Section 00710, PROJECT MANAGEMENT AND SUPERINTENDENCE AND KEY PERSONNEL and Section 01111, KEY DESIGN-BUILDER FUNCTIONS.
11. Preconstruction Inspection Records as specified in Section 00716, PRECONSTRUCTION INSPECTION and Section 01711, ACCEPTANCE OF CONDITIONS.
12. Differing Site Conditions Report if applicable as specified in Section 00717, DIFFERING SITE CONDITIONS and Section 01711, ACCEPTANCE OF CONDITIONS.
13. VECP's if applicable as specified in Section 00721, VALUE ENGINEERING INCENTIVE.
14. Schedules and Progress Reporting as specified in Section 00724, PROGRESS SCHEDULES AND REQUIREMENTS FOR MAINTAINING PROGRESS RECORDS and Section 01322, CONTRACT PROGRESS REPORTING.
15. Schedule to complete the Work earlier than any required milestone, interim or final completion date, if applicable as specified in Section 00725, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE.
16. Insurance Certificates as specified in Section 00726, COMMENCING THE WORK and Section 00787, INDEMNIFICATION AND INSURANCE REQUIREMENTS AND SPECIAL PROVISIONS OF INSURANCE FURNISHED BY DESIGN-BUILDER.
17. Designer, Builder, Major Subcontractors and Key Personnel Identification Confirmation as specified in Section 00726, COMMENCING THE WORK and Section 01111, KEY DESIGN-BUILDER FUNCTIONS.
18. Notification of the Causes of Delay if applicable as specified in Section 00728, TERMINATION FOR DEFAULT, DAMAGES FOR DELAY AND TIME EXTENSIONS.
19. Termination Claims if applicable as specified in Section 00730, TERMINATION FOR THE CONVENIENCE OF THE AUTHORITY.
20. Request for an Equitable Adjustment of the price for the portion not terminated by the Notice of Termination if applicable as specified in Section 00730, TERMINATION FOR THE CONVENIENCE OF THE AUTHORITY.

21. Requests for and Notice of Assignment if applicable in Section 00731, ASSIGNMENT.
22. Notice of Appeal if applicable as specified in Section 00732, DISPUTE RESOLUTION.
23. Advance notice to witness all tests and inspections as specified in Section 00735, ACCEPTANCE AND INSPECTION OF WORK , Section 01113, SYSTEMS INTEGRATION, Section 01470, QUALITY SYSTEM, Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING.
24. Equitable Adjustment Request for Authority-furnished property not made available as applicable as specified in Section 00736, AUTHORITY-FURNISHED PROPERTY.
25. Name of the manufacturer, the model number and other identifying data and information concerning the performance, capacity, nature and rating of the machinery and mechanical and other equipment and full information about the material or articles which are to be incorporated into the Work as specified in Section 00737, MATERIALS, WORKMANSHIP AND EQUIPMENT.
26. Hazardous Materials Report as applicable as specified in Section 00738, HAZARDOUS MATERIALS.
27. Accident Prevention Proposals, Exposure and Accident Data as specified in Section 00742, ACCIDENT PREVENTION.
28. Temporary Fire Protection Plan as specified in Section 00743, FIRE PROTECTION EQUIPMENT AND LIFE SAFETY AGREEMENT and Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS.
29. Updated Organizational Health and Safety Program (as part of the Updated PMP) and Construction and Environmental Safety Plans and other required submittals that comply with the attachments to the Project Manual; i.e., the WMATA Construction Safety and Environmental Manual as specified in Section 00371, and the Safety and Security Certification Program Plan as specified in Section 00381, the System Safety Program Plan as specified in Section 00391, and as further specified in the Safety Rules and Procedures Manual, Section 00744, PROTECTION OF PERSONS AND PROPERTY, Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS and Section 01310, PROJECT MANAGEMENT AND COORDINATION.
30. Request for an Extension of Time due to delay from quantity variation if applicable as specified in Section 00748, VARIATIONS IN ESTIMATED QUANTITIES.
31. Applications for Payment including breakdown of price for major work categories, updated schedules, evidence of proof of the ownership, quantity and value of such delivered materials, properly executed bills of sale for materials and QA/QC Manager's Statement of Compliance Quality Certification for Payment Verification as specified in Section 00749, METHOD OF PAYMENT, Section 01111, KEY DESIGN-BUILDER FUNCTIONS, Section 01290, PAYMENT PROCEDURES and Section 01470, QUALITY SYSTEM.
32. Request for Final Payment as specified in Section 00749, METHOD OF PAYMENT, Section 01290, PAYMENT PROCEDURES, Section 01770, CLOSEOUT PROCEDURES and Section 01780, CLOSEOUT SUBMITTALS.

33. Properly executed voucher; Release of all claims against the Authority; and satisfactory records for design, inspection, testing or other quality elements upon completion and acceptance of all work as specified in Section 00749, METHOD OF PAYMENT, Section 01770, CLOSEOUT PROCEDURES and Section 01780, CLOSEOUT SUBMITTALS.
34. Breakdown of the Total Contract Price for every lump sum item on the Price Schedule with supporting data as applicable as specified in Section 00750, PROGRESS PAYMENTS FOR LUMP SUM ITEMS.
35. Subcontractor Applications for Payment, Subcontractor Payment Certification and Subcontractor non-payment notice with Payment Request as applicable as specified Section 00752, SUBCONTRACT PAYMENTS.
36. Equitable Adjustment Proposals and Written Notice of Change as applicable as specified in Section 00753, CHANGES and Section 01250, CONTRACT MODIFICATION PROCEDURES.
37. Cost proposal in advance of performance of any work for which a price adjustment is requested under this Contract as applicable, proposed cost records and accounting system and daily report form as specified in Section 00755, ACCOUNTING AND RECORD KEEPING and Section 01250, CONTRACT MODIFICATION PROCEDURES.
38. Warranties and Guarantees as specified in Section 00762, WARRANTY OF CONSTRUCTION and Section 01780, CLOSEOUT SUBMITTALS.
39. If applicable, recommendation for Corrective Actions, together with supporting information; Schedule of Deficiency Corrections; Data and Reports applicable to any correction; and a Technical and Cost Proposal to amend the Contract to permit acceptance of the affected materials, equipment, systems or subsystems as specified in Section 00763, CORRECTION OF DEFICIENCIES and Section 01780, CLOSEOUT SUBMITTALS.
40. Request for Exception to conflict of interest clause with full disclosure and for good cause as applicable and notification of non-compliance the provisions of conflict of interest clause with full disclosure as applicable as specified in Section 00767, CONFLICT OF INTEREST.
41. Request to consider the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program and Weekly Payrolls and Employee Records accompanied by a "Statement of Compliance" as specified in Section 00774, LABOR PROVISIONS.
42. Notification of actual or potential labor dispute delaying or threatens to delay the timely performance including all relevant information with respect thereto as applicable as specified in Section 00777, NOTICE TO THE AUTHORITY OF LABOR DISPUTES.
43. Warrant that no amount for newly imposed Federal excise tax or duty or rate increase was included in the Contract price as a contingency reserve or otherwise as applicable; request to furnish evidence appropriate to establish exemption from any Federal, State, or Local tax as applicable; and notification of matters which will result in either an increase or decrease in the Contract price as applicable as specified in Section 00779, FEDERAL, STATE AND LOCAL TAXES.
44. Report of each notice or claim of patent or copyright infringement based on the performance

of this Contract of which the Design-Builder has knowledge as applicable and all evidence and information in possession of the Design-Builder pertaining to any action, suit or claim against the Authority on account of any alleged patent or copyright infringement arising out of or related to the performance of this Contract or out of the use of any supplies furnished or work or services performed hereunder as applicable as specified in Section 00784, NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT.

45. Technical data including technical writing, computer software, sound recordings, pictorial reproductions, drawings, or other graphic representations and works of a technical nature, whether or not copyrighted, which are specified to be delivered pursuant to this Contract. The term does not include financial reports, cost analyses, and other information incidental to Contract administration. Computer software means computer programs, computer data bases, and documentation; and Notice or claim of copyright infringement with respect to any technical data delivered hereunder as specified in Section 00785, TECHNICAL DATA - WITHHOLDING OF PAYMENT and Section 01780, CLOSEOUT SUBMITTALS.
46. Equitable Adjustment Request for Authority-furnished property not made available as applicable as specified in Section 00836, AUTHORITY-FURNISHED PROPERTY REQUIREMENTS if applicable.
47. Assistant Safety Superintendent if applicable and First Aid Attendant if applicable resumes and certifications as specified in Section 00844, SAFETY SUPERINTENDENCE REQUIREMENTS.
48. Certified Safety Statement for Insurance Coverages with Weekly Certified Payroll Records for Authority-Furnished Insurance as applicable as specified in Section 00887, INSURANCE REQUIREMENTS.
49. Written demand requesting an equitable adjustment as applicable, review request of decision on whether to proceed with DRB proceedings as applicable, request that a specific dispute not be subject to the Disputes Review Board as applicable and written appeal as applicable as specified in Section 00832, DISPUTES REVIEW BOARD REQUIREMENTS if applicable.
50. FTA Clauses, if applicable, as specified in Section 00892, FTA REQUIREMENTS:
 - a. Rights in Data and Copyrights - FTA Subject Data whether or not copyrighted.
 - b. Cargo Preference - Use of United States Flag Vessels: Certification that no U.S. Flagships Available.
 - c. Fly America Requirements: Certificate of Compliance with the Fly America requirements and if a foreign air carrier was used, an appropriate certification or memorandum if a foreign air carrier was used adequately explaining why service by a U.S. flag air carrier was not available.
51. Updated Overview of the Quality Management System and Updated Finalized Design Control Plan, Finalized Quality Plan, Updated Quality Management System (as part of the Updated PMP) and Inspection and Testing Plans and Reports including Quality Manual, Plans, Reports and Procedures; Document Control Procedures; Subcontracting and Purchasing Procedures; Process Control Procedures; Inspection, Measuring and Test Equipment Procedures; Reporting, Review and Disposition of Non-Conforming Product Procedures; Control of Quality Records Procedures; Internal Quality Audit Procedures and QA/QC Records; Summary of

Management Review Findings and Corrective Actions; Audit Results; Status Reports; QA/QC Manager's Statement of Compliance Quality Certification for Payment Verification; and Certifications in General Requirements Section 01111, KEY DESIGN-BUILDER FUNCTIONS; Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA; Section 01113, SYSTEMS INTEGRATION; Section 01310, PROJECT MANAGEMENT AND COORDINATION; and Section 01470, QUALITY SYSTEM.

52. Systems Integration and Testing Plans, Procedures and Records as applicable: Systems Integration Procedure and Systems Operations Description including Interface Control Document; Interface Matrix; Systems Interface Report; Description of Route Operations; Integration Procedure; Working Model of Systems Integration Database; Systems Integrator Identification; Major Systems Identification; Major Coordination Effort Identification; Interfaces on Critical Path Identification; WMATA Reliability, Availability and Safety Goals Identification and Compliance; Layout and Interface Identification; Emergency Procedures; All Systems, Interfaces and Schedule Impact Identification; All Coordination Efforts; High Priority Interface Identification; Consolidated Drawings; Integration Design Technical Documentation; Operations Procedures for All Interfaces; Proposed Standards; Manuals; Flow Charts; Operation Procedures; Verification Procedures; Test Procedures; Inspection Records; Test Results; Certificates of Compliance; Audit Information; and Acceptance Testing Plan in General Requirements Section 01111, KEY DESIGN-BUILDER FUNCTIONS; Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION, Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS, Section 01310, PROJECT MANAGEMENT AND COORDINATION, Section 01470, QUALITY SYSTEM, Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING.
53. Memorandum of record of conferences with governmental, public and private agencies and others and notification of any betterments or other work beyond the Contract scope requested by private and public agencies and property owners as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
54. ADAAG Design Compliance Certification and the ADA Facilities Accessibility Checklist; Design Review Team documentation of jurisdictional compliance; Design Control Procedures; Configuration Management Plans and Procedures; Design Change Requests; Design Documentation; Records of Design Reviews; and Design Analysis and Calculations Substantiation Reports, Product Test, Acceptance and Verification Criteria/Procedures as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.
55. Satisfactory records for design, inspection, testing or other quality elements required under the approved Design-Build Quality System as specified in Section 01113, SYSTEMS INTEGRATION, Section 01470, QUALITY SYSTEM and Section 01780, CLOSEOUT SUBMITTALS.
56. Record of federal, state, or local violations of environmental and occupational safety and health regulations for the last 3 years; Updated Organizational Health and Safety Program including OSHA required programs applicable to the work and site (for work and sites not addressed in the original Updated Organizational Health and Safety Program, addenda may be added when the work and sites are identified and resubmitted to the Authority Representative); Job Hazard Analysis (prior to each phase of work); Site-specific Emergency Response Plan; Site-specific Temporary Fire Protection System Plans; Site-specific Waste Water Discharge Plan (if wastewater is generated); Site-specific Pollution Control Program; Site-specific Dust and Debris Control Plan; Bloodborne Pathogens Exposure Control Plan; Hearing Conservation

Program (if employees are exposed to continuous noise in excess of the OSHA Action Level); Respiratory Protection Program (if employees are exposed to dust [including crystalline silica] or other toxic atmospheres in excess of the OSHA permissible exposure limits. If a respiratory program is required, the Design-Builder also must provide documentation of training, medical clearance for respirator use and respirator fit testing documentation); Hot Work Program; Lockout-Tagout Program; Site-specific Confined Space Program; Documentation of applicable training, licenses, certifications; Results of noise monitoring, air monitoring, and soil, water or waste sampling (these to be submitted at least weekly during work activities); Documentation of medical surveillance; Documentation and Certifications of Assistant Safety Superintendent's and First Aid Attendant's, as applicable, experience in construction safety; Identity of all materials or chemicals the Design-Builder will use on Authority property (including welding rods, material safety data sheets (MSDS's) for these products, and a brief explanation of how they will be used and if any wastes will be generated); Identity of equipment that may generate toxic atmospheres such as gasoline or diesel-powered generators, welding and cutting equipment; Documentation of licenses and certificates required for lead or asbestos abatement or other work requiring licensing or certification such as welding; Documentation of licenses, certificates, and U.S. EPA identification numbers required for transportation of hazardous materials, hazardous substances, or hazardous wastes; Documentation of licenses, permits, and certificates required for disposal of hazardous wastes including the name and address of the waste disposal facility where hazardous waste materials are to be disposed; Certificates of Insurance (including pollution liability coverage endorsed to WMATA for Design-Builder or subcontractors performing work involving hazardous materials, hazardous substances, hazardous wastes, or contaminated soil or water); CCO Certificate before the crane operator works on the site; Site-specific Fall Protection Plan; and Documentation to show that all Confined Space entrants and attendants are trained in Confined Space Entry, including hands-on-training or Confined Space Awareness as applicable and possesses applicable licenses and certifications as specified in Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS.

57. Site Specific Work Plan, detailed weekly work schedule; special requests for access, single tracking, power outages, escorts and other authority support services; request for use of work train; request for track rights; and advance notice of abatement work as applicable as specified in Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS.
58. Noise monitoring data and compliance information, noise measurement report, proposed noise monitoring locations, proposed haul routes, notification of commencement and completion of work and ready for inspection on parkland property, notification of temporary work stoppage and resumption of work, layout drawings of Design-Builder's facilities, proposed vibration monitoring locations, conditions requiring blasting during restricted hours report, historical and scientific specimens located notification, explosives magazines and truck parking locations and advance notice of work on railroad property as applicable as specified in Section 01143, USE OF SITE.
59. Documented offer for credit; All computed percentages prior to any time and materials work being performed; Material charges substantiated by valid copies of vendor's invoices with the daily report sheets, or if not available, they shall be submitted with subsequent daily report sheets; Report sheets of each day's work paid for on a time and materials basis itemizing the materials used, covering the direct cost of labor and the charges for equipment rental, with names or identifications and classifications of workmen, the hours worked, and also the size, type and identification number of equipment, and hours operated; Satisfactory evidence of the cost of such materials from the actual supplier thereof; and Cost Data and Basic Equipment Information including manufacturer, year, size, model, serial number, capacity, and weight and all other data which might assist the Authority in the establishment of equipment costs;

Subcontractor(s) requests for a Part 1 modification; as applicable as specified in Section 01250, CONTRACT MODIFICATION PROCEDURES.

60. DRB candidate members' and chairperson's complete disclosure statements including resume of experience and education; detailed description of all past, present, and planned future relationship(s) to the Authority's Rail Capital Construction Program or with any party involved in the Contract, including any fee-based consulting services on any other projects, and certification that the prospective member meets the qualifications set forth; rules of operation; draft and final findings and recommendations; and request a final decision of the Contracting Officer accompanied by a full explanation as to basis for the rejection of the DRB recommendation(s) as applicable as specified in Section 01260, DISPUTES REVIEW BOARD PROCEDURES.
61. Updated Comprehensive Project Management Plan (PMP), Coordination Drawings/Composite Drawings, and Staff Names: List of principal staff assignments in attendance at Project site as specified in Section 01310, PROJECT MANAGEMENT AND COORDINATION.
62. Complete correspondence file as specified in Section 01310, PROJECT MANAGEMENT AND COORDINATION and Section 01780, CLOSEOUT SUBMITTALS.
63. Construction Sequence and Staging Plans as specified in Section 01310, PROJECT MANAGEMENT AND COORDINATION and Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.
64. Meeting Agendas and Minutes as specified in Section 01312, PROJECT MEETINGS.
65. Construction Photographs as specified in Section 01321, CONSTRUCTION PHOTOGRAPHS.
66. Schedules and Progress Reporting including Submittal Logs, Daily Progress Reports, Updated Initial 90-Day Schedule, Updated Initial Bar Graph/Cost-Loaded CPM Schedule, Monthly Updates of Design Schedule, Monthly Progress Status Report, Monthly Narrative Report, Monthly Updates of Bar Graph/Cost-Loaded CPM Schedule, 90-Day Rolling Schedule, Two-Week Work Plan, and Daily Progress Reports as applicable; Request for any Extension of Contract time as applicable including documentation with written justification and CPM schedule; Notice of Disagreement to Authority's requested corrections to the schedule as applicable; and Resume of Replacement Scheduler Candidate as applicable as specified in Section 01322, CONTRACT PROGRESS REPORTING.
67. Site plans indicating all temporary utility connections; detailed working drawings of utility connections and special facilities; necessary revisions to working drawings after existing utility facilities have been located by field investigations to reflect actual site conditions; reports for tests, inspections, meter readings and similar procedures performed for temporary utilities; and on its first schedule submission as described in Section 01322, CONTRACT PROGRESS REPORTING, the implementation and termination of each temporary utility as applicable as specified in Section 01510, TEMPORARY UTILITIES.
68. Working Drawings for Temporary Facilities, Layout of Plant and Materials Storage Plan as specified in Section 01520, TEMPORARY CONSTRUCTION FACILITIES.
69. Working Drawings and design calculations showing proposed procedures and methods of constructing temporary structures including support system and necessary construction details and certified information concerning each previous use of materials to include purpose, duration and type of loading as specified in Section 01530, TEMPORARY CONSTRUCTION.

70. Maintenance of Traffic Plan as specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.
71. Working Drawings and design calculations for barriers, fences and pedestrian bridges as specified in Section 01560, TEMPORARY BARRIERS AND ENCLOSURES.
72. Products List as specified in Section 01610, BASIC PRODUCT REQUIREMENTS.
73. As applicable, all survey field notes and all results of Control Surveys, Project Structural As-Built Surveys, Movement Detection Surveys, Early Alignment As-Built Surveys, Hi-Lo Surveys, Post Construction Alignment As-Built Surveys and Final Trackway Monumentation Surveys, survey procedures, and surveyor resumes, as applicable, as specified in Section 01721, LAYOUT OF WORK AND FIELD ENGINEERING.
74. Contract Record Drawings including As-Built Contract Drawings, Standard Drawings, Informational Layout and Detail Drawings, Authority Record Drawings, Shop Drawings, Working Drawings, Manufacturers' Shop Drawings, Field Drawings, and Installation Drawings as applicable; As-Built Record Specifications in CSI format; As-Built CPM Schedule as applicable; Operation and Maintenance Manuals as applicable; Electronic Media Drawing Files for Operation and Maintenance Manuals as applicable; Fully documented complete Configuration Management System; List of required Spare Parts as applicable; Survey Record Log as applicable; and Releases & Vouchers as specified in Section 01780, CLOSEOUT SUBMITTALS.
75. Instructor's Training Manual, Lesson Plans, Student's Training Manual and Electronic Media as applicable as specified in Section 01780, CLOSEOUT SUBMITTALS and Section 01820, DEMONSTRATION AND TRAINING.

3.10 ORGANIZATION AND SUBMISSION OF SUBMITTALS

- A. The Design-Builder shall organize its submittal packages to the Authority so that each submittal package contains all relevant material necessary to allow WMATA to conduct a thorough review. For example, if approval of a structural design element also requires consideration of electrical conduit placement and mechanical pipe elements, then all relevant structural, electrical and mechanical drawings should be provided within the same submittal package to allow consideration of relevant elements in the approval of structural element. As well, composite drawing may be required as described elsewhere in this document.
- B. The Design-Builder shall organize its submittal packages so that each submittal package corresponds to a submittal or submittal and approval requirement. For example, if an electrical drawing that illustrates conduit layout is to be submitted as part of a structural submittal, and it also forms part of an electrical submittal, then the drawing should be submitted as a part of each submittal packages.

END OF SECTION



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SECTION 01410

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

This Section specifies information required for conformance to regulatory requirements, such as building codes, mechanical codes, electrical codes, ADAAG regulations or other regulations applicable to the project.

1.02 RELATED DOCUMENTS

Section 00705, General Conditions: Legal Requirements

Section 00707, General Conditions: Permits and Responsibilities

Section 00708, General Conditions: Responsibility of the Design-Builder for Design-Related Services

Division 01, General Requirements

Divisions 2 through 16, Standard and Technical Specifications Requirements

1.03 GENERAL

The Design-Builder shall meet or exceed the Authority's Design Criteria relevant for each element of the work as these represent the minimum standards to be used for design and construction. If the International, Federal, State, or local jurisdictional laws, codes and regulations that also control the design and construction of the Project exceed the Authority requirements, then the more stringent standard shall govern.

1.04 THE JURISDICTIONAL AGENCIES, RAILROADS, UTILITIES AND MISCELLANEOUS AGENCIES

A. Federal agencies:

1. Environmental Protection Agency (EPA).
2. Federal Aviation Administration (FAA).
3. Federal Highway Administration (FHWA).
4. Federal Transit Administration (FTA).
5. General Services Administration (GSA).
6. Department of the Interior:
 - a. National Park Service (NPS), National Capital Region.
7. Occupational Safety and Health Administration (OSHA).

8. U.S. Army, Corps of Engineers (COE):
 - a. Washington Aqueduct Division.
 - b. Baltimore District.
 - c. Norfolk.
 9. U.S. Coast Guard (USCG).
 10. U.S. Navy, Naval Facilities Engineering Command (NAVFAC).
 11. Architectural and Transportation Barriers Compliance Board (ATBCB):
 - a. American with Disabilities Act Accessibility Guidelines (ADAAG).
 12. Federal Emergency Management Agency (FEMA).
 13. U.S. Army Engineer District.
 14. Department of Defense (DOD).
- B. District of Columbia:
1. Department of Consumer and Regulatory Affairs:
 - a. Building and Land Regulation Administration.
 2. Department of Environmental Services.
 3. Department of Health (Environmental Health Administration).
 4. Bureau of Hazardous Materials and Toxic Substances - NOT USED
 5. Bureau of Environmental Quality - NOT USED.
 6. Department of Housing and Community Development:
 - a. Redevelopment Land Agency.
 7. Department of Human Services.
 8. Department of Public Works:
 - a. Bureau of Traffic Services.
 - b. Design and Engineering Construction Administration.
 - c. Bureau of Design, Engineering and Research.
 - (1) Traffic and Electrical Services Division.
 - d. Bureau of Engineering and Construction.

(1) Project Development Division.

9. Department of Recreation and Parks.
10. Department of Transportation:
 - a. Office of Mass Transit.
11. Fire Department.
12. Metropolitan Police Department.
13. Bureau of Air & Water Quality Control - NOT USED.
14. Department of Sanitary Engineering.
15. Department of Highway Facilities.
16. Department of Planning.

C. State of Maryland:

1. Department of Transportation.
 - a. State Highway Administration.
 - b. State Railroad Division.
 - c. Office of Traffic.
 - d. Office of the District Engineer (District #3).
2. Department of Natural Resources:
 - a. Water Resources.
3. Department of Health and Mental Hygiene.
4. Department of the Environment:
 - a. Industrial Waste Division.
5. Department of Transportation.

D. Montgomery County:

1. Department of Transportation.
2. Storm Water Control.
3. Department of Fire and Rescue Services.
4. Department of Public Works.

5. Soil Conservation District.
6. Department of Environmental Protection:
 - a. Division of Pollution Control.
 - b. Sediment Control Permit.
7. Office of Architectural Service.
8. Police Department.
- E. Prince George's County:
 1. Department of Public Works and Transportation.
 2. Soil Conservation District.
 3. Health Department.
 4. Fire Department.
 5. Department of Environmental Resources.
- F. City of Greenbelt.
- G. Railroads:
 1. Consolidated Rail System Corporation.
 2. CSX Transportation:
 - a. Baltimore and Ohio Railroad.
 - b. Chesapeake and Ohio Railroad.
 - c. Richmond, Fredericksburg and Potomac Railroad Company.
 3. National Railroad Passenger Corporation (AMTRAK):
 - a. Washington Terminal Company.
 4. Southern Railway System.
 5. Norfolk Southern Corporation.
 6. Penn Central Transportation Company.
 7. Philadelphia, Baltimore & Washington Railroad Co.
- H. Utilities: See Section 01180.

- I. Miscellaneous agencies:
1. Maryland-National Capital Park and Planning Commission.
 2. Metropolitan Washington Airports Authority.
 3. National Capitol Planning Commission.
 4. Washington Suburban Transit Commission.
 5. Metropolitan Washington Council of Governments.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION

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SECTION 01420

REFERENCES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section lists the reference standards cited in the Contract Documents, the organizations or jurisdictional agencies whose standards are cited, or both.
- B. When reference is made to codes, regulations, reference standards and specifications, the work shall conform to the current edition as of the date of receipt of proposals, unless otherwise specified.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions

Section 00800, Supplementary Conditions

Division 01, General Requirements

Divisions 02 through 16, Standard and Technical Specifications Requirements

1.03 ABBREVIATIONS AND ACRONYMS

AAR:	Association of American Railroads.
AASHTO:	American Association of State Highway and Transportation Officials.
ABS:	Acrylonitrile-Butadiene-Styrene.
ac:	Alternating Current.
ACGIH:	American Conference of Governmental Industrial Hygienists.
ACI:	American Concrete Institute.
A/D:	Analog to Digital.
ADA:	Americans with Disabilities Act.
ADAAG:	Americans with Disabilities Act Accessibility Guidelines.
AHA:	American Hardboard Association.
AHDGA:	American Hot Dip Galvanized Association, Inc.
AI:	Asphalt Institute.
AISC:	American Institute of Steel Construction.
AISI:	American Iron and Steel Institute.
AMCA:	Air Moving and Conditioning Association.
AMTRAK:	National Railroad Passenger Corporation.
ANSI:	American National Standards



	Institute (synonymous with USASI-ASA).
API:	American Petroleum Institute.
AREA:	American Railway Engineering Association (See AREMA).
AREMA:	American Railway Engineering and Maintenance of Way Association (formerly AREA.
ARI:	Air Conditioning and Refrigeration Institute.
ASHRAE:	American Society of Heating, Refrigerating and Air-Conditioning Engineers.
ASME:	American Society of Mechanical Engineers.
ASNT:	American Society of Nondestructive Testing.
ASTM:	American Society of Testing and Materials.
ATBCB:	Architectural and Transportation Barriers Compliance Board.
AT&T:	American Telephone and Telegraph Company.
AWG:	American Wire Gauge (synonymous with Brown and Sharpe).
AWI:	Architectural Woodwork Institute.
AWWA:	American Water Works Association.
AWS:	American Welding Society.
AWPA:	American Wood Preservers' Association.
BG&E:	Baltimore Gas and Electric Company.
BIA:	Brick Institute of America.
BLS:	Bureau of Labor Statistics.
B&O:	Baltimore & Ohio Railroad. (Division of the CSX Transportation).
BOCA:	Building Officials and Code Administrators International.
BTU:	British Thermal Unit.
BTUH:	British Thermal Units Per Hour.
C:	Celsius (Centigrade).
CAGI:	Compressed Air and Gas Institute.
CE:	U.S. Army, Corps of Engineers.
cfm:	Cubic Feet Per Minute.
CISPI:	Cast Iron Soil Pipe Institute.
CMU:	Concrete Masonry Unit.
C&O:	Chesapeake and Ohio Railroad (Division of the CSX Transportation).
CONRAIL:	Consolidated Rail Corporation (formerly Penn Central).
CQCS	Contractor's Quality Control System.
CRSI:	Concrete Reinforcing Steel Institute.
CSX:	CSX Transportation (formerly Chessie

	System, B&O, C&O, and Chesapeake & Ohio).
CTI:	Cooling Tower Institute.
dB:	Decibel(s).
dc:	Direct Current.
DCDCRA:	District of Columbia, Department of Consumer and Regulatory Affairs.
DCDES:	District of Columbia Department of Environmental Services.
DCDHS:	District of Columbia Department of Human Services.
DCDOH:	District of Columbia, Department of Health (Environmental Health Administration [EHA]).
DCDOT:	District of Columbia Department of Transportation.
DCDPW:	District of Columbia Department of Public Works.
DCHCD:	District of Columbia Department of Housing and Community Development.
DCMPD:	District of Columbia Metropolitan Police Department.
DCWASA:	District of Columbia Water and Sewer Authority.
DFT:	Dry Film Thickness.
DILM:	Ductile Iron Pipe, Cement-Lined and Coated, Mechanical Joint.
DILP:	Ductile Iron Pipe, Cement-Lined and Coated, Push-On-Joint.
DPST:	Double Pole, Single Throw.
DTS:	Data Transmission System.
EPA:	Environmental Protection Agency.
EPR:	Ethylene-Propylene-Rubber.
F:	Fahrenheit.
FAA:	Federal Aviation Administration.
FCCCR:	Foundation for Cross-Connection Control Research of the University of Southern California Engineering Center.
FHWA:	Federal Highway Administration.
FM:	Factory Mutual Associates.
FS:	Federal Specifications.
FED STD:	Federal Standard.
FTA:	Federal Transit Administration (formerly UMTA).
GPH:	Gallons Per Hour.
GSA:	General Services Administration.
HOA:	HAND/OFF/AUTOMATIC.
HP:	Horsepower.
HVAC:	Heating, Ventilating and Air Conditioning.
IBC;	International Building Code.
ICEA:	Insulated Cable Engineers Association.
ICI:	Industrial Coatings International.
ID:	Inside Diameter.
IEEE:	Institute of Electrical and Electronic Engineers.
IPS:	Iron Pipe Size.
JGB:	Jackson Graham Building



	600 Fifth Street, N.W. Washington, D.C. 20001 (formerly OCCB)
kHz:	Kilo Hertz.
kV:	Kilovolts.
kVA:	Kilovolts-amperes.
kW:	Length-to-Diameter Ratio.
LED:	Light Emitting Diode.
mV:	1,000 volts.
mVA:	1,000 volts-amperes.
MCM:	1,000 Circular Mils.
MCP:	Motor Circuit Protector.
MDNR:	Maryland Department of Natural Resources.
METRO:	Logo for the Washington Metropolitan Area Transit Authority.
MNCPPC:	Maryland-National Capitol Park and Planning Commission.
MS:	Military Specification.
MSG:	Manufacturers' Standard Gauge.
MIL STD:	Military Standard.
MSHA:	Maryland State Highway Administration.
MSS:	Manufacturer's Standardization Society of the Valve and Fitting Industry.
MTPD:	Metro Transit Police Department.
MWAA:	Metropolitan Washington Airports Authority.
MWRA:	Maryland Water Resources Administration (Part of MDNR).
NAAMM:	National Association of Architectural Metal Manufacturers.
NACE:	National Association of Corrosion Engineers.
NAVFAC:	USN, Naval Facilities Engineering Command.
NBGQA:	National Building Granite Quarries Association.
NBS:	National Bureau of Standards.
NC:	Normally Closed.
NCMA:	National Concrete Masonry Association.
NEBB:	National Environmental Balancing Bureau.
NEC:	National Electrical Code.
NEMA:	National Electrical Manufacturers Association.
NFPA:	National Fire Protection Association.
NIOSH:	National Institute for Occupational Safety and Health.
NO:	Normally Open.
NPS:	National Park Service.

NTP:	Notice to Proceed.
NTIS:	National Technical Information Service.
OCCB:	Operations Control Center Building 600 Fifth Street, N.W. Washington, D.C. 20001 (see JGB)
OD:	Outside Diameter.
OS&Y:	Outside Stem and Yoke.
OSHA:	U.S. Department of Labor, Occupational Safety and Health Administration.
PCI:	Prestressed Concrete Institute.
PDI:	Plumbing and Drainage Institute.
PE:	Polyethylene.
PEI:	Porcelain Enamel Institute.
PEPCO:	Potomac Electric Power Company.
PGFD:	Prince Georges County, Fire Department.
PGDPW&T:	Prince Georges County, Department of Public Works and Transportation.
PGSCD:	Prince Georges County, Soil Conservation District.
PPHM:	Parts Per Hundred Million.
PPM:	Parts Per Million.
psf:	Pounds Per Square Foot.
psi:	Pounds Per Square Inch.
psig:	Pounds Per Square Inch Gauge.
PVC:	Polyvinyl Chloride.
RCRA:	Resource Conservation and Recovery Act.
rms:	Root Mean Square.
rpm:	Revolutions Per Minute.
ROD:	Revenue Operation Date.
RQD:	Rock Quality Designation.
SDI:	Steel Deck Institute or Steel Door Institute, depending upon context in which it occurs.
SMACNA:	Sheet Metal and Air-Conditioning Contractors National Association.
S1S:	Smooth One Side.
S2S:	Smooth Both Sides.
SJI:	Steel Joist Institute.
SPDT:	Single Pole, Double Throw.
SPST:	Single Pole, Single Throw.
SSPC:	Steel Structures Painting Council.
TBM:	Tunnel Boring Machine.
TCA:	Tile Council of America.
TGA:	Thermogravimetric Analysis.
UFAS:	Uniform Federal Accessibility Standards.
UL:	Underwriter's Laboratories, Incorporated.
UMTA:	Urban Mass Transit Administration.

UPS: Unit Price Schedule or Uninterruptible Power System, depending upon context in which it occurs.

USBR: U.S. Bureau of Reclamation.

USCG: U.S. Coast Guard.

USCS: U.S. Commercial Standard.

USDA/SCS: U.S. Department of Agriculture - Soil Conservation Service.

USDOT: U.S. Department of Transportation.

USN/CD: U.S. Navy, Chesapeake Division.

USPS: U.S. Product Standard.

USSG: United States Standard Gauge.

WAD: Washington Aqueduct Division (Element of U.S. Army C.E., Baltimore District).

WSSC: Washington Suburban Sanitary Commission.

XLPE: Cross-Linked Polyethylene.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

SECTION 01470

QUALITY SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

- A. This Section specifies the Quality System that is to be established, documented, maintained, and executed by the Design-Builder to ensure that the performed Work conforms to the specified requirements. The Quality System shall be consistent with the ISO 9001:1994 standard. Certification of the Design-Builder to ISO 9001 is not required. However, certain suppliers and manufacturers shall be certified as required in the specifications.
- B. Quality System elements include the following documentation:
1. An Interim Quality Management System to document the Design-Builder's plan for a complete and executable Quality Management System.
 2. A Quality Management System (including a Quality Manual and Quality Procedures) to consist of:
 - a. Design Control Plan
 - b. Document Control Procedures.
 - c. Subcontracting and Purchasing Procedures
 - d. Process Control Procedures
 - e. Inspection and Test Plans
 - f. Integrated System Test Plan
 - g. Procedures for Control of Inspection, Measuring and Test Equipment
 - h. Procedures for Reporting, Review and Disposition of Nonconforming Product
 - i. Procedures for Control of Quality Records
 - j. Procedures for Performing Internal Quality Audits
- C. Quality Assurance Standards applicable to the work include the following:
1. ISO 9001:1994: Quality systems - Model for quality assurance in design, development, production, installation and servicing.
 2. ISO 10013:1995 - Guidelines for Developing Quality Manuals.
- D. For definitions regarding quality used in this Section, refer to ISO 8402:1994, Quality management and quality assurance - Vocabulary.

1.02 RELATED DOCUMENTS

Section 00371, WMATA Construction Safety and Environmental Manual Requirements
Section 00381, Safety and Security Certification Program Plan Requirements
Section 00391, System Safety Program Plan Requirements
Section 00700, General Conditions
Section 00800, Supplementary Conditions
Division 01, General Requirements
Divisions 2 through 16, Standard and Technical Specifications Requirements
Safety Rules and Procedures Manual
Metrorail Safety Rules and Procedures Handbook

1.03 PROGRAM REQUIREMENTS

- A. The Design-Builder shall maintain a documented, operational, and approved Quality Management System throughout the term of the Contract. This system shall generally be as prescribed in ISO 9001:1994 and as supplemented in the Contract Documents.
- B. Certification of the Design-Builder under ISO 9001 is not required. The purpose of this program is for the Design-Builder to document how it will execute the work to assure that:
1. The Design-Builder's design process translates the Authority's needs and requirements into an acceptable design, including the requirements for Design-Builder certification of ADAAG regulations compliance and completion of an ADA Facilities Accessibility Checklist as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA to accompany each specified level of completion design review submittal as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL REQUIREMENTS.
 2. Material, equipment, construction, and workmanship are furnished in conformance with the original Contract Documents and the Design-Builder's Final Design Drawings and Final Design specifications Issued for Construction and with all jurisdictional codes and regulations, including the requirement for certification of ADAAG regulations compliance submittal at completion of construction by the Design-Builder as specified in Section 01780, CLOSEOUT SUBMITTALS. The Design-Builder's attention is directed to the fact that all projects are subject to FTA assessment for ADAAG compliance.
 3. The work is properly completed, tested, and furnished to the Authority on time as specified in this Section; and in Section 01113, SYSTEMS INTEGRATION; Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS; and Section 01810, COMMISSIONING; in the WMATA Safety and Security Certification Program Plan and the System Safety Program Plan Attachments to the Project Manual; and in the Safety Certification Program of the Safety Rules and Procedures Manual.
- C. During the Term of the Contract, the Design-Builder shall exercise positive control over all of the Work, including that of subconsultants, subcontractors, fabricators, manufacturers, installers, and suppliers (suppliers and subcontractors) in accordance with the Quality Manual and Quality Procedures described in an approved Design-Builder Quality Management System.
- D. In addition to the basic Quality Management System, the Design-Builder shall develop, implement, and update specified Plans that are fundamentally required to assure satisfactory execution of the Work. These Design-Builder Plans shall supplement and shall be integral components of the Quality Management System.

- E. The Quality Management System shall be revised, updated, and approved as necessary throughout the term of the Contract to reflect changes determined by management review, internal audit and/or WMATA audit to be necessary to improve the system.

1.04 OVERVIEW OF PROPOSED QUALITY MANAGEMENT SYSTEM

- A. Revision 0 of the Quality Management System describing the proposed Quality Management System including Quality Plan from a past similar project that was modeled on ISO 9000 or similar quality control system was submitted with the Phase One Qualifications.
- B. The Interim Plan shall provide:
 - 1. A description of the approach, plan and schedule for providing a documented Quality Management System as required in this Section and elsewhere in the Contract Documents.
 - 2. Interim steps to be taken by Design-Builder to assure quality while the Finalized Quality Management System is being developed, approved, and implemented.
 - 3. Identification of staffing (e.g. positions) for personnel who will fulfill key functions affecting quality, including key managers of design, construction, and the quality staff.
 - 4. A contract-specific Finalized Design Control Plan for this project.
 - 5. The planned approach for construction and systems inspection and testing including that of suppliers and subcontractors.
 - 6. The planned approach for systems testing, including that of Design-Builder suppliers and subcontractors.
 - 7. Planned means for communication of quality requirements of this section to subconsultants, subcontractors and manufacturers including requirements for Quality Plans to management, plant/site visits and discussions with subcontractor executive management.
 - 8. Development and implementation of subcontractor quality oversight by the Design-Builder including inspection, and testing required by the Contract Documents.
 - 9. Development of Quality Management System requirements for critical subcontract elements.
 - 10. The planned approach for employee training.
 - 11. The planned approach for performing internal audits and audits of subconsultants and subcontractors.

1.05 FINALIZED QUALITY MANAGEMENT SYSTEM

- A. The Design-Builder shall develop a Quality Management System for the project using article 4.0 of the ISO 9001:1994 Standard and ISO 10013 as guides. The QMS shall be an executable system of Quality Assurance and Quality Control that addresses all twenty elements of the Standard and the System. As a minimum, it shall include a Quality Manual, Procedures, and the

Plans specified in this Section. Further, the Quality Manual shall show the connection and relationship of all Procedures and Quality Plans to the Quality Manual.

- B. The Quality Manual, Procedures, and Plans shall be approved by the Executive(s) responsible for the Design-Build entity.
- C. Initial submission and subsequent revisions of the Quality Manual and Quality Procedures shall require Authority approval. In addition, the execution of the Quality Management System shall be subject to Authority audit throughout the term of the Contract.
- D. Work Instructions shall be approved at the appropriate level within the Design-Builder organization and are subject to audit by the Authority.

1.06 CLARIFICATIONS AND ADDITIONAL REQUIREMENTS

The following clarifications and additional requirements, as they relate to article 4.0 of the ISO 9001:1994 Standard and ISO 10013, shall be incorporated in the Quality Management System:

A. Organization

- 1. Responsibility and Authority (ISO 9001, article 4.1.2.1) - Design-Builder personnel responsible for implementing the quality system shall have the authority to stop the work.
- 2. There shall be a clearly articulated Quality Policy (ISO 9001, article 4.1.1) approved by the Executive(s) of the Design-Builder entity and which shall be widely publicized and known throughout the project team.
- 3. Management Representative (ISO 9001, article 4.1.2.3) - The Quality Manager shall perform as the Management Representative.
- 4. Management Review (ISO 9001, article 4.1.3) - shall occur monthly during the first six months of the Contract and no less than quarterly thereafter. Written summaries of findings and major corrective actions shall be provided to the Authority Representative within five business days following completion of each Review.
- 5. Organizational and Technical Interfaces (ISO 9001, article 4.4.3) shall be defined in a manner that assures inter-discipline coordination and communication among and between designers, builders, major subcontractors, manufacturers, systems and facilities personnel, and the Authority.

B. Design Control Procedures (ISO 9001, article 4.4)

- 1. Design Control procedures shall be integrated and consistent with the Design Control Plan for the project. Design control plan and procedures are further described in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA and Section 01113, SYSTEMS INTEGRATION.
- 2. Control of design inputs and changes shall be managed by the Design-Builder in a manner that assures Contract and Design-Builder requirements are correctly translated into the drawings and specifications used for procurement, manufacturing, construction, and testing.
- 3. Completion of design, and the subsequent review, approval and distribution of submittals shall

be completed prior to the start of a related Construction activity.

4. Design Verification Activities (ISO 9001, article 4.4.7) - shall include checking and back-checking calculations, drawings, and other design elements without reliance on review and comments from the Authority shall be conducted before providing each design submittal to the Authority and before the start of construction or fabrication. In addition, verification and validation of software products designed for the Project shall be planned and provided for within the Design Control Procedures.
5. Design Review - The Design-Builder shall include in Design Control procedures, methods for completing internal verification activity prior to the submission of documents to the Authority for Design Review per Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA. The Design-Builder shall submit as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL REQUIREMENTS, certification that the design complies with ADAAG regulations along with submission of ADA Facilities Accessibility Checklist as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA with every required level of completion design review submittal specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. The Design-Builder shall also submit as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL REQUIREMENTS, a statement by the Design Professional who signed the drawings that the Final Design Drawings and Final Design Specifications conform to applicable architectural, engineering, Systems and Authority requirements and to the appropriate jurisdictional regulations as specified in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.
6. The Design-Builder's approach to meeting the requirement for Configuration Management shall be defined in the Design Control Plan and shall comply with the requirements included in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA and Section 01113, SYSTEMS INTEGRATION. In addition, a Configuration Management System shall be developed and managed by the Design-Builder and shall include the means for contemporaneously:
 - a. Relating the modification status of equipment and construction to the corresponding drawing or specification.
 - b. Ensuring that versions of software are controlled at all levels of design, development and production.

C. Document Control (ISO 9001, article 4.5)

The Design-Builder shall use a computerized database to identify and manage the current revision of instructions, procedures, drawings, software revision numbers and specifications. The database shall be kept current throughout the term of the Contract. The Design-Builder shall provide the Authority real-time access to the information in this database through a direct connection, dial up modem connection, or web-page access. Systems interface database is further described in Section 01113, SYSTEMS INTEGRATION.

D. Subcontracting & Purchasing (ISO 9001, article 4.6)

1. Purchased material, equipment, and services shall be controlled to ensure that they are properly integrated into the Work.
2. Procedural means shall be included to assure that Design-Builder subconsultants, suppliers

and subcontractors satisfactorily demonstrate and document an adequate system for managing quality to the Design-Builder.

3. The Design-Builder shall have procedures for providing adequate surveillance of subconsultants, subcontractors and suppliers to assure conformance with the Quality Management System and Specification requirements. This surveillance shall include inspection and audit of off-site activities of Design-Builder subconsultants, subcontractors and suppliers.

E. Product Identification and Traceability (ISO 9001, article 4.8)

The Design-Builder's quality system shall include provisions to identify and trace products and materials where appropriate and as required in the WMATA Standard and Technical Specifications.

F. Process Control (ISO 9001, article 4.9)

The Design-Builder shall include procedures for control of, including but not limited to, the following processes:

1. Completion of quality procedures, work instructions, preactivity and coordination meetings, and training prior to the start of a related activity.
2. A formal system of continuous feedback of problems and their resolution shall be developed between the Design-Builder's Design Professional and construction staff.
3. Documented Procedures for checking of survey computations.
4. Documented Procedures for verifying the accuracy of and the maintenance of secondary survey controls.

G. Inspection and Testing/General (ISO 9001, article 4.10.1)

1. The Design-Builder shall establish an integrated Inspection and Test Plan that conforms to the Quality Management System and the individual technical specifications and that allows for tracking of actual performance of inspections and tests. Systems inspection/testing is further described in Section 01113, SYSTEMS INTEGRATION.
2. Inspection procedures shall include instructions necessary to implement: source inspections; receiving inspections; inspection of work in progress; hold point inspections and completion inspections.
3. Test procedures shall utilize forms for recording test results and authorized approval signatures. Each test procedure shall identify the applicable specification section, article, and paragraph.
4. Daily Quality Reports shall be provided to the Authority that summarize the construction activities, record the inspections and tests completed and the results, and record deficiencies identified, during the previous 24 hours.

H. Control of Inspection, Measuring and Test Equipment (ISO 9001, article 4.11)

Processes will be included to assure that test equipment used by the Design-Builder and subcontractors meets the requirements of the standards, and that the equipment and instruments are controlled, maintained and calibrated by a nationally recognized certification entity/agency. Devices used to calibrate measuring and test equipment or other measurement standards shall be traceable to one or more of the following:

1. U.S. national standards maintained by the U.S. National Institute of Standards and Technology (NIST) and the U.S. Naval Observatory.
2. Fundamental or natural physical constants with values assigned or accepted by the U.S. NIST.
3. National standards of other countries, which are correlated, with U.S. national standards.
4. Comparison to consensus standards.

I. Review and Disposition of Nonconforming Product (ISO 9001 article 4.13.2)

The authority within the Design-Builder organization to review and provide disposition of nonconforming products shall be identified. The disposition of product that does not conform to Contract Requirements shall be subject to approval by the Authority Representative.

J. Control of Quality Records (ISO 9001, article 4.16)

1. The Design-Builder shall establish and implement measures to identify, collect, index, file, and store. These procedures shall include a database to track and maintain control over all Quality Records generated by the Contract Work.
2. Quality control records shall be available at designated, controlled, but accessible areas at work locations. Procedures shall identify the responsible custodians for these records.
3. Quality control records shall be stored and maintained in such a way that they are readily retrievable and provided with a suitable environment that minimize deterioration or damage, and prevent unauthorized alteration or loss.
4. Quality control records shall be legible, reproducible, identifiable with the item involved, and contain the date of origination and identity of the originator, verifier, and/or responsible supervisor.
5. Applies as well to quality records, as appropriate, from subcontractors, suppliers, fabricators, and test laboratories.
6. Retention period for quality control records shall be defined as seven years unless otherwise specified in the Contract. Quality control records shall be made available to the Authority throughout the retention period.

K. Internal Quality Audits (ISO 9001, article 4.17)

1. Perform internal audits at least quarterly.
2. Record in the audit results any deficiencies in the quality system, the causes of deficiencies in the Quality System, and the status of corrective action or preventive action, when

appropriate.

3. Provide the audit results to the Authority Representative and complete required corrective actions within 30 days of the audit.

1.07 DESIGN CONTROL PLAN

- A. Within 15 days after NTP, the Design Builder shall submit the contract specific Design Control Plan.
- B. In addition to that described in Article 1.06 B., the Design Control Plan shall include a Design Status Report that visibly tracks and reports the status of design products to be submitted by the Design-Builder for Authority review. The Design-Builder shall revise, update, and submit the Design Status Report for approval at least monthly.
- C. The Design Status Report shall:
 1. Be consistent with and follow from the Finalized Design Control Plan and shall specifically track all design and design verification activities included in the approved Finalized Design Control Plan.
 2. Be in a format that allows the Design-Builder and the Authority to reasonably understand the means by which each design element of the project is being completed. It will provide planned versus actual schedule performance and shall be accurate and useful as a means for project personnel to understand how the Design is proceeding throughout the Term.
 3. Include subcontracted design work, if appropriate.
 4. Include a Configuration Control system for drawings that allows for all concerned Design-Builder and Authority personnel associated with the Contract to know the development and approval status of the various design documents. Systems configuration control is further described in Section 01113, SYSTEMS INTEGRATION.

1.08 INSPECTION AND TEST PLANS

- A. The Design-Builder shall submit Inspection and Test Plans that delineate the specific inspections and tests required to assure that characteristic design and Contract requirements of structures, components and systems are fully complied with. These Plans shall be an extension of the Quality Management System required and established in accordance with this Section. The Design-Builder shall submit for approval the Inspection and Test Plans for the Civil and Structural areas of construction and Inspection and Test Plans for the other areas of work. Systems Inspection/Test Plans are further described in Section 01113, SYSTEMS INTEGRATION.
- B. The Inspection and Test Plans shall include the following:
 1. A matrix of all tests required by the Contract Documents and the Design Specifications and Design Drawings to be performed by Design-Builder, suppliers, or subcontractors.
 2. Samples of test reports - the test reports are to meet the minimum requirements called for in the applicable test standards or specifications.
 3. Provisions for coordinating onsite and offsite testing.

4. Provisions for meeting the Authority notification criteria for planned tests and inspections specified to be witnessed by the Authority. Provide the Authority a minimum of 14 calendar days advance notice.
- C. Where required by the Contract Documents, the Design-Builder shall separate inspection and testing requirements into sub-plans. This shall be done to facilitate coordination, and tracking of results through the "Final Completion" date.
- D. As a minimum, the Test Plans shall include the following information:
1. Specification section, article, paragraph
 2. Description of test
 3. Type of test (e.g. total System, sub-system, factory)
 4. Applicable standard
 5. Test frequency
 6. Responsibility for test performance
 7. Completion status
 8. Means of tracking and recording corrective actions being taken to assure compliance with the Contract Documents.
 9. Means for recording test results.
- E. As a minimum, the Inspection Plans shall include the following information:
1. A matrix of all inspections required by the Contract Documents and the Design Specifications and Design Drawings to be performed by Design-Builder, suppliers, or subcontractors and their frequency.
 2. Established hold points.
 3. Checklists to be utilized.

1.09 INTEGRATED SYSTEM TEST PLAN

- A. The Design-Builder shall submit an Integrated System Test Plan that delineates the specific tests required. These tests will directly involve Authority personnel. The Design-Builder shall revise, update, and submit for approval the System Integration Test Plan at least monthly. Systems Test Plans are further described in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA and Section 01113, SYSTEMS INTEGRATION.
- B. The Integrated System Test Plan shall include the following:
1. A matrix of all Systems testing required by the Contract Documents and the Design Specifications and Design Drawings to be performed by Design-Builder, suppliers, or

subcontractors. This shall encompass all systems tests through to and including final testing.

2. Samples of test reports - the test reports are to meet the minimum requirements called for in the applicable test standards or specifications.
 3. Provisions for coordinating onsite and offsite testing.
 4. Provisions for meeting the Authority notification criteria for planned tests and inspections.
 5. Provisions for Integrated Systems Testing Status Report that visibly tracks and reports the status of systems testing. The Design-Builder shall revise, update, and submit the Integrated Systems Testing Status Report at least monthly.
- C. As a minimum, the Plan shall include the following information:
1. Specification section, article, paragraph
 2. Description of test
 3. Type of test (e.g. total System, sub-system, factory)
 4. Applicable standard
 5. Test frequency
 6. Responsibility for test performance
 7. Completion status
 8. Means of tracking and recording corrective actions being taken to assure compliance with the Contract Documents.
 9. Means for recording test results.
- D. The Design-Builder shall provide the Authority 5 working days notice of any test except when greater notice is required in the specifications.

1.10 SUMMARY OF SUBMITTALS

A. Quality Management System

1. Interim Quality Management System: Any changes and additions shall be incorporated into the Updated Interim Quality Management System and Updated Finalized Design Control Plan, and the original and six paper copies and one electronic copy shall be submitted within 10 calendar days after Award, and shall also accompany each required level of completion design review submittal as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
2. Finalized Quality Management System (Quality Manual and Quality Procedures)

Original and six paper copies and one electronic copy (NTP plus 30 calendar days and when revised).

3. Daily Quality Reports

Original and six paper copies and one electronic copy (Daily).

4. Summary of Management Review

Original and six paper copies and one electronic copy (monthly during the first six months after NTP; no less than quarterly thereafter).

5. Review and Disposition of Nonconforming Product

Original and six paper copies and one electronic copy (as occurring).

6. Report of Audit Results

Original and six paper copies and one electronic copy (within five days of the completion of an audit).

7. Report of Completion of Corrective Actions

Original and six paper copies and one electronic copy (within 30 days of an audit).

8. Design Status Reports

Original and six paper copies and one electronic copy (monthly). Status Reports are further described in Section 01322, CONTRACT PROGRESS REPORTING.

9. Integrated Systems Testing Status Report.

Original and six paper copies and one electronic copy (monthly). Systems Test Plans are further described in Section 01113, SYSTEMS INTEGRATION and Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.

10. Statement of Compliance Quality Certification for Payment Verification

Original and six paper copies and one electronic copy (included with each payment request). QA/QC Manager's Statement of Compliance Quality Certification accompanying Payment Request is further described in SECTION 01290, PAYMENT PROCEDURES and Section 01111, KEY DESIGN-BUILDER FUNCTIONS.

B. Quality Plans

1. Design Control Plan (NTP + 15 calendar days and updated monthly).

2. Inspection and Test Plans

Original and six paper copies and one electronic copy (NTP plus 60 calendar days for Civil and Structural work, others minimum 30 calendar days in advance of the covered work scheduled to start). Systems Inspection/Test Plans are further described in Section 01113, SYSTEMS INTEGRATION and Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA

3. Payment Verification Certificate - NOT USED.

4. Integrated System Test Plan

Original and six paper copies and one electronic copy (NTP plus 180 calendar days). Systems Test Plans are further described in Section 01113, SYSTEMS INTEGRATION and Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA.

5. Integrated Systems Testing Status Report

Original and six paper copies and one electronic copy (monthly). Systems Testing Status Reports are further described in Section 01113, SYSTEMS INTEGRATION.

C. All submittals shall be submitted for approval and submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION

3.01 QUALITY SYSTEM

The Design-Builder will submit and execute a Quality Management System and the executable Plans as prescribed in this Section.

3.02 QUALITY SYSTEM MANAGER AND OTHER RESOURCES

A. The Design-Builder shall appoint a full-time Quality System Manager. The Quality System Manager shall be a degreed engineer, trained as a Lead Auditor in a RAB approved course to the requirements of ISO 9000:2000; and shall have 10 years of related experience including 5 years of management positions in a production, manufacturing, or construction environment and experience in QA/QC auditing.

B. The Quality System Manager shall:

1. Have no other assigned duties except to establish, implement and maintain the Quality Management System
2. Report directly to and be supervised by an Officer of the Design-Builder at a level above that of the Project Manager responsible for the project
3. Serve as a liaison officer with WMATA and the jurisdictional agencies on matters relating to the Design-Builder's quality system
4. Be responsible for ensuring that the Quality System is effective in ensuring that the Contract requirements are satisfied.
5. Be responsible for the oversight of onsite and offsite testing by the Design-Builder.

C. In the event that the Quality System Manager is not found to be competent or to have sufficient

relevant experience, the Authority will request that the Quality System Manager be removed from the project pursuant to Section 00710, PROJECT MANAGEMENT, SUPERINTENDENCE AND KEY PERSONNEL. In that event, the Design-Builder shall submit a new candidate for consideration within 10 calendar days by submitting a resume.

- D. In addition to the Quality System Manager, the Design-Builder shall assign additional trained and experienced staff to fulfill Contract and Design-Builder requirements for meeting quality. The Design-Builder shall provide sufficient resources to effectively manage quality related functions including the following:
1. Quality Management System Administration
 2. Design Quality
 3. Construction Quality
 4. Subcontractor Quality
 5. Oversight of Quality Control
 6. Configuration Management
 7. System Testing

3.03 AUTHORITY QUALITY OVERSIGHT

- A. The principal role of the Authority in the implementation of the Design-Build Quality Program will be oversight of the effectiveness of the Design-Builder's Quality Management System including quality control and quality assurance activities. However, the Authority reserves the right to conduct inspection of all phases of design of the Designer of the Design-Builder and onsite construction work activities of the Builder of the Design-Builder and subcontractors by Authority field staff. Any deficiencies discovered shall be brought to the immediate attention of the Design-Builder including written follow-up notification to the Design-Builder.
- B. At its sole discretion, the Authority may conduct audits, tests, and inspections in addition to those performed by the Design-Builder.
- C. When the Authority determines that the approved Quality Management System or Plans, or any portion or feature thereof, is not controlling work sufficiently for the work to conform to Contract standards, the Design-Builder shall take appropriate action to correct such deficiencies. The Authority Representative may stop the work activities if the Quality Management System is not working due to lack of Design-Builder's staff or for any other Contract non-compliance.
- D. Notwithstanding the above, Authority inspection, testing, or other actions shall not constitute acceptance of work, nor shall it relieve the Design-Builder of its contractual responsibilities.
- E. When Authority inspection is required, the Design-Builder shall add to the purchasing document the following statement:

"Authority inspection is required prior to shipment from your plant. Upon receipt of this order, promptly notify the Authority's Representative at the Authority, in writing, so that appropriate planning for Authority inspection can be accomplished."

3.04 AUDITS OF THE DESIGN-BUILDER'S DESIGN-BUILD QUALITY PROGRAM

- A. There will be an ongoing review and evaluation of implementation of the Design-Builder's Quality Management System to verify that the Design-Builder is effectively controlling the quality of design and construction. If the implementation of the Design-Builder's Quality Management System is determined to be ineffective by the Authority, the Authority, at its sole discretion, may withhold payment at the appropriate percentage for any and all work it deems to be deficient or non-conforming to the Contract Documents, approved Final Design Specifications, approved Final Design Drawings, and/or appropriate standards. The Design-Builder will be expected to make whatever changes are necessary in the organization or in the Design-Builder Quality Management System to provide effective control of the quality of the work.
- B. The Authority will perform audits to verify that the Design-Builder is effectively controlling the quality of the work. The basis for the audits will be the Design-Builder Quality Management System and the Contract Documents and Final Design Drawings and Final Design Specifications Issued for Construction.

3.05 INSPECTION AND TESTING PROGRAM

- A. The Inspection and Test programs shall be designed by the Design-Builder to assure that testing is performed to demonstrate that systems or components perform satisfactorily in service. Testing shall be performed by qualified and experienced personnel in accordance with approved test procedures. These procedures shall incorporate acceptance limits defined by industry codes and standards or by the Specifications; the more restrictive standard shall take precedence. All test results shall be documented, and submitted to the Authority for review in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES. Systems Inspection and Test Programs are further described in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION, Section 01810, COMMISSIONING and Section 01820, DEMONSTRATION AND TRAINING.
- B. Inspection and test equipment shall be controlled and maintained in serviceable condition and within correct calibration with primary standards traceable to the NIST, or an approved alternative, shall be maintained. The system shall assure the accuracy of equipment and tools used to support this procurement.
- C. Subcontractors testing their own work shall be supervised and managed by the Design-Builder. Overall, responsibility for testing and subcontractor performance remains with the Design-Builder.
- D. If tests or certifications conducted by the Authority disclose that work is not in conformance with the Contract Documents and Final Design Drawings and Final Design Specifications Issued for Construction, then the Authority will advise the Design-Builder as to the particular defects to be remedied. Upon correction of the defects, Design-Builder shall provide written notification to the Authority Representative and additional testing or certification shall be conducted as necessary to result in a proven and certified system(s). Further, in the case of such non-conformance with the Contract Documents and Final Design Drawings and Final Design Specifications Issued for Construction, the Design-Builder shall provide details on the preventive action taken to consistent with the requirements of ISO 9001, Article 4.14 and the Design-Builder's approved Quality Management System.

3.06 STATEMENT OF COMPLIANCE QUALITY CERTIFICATION FOR PAYMENT VERIFICATION

The Design-Builder shall provide the original and six paper copies and an electronic copy of an approved QA/QC Manager's Statement of Compliance Quality Certification with each pay request as specified in Section 01290, PAYMENT PROCEDURES stating that the Quality System has effectively ensured that the items requested for payment have been designed or constructed to meet the design requirements, or have been inspected and tested as required to comply with Contract requirements including those of the Quality Management System reflecting the outcome of the Formal Progress

Status Report Review as specified in Section 01312, PROJECT MEETINGS. Work for which satisfactory records for design, testing, inspection, or other quality elements are not available shall not qualify for payment.

END OF SECTION

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SECTION 01510

TEMPORARY UTILITIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for temporary utility services for use during construction.
- B. As applicable, temporary utilities required include but are not limited to:
 - 1. Water service and distribution.
 - 2. Temporary electric power and light.
 - 3. Telephone service.
 - 4. Storm and sanitary sewer.

1.02 RELATED DOCUMENTS

Section 00701, General Conditions: Definitions
Section 00707, General Conditions: Permits and Responsibilities
Section 00708, General Conditions: Responsibility of the Design-Builder for Design-Related Services
Section 01310, General Requirements - Administrative Requirements: Project Management and Coordination;
Section 01322, General Requirements - Administrative Requirements: Contract Progress Reporting
Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures
Section 01410, General Requirements - Quality Requirements: Regulatory Requirements
Section 01420, General Requirements - Quality Requirements: References
Section 01520, General Requirements - Temporary Facilities and Controls: Temporary Construction Facilities
Section 01530, General Requirements - Temporary Facilities and Controls: Temporary Construction

1.03 SUBMITTALS

- A. The Design-Builder shall provide review and approval site plans indicating all temporary utility connections. Provide detailed working drawings of utility connections and special facilities and after existing utility facilities have been located by field investigations make necessary revisions to working drawings to reflect actual site conditions and resubmit drawings. Submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
- B. The Design-Builder shall provide reports for tests, inspections, meter readings and similar procedures performed for temporary utilities. Submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
- C. The Designer shall indicate on its first schedule submission to the Authority as described in Section 01322, CONTRACT PROGRESS REPORTING and submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, the implementation and termination of each temporary utility as appropriate.

1.04 QUALITY ASSURANCE

- A. The Design-Builder shall comply with industry standards and applicable laws and regulations of authorities having jurisdiction as specified in Section 01420, REFERENCES, Section 01410, REGULATORY REQUIREMENTS, Section 00701, DEFINITIONS, Section 00708

RESPONSIBILITY OF THE DESIGN-BUILDER FOR DESIGN-RELATED SERVICES, and Section 00707 PERMITS AND RESPONSIBILITIES, including but not limited to:

1. Building Code requirements.
 2. Health and safety regulations.
 3. Utility company regulations.
 4. Police, Fire Department and Rescue Squad rules.
 5. Environmental protection regulations.
- B. The Design-Builder shall: comply with NFPA Code 241, "Construction Alteration and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library, "Temporary Electrical Facilities". For Electrical Service, the Design-Builder shall comply with NEMA, NECA and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70).
- C. Inspections: The Design-Builder shall arrange for the inspection and testing of each temporary utility before use, and shall coordinate all requirements for certifications and permits. The Authority Representative shall be notified sufficiently in advance so as to be present at all planned inspections and onsite activities.

1.05 PROJECT CONDITIONS

- A. The Design-Builder shall incorporate into the construction schedule dates for implementation and termination of each temporary utility. At the earliest practical time and when acceptable to the Authority, change over from use of temporary service to use of the permanent service.
- B. The Design-Builder shall keep temporary services and facilities clean and neat in appearance. Temporary services and facilities shall operate in a safe and efficient manner. The Design-Builder shall take all necessary fire prevention measures and shall ensure that facilities shall not be overloaded or permitted to interfere with progress. The Design-Builder shall not allow hazardous, dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. The Design-Builder shall determine temporary utility services requirements and shall make arrangements with utility companies and governmental agencies to obtain such services. The Design-Builder shall be responsible for the cost of all utility use until the Authority takes beneficial occupancy of the facility unless specified otherwise.
- D. The Design-Builder shall provide temporary electrical service of sufficient capacity to serve the temporary requirements during the life of the Contract. The source of temporary power for testing may be the temporary service, portable generator or other approved system which will deliver power at the voltage and other characteristics required to accomplish testing as specified. Circuits and construction for temporary systems shall suit the needs of the work and comply with NEC and the codes and regulations of the jurisdictional authorities.
- E. Temporary services shall be furnished, installed, connected and maintained by the Design-Builder in an approved manner. Prior to completion of the work, the Design-Builder shall remove all temporary services and restore affected areas as approved.
- F. Shop drawings for all temporary utility and electrical services shall be submitted for approval. Power supply shall be of such quantity and type required to perform the work of the Contract. Maximum primary voltage shall be 600 volts, unless otherwise approved. Lighting equipment shall be of the type and quantity needed to provide illumination of all project areas. Materials for and installation of temporary services shall comply with OSHA requirements and with the minimum requirements of the technical specifications.

1.06 ACCESS TO FIRE HYDRANTS AND FIRE ALARM BOXES

- A. Whenever the work is being carried on, free access must be given to each fire hydrant, fire alarm box and standpipe; when required, hydrants shall be extended by suitable tubes or piping to an accessible point as approved and to the satisfaction of the jurisdictional fire department. Obstructions shall not be piled at any time or placed within 10 feet of any fire hydrant or fire alarm box and, where materials are placed in the vicinity of a fire hydrant or fire alarm box and to such height as to prevent the same from being readily seen, the position of such hydrants or fire alarm boxes shall be indicated by suitable signs and lights, both day and night.
- B. The Design-Builder shall safeguard, maintain and protect the wires, cables, ducts, manholes, posts and poles, signals, and alarm boxes of fire departments. The Design-Builder shall not cause interruption to the fire department fire alarm telegraph service, and in case of accident, shall promptly notify the fire department. No fire department wire, cable, duct, manhole, post or pole, signal or fire alarm box shall be disturbed, except in the presence of a representative of the Bureau of Fire Alarm Telegraph. In case such wire, cable, duct, manhole, post or pole, signal or fire alarm box is disturbed, the Design-Builder shall immediately notify the Authority Representative, and it shall be restored immediately to its original condition.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

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SECTION 01520

TEMPORARY CONSTRUCTION FACILITIES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for temporary facilities for use during construction.
- B. Temporary facilities required include but are not limited to:
 - 1. Temporary heat.
 - 2. Field offices and storage sheds.
 - 3. Sanitary facilities, including drinking water.
 - 4. Waste disposal services.
 - 5. Rodent and pest control.
 - 6. Miscellaneous services and facilities.
 - 7. Authority Representative's Site Facility (co-located with Design-Builder's Field Office) and Parking Area.
 - 8. First Aid Station.
 - 9. Storage/Laydown Areas.

1.02 RELATED DOCUMENTS

Section 00844, Supplementary Conditions: Safety Superintendence Requirements;
Section 01114, Safety/Environmental Requirements
Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures;
Section 01310, General Requirements - Administrative Requirements: Project Management and Coordination;
Section 01510, General Requirements - Temporary Facilities and Controls: Temporary Utilities;
Section 01530, General Requirements - Temporary Facilities and Controls: Temporary Construction;
Section 01550, General Requirements - Temporary Facilities and Controls: Maintenance of Traffic, Construction Sequence and Staging, Access and Parking;
Section 01560, General Requirements - Temporary Facilities and Controls: Temporary Barriers and Enclosures;
Section 01770, General Requirements - Execution Requirements: Contract Closeout

1.03 SUBMITTALS

- A. The Design-Builder shall submit for review and approval site plans indicating all temporary facilities, utility connections and traffic flows and working drawings of temporary facilities as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

- B. The Design-Builder shall submit reports to the Authority Representative the results of tests, inspections, meter readings and similar procedures performed for temporary facilities for the Authority's information and records as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
- C. The Design-Builder shall submit a schedule to the Authority indicating implementation and termination of each temporary facility within 60 calendar days prior to the start of construction or other period as may be approved by the Authority as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

1.04 QUALITY ASSURANCE

- A. The Design-Builder shall comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:
 - 1. Building Code requirements - local and international as applicable.
 - 2. Health and safety regulations.
 - 3. Utility company regulations.
 - 4. Police, Fire Department and Rescue Squad rules.
 - 5. Environmental protection regulations.
 - 6. Governmental Agencies
- B. The Design-Builder shall: comply with NFPA Code 241, "Construction Alteration and Demolition Operations", ANSI-A10 Series standards for "Safety Requirements for Construction and Demolition", and NECA Electrical Design Library, "Temporary Electrical Facilities". For Electrical Service, the Design-Builder shall comply with NEMA, NECA and UL standards and regulations for temporary electric service. Install service in compliance with National Electric Code (NFPA 70). Also comply with the IBC as applicable.
- C. Inspections: The Design-Builder shall arrange for the inspection and testing of each temporary facility before use and shall coordinate all regarding requirements for certifications and permits. The Authority shall be kept informed of all planned inspections and onsite activities.

1.05 PROJECT CONDITIONS

- A. The Design-Builder shall incorporate into the construction schedule dates for implementation and termination of each temporary facility. At the earliest practical time and when acceptable to the Authority, the Design-Builder shall change over from use of temporary facilities to use of the permanent facilities if applicable.
- B. The Design-Builder shall keep temporary facilities clean and neat in appearance. Temporary facilities are to be operated in a safe and efficient manner. The Design-Builder shall take the necessary fire prevention measures and shall not overload facilities, or permit them to interfere with progress of the Work. Hazardous, dangerous, unsanitary conditions, or public nuisances shall not be allowed to develop or persist on the site.
- C. Due to limited space available at each site, the Design Builder will be allowed one single wide trailer at Greenbelt Yard and one single wide trailer at Shady Grove Yard. At Brentwood Yard, space within the basement work area of the S&I Shop can be utilized. The Design Builder's

office facility shall be co-located with WMATA off-site. See Article 1.07, this specification.

- D. A small single wide trailer for WMATA field staff will be necessary at Greenbelt Yard only. WMATA field personnel at Brentwood and Shady Grove will make use of office space available in the existing S&I Shop buildings.
1. The Greenbelt facility shall be compliant with all codes, air conditioned, be provided with all utilities, and meet the requirements of Article 1.07.C of this specification, except for furnishings and restrooms.
 2. The Design Builder shall pay all cost for hauling and connection purposes.
 3. The Greenbelt facility shall be ready for occupancy within seven (7) calendar days after the start of the construction phase of the work and shall be maintained and serviced by the Design Builder until completion of the work.
 4. The Greenbelt facility shall be large enough to house four desks and chairs, and filing cabinets.
 5. Upon completion of this contract, the complete facility will become the property of the Design Builder who shall remove it from Authority property and restore the site to its original condition.

1.06 DESIGN-BUILDER'S ON-SITE PLANT

- A. The Design-Builder shall submit a plan of its plant layout as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES for approval 60 calendar days prior to the start of construction. All necessary construction in connection therewith shall be done in a neat workmanlike manner to the Authority's satisfaction.
- B. Sufficient construction plant shall be provided and maintained at points where work is in progress to adequately meet demands of the work and with ample margin for emergencies or overload. The plant shall be of sufficient capacity, in the opinion of the Authority, to permit a rate of progress which will ensure completion of the work within the time specified in the Contract. The Authority shall have the right to reject or condemn any plant, apparatus or staging which in its opinion is unsafe, improper or inadequate. Whether the Authority exercises this authority or not, the Design-Builder is not relieved of its responsibility for the safe, proper and lawful construction, maintenance and use of such plant, apparatus or staging. Condemned plants or equipment shall be brought to acceptable condition or shall be removed from the site.
- C. The location of stationary equipment and the location of miscellaneous mobile equipment shall be subject to approval.

1.07 AUTHORITY REPRESENTATIVE'S FACILITY

- A. The Design-Builder shall locate, and acquire or construct and fit out facilities a mobile unit or a building and co-locate its key personnel and management activities with WMATA, off-site at one mutually agreed upon location. The facility shall remain operational until the Authority has assumed full maintenance and operation of all project elements and the facility will be maintained by the Design-Builder at their own expense.

- B. The facility shall be compliant with the ADAAG regulations and provide ADAAG accessibility, complete with parking facilities, hereinafter called field office. The field office shall be situated in the work area at an approved location. The field office shall be complete as specified and ready for occupancy by the Authority Representative within seven (7) calendar days after the start of the construction phase of work. It shall be maintained and serviced by the Design-Builder as hereinafter specified until completion of the work. A mobile unit shall have the features specified. If the Design-Builder elects to provide a building in lieu of a mobile unit, the building shall conform to local building codes, and international building codes as applicable, and shall have the basic features specified herein, with substitute materials allowable, subject to approval. The facility shall be fully winterized.
- C. The Design-Builder shall obtain and pay all costs for hauling, building and connection permits. The field office shall be substantially constructed satisfactory to the Authority Representative. All materials shall be good commercial quality. The field office shall provide a minimum of 1,200 square feet of usable area, with furniture, parking, and the following additional requirements:
1. Painting:
 - a. Exterior surfaces of buildings and all interior surfaces, other than factory-finished surfaces, shall be painted with two coats of an approved paint of approved color(s).
 - b. No painting will be required on aluminum or stainless steel surfaces.
 2. Exterior walls, ceilings and floors, shall be insulated; interior walls shall be paneled with finished plywood or gypsum wallboard of not less than one-half inch thickness on steel stud support, or other suitable materials as approved. Ceiling surfaces shall be either gypsum wallboard of not less than one-half inch thickness or suspended grid with lay-in acoustical tiles. Floors shall be covered with flooring material such as resilient tile or sheet linoleum. Floors shall be constructed to withstand a live load of 125 psf. Interior layout and materials to be approved by the Authority Representative.
 3. Construction is to be gypsum board on steel studding with lay in acoustical tile and tile or carpeted flooring or equal. Floors shall be constructed to withstand a live load of 125 psf. The field office shall also have a 60' X 6' covered porch or deck secured by a lockable gate.
 4. Two rest rooms shall be provided, each with lavatory, toilet, mirror, soap holder, toilet paper holder, paper towel dispenser, and sanitary napkin dispenser and hot and cold water supply.
 5. Lighting shall be provided to furnish a minimum of 100 foot-candles at desk height uniformly in all areas except rest rooms. Rest rooms shall be provided with adequate lighting.
 6. Duplex electrical receptacles shall be provided around interior walls at approximately ten-foot spacing.
 7. An electric water cooler shall be installed to supply cool water.
 8. Heating and air conditioning systems shall have thermostatic control. Systems shall be capable of maintaining office at ambient temperature of 72F.
 9. Water, sewer and electrical utility connections shall be provided as necessary.
 10. Adequate access from public streets shall be provided to the field office together with adjacent space for 10 parking spaces. The access roadway and parking area shall be graded for

drainage and surfaced with gravel, concrete or bituminous pavement in an approved manner.

11. The interior of the field office shall provide two completely partitioned office rooms approximately 200 square feet, two interior and two exterior doors, two coat closets, 30 feet of counter space and 50 feet of shelving arranged as directed. Each exterior door shall be equipped with a cylinder lock and two keys. This area shall also have a 60' x 6' covered porch or deck secured by a lockable gate.
12. The field office shall be furnished with the following new furniture as approved:
 - a. Desk, 60 inches by 30 inches; with 3 drawers and one file drawer, all with locks; with armchair: Seven
 - b. Secretary desk, 54 inches by 30 inches, with typewriter shelf, file drawer and paper rack with secretarial chair: One
 - c. Drafting table, 60 inches by 36 inches, with drawer and stool: One
 - d. Side chair: Twenty
 - e. Bookcase, 36 inches by 42 inches, with four shelves: Three
 - f. File cabinet, letter size, four drawers, with lock: Six
 - g. File cabinet, legal size, four drawers, with lock: Two
 - h. Reference table, 54 inches by 30 inches: Twelve
 - i. Storage cabinet, 36 inches by 18 inches by six feet, with lock: Two
 - j. Rolling Plan storage rack, six stick: Two
 - k. Utility cabinet, 18 inches by 46 inches by 30 inches, with lock: Six
 - l. Coat rack: One
 - m. Chalk board and stand, 60 inches by 36 inches: One
 - n. Eighteen cubic foot, frost free, refrigerator: One
 - o. 800 watt microwave: One
 - p. First aid kit containing eye and skin protection for emergencies
 - q. Fire Extinguishers: As required by code, not less than three
 - r. 20 drawer flat file: One
13. All windows shall be provided with shades, blinds or curtains and security grills.
14. The field office shall be furnished with the following new equipment as approved by the Authority Representative:
 - a. Facsimile machine: One.

- b. Copier with the following functions: One.
- (1) High capacity, 115-volt operation.
 - (2) Twenty bin sorter, 50 sheets per bin, at least 11" x 17" sheet size, with stapler function.
- c. Computers and Printers: The following Authority-provided items is are specified to establish system capabilities and quantities; however, an equal system may be substituted as approved:
- (1) Computers: Four (4) Dell Minitower (OptiPlex GX260) with Pentium 4 Processor, 2.40 GHz, 533FSB, 512K Cache, Intel Gigabit NIC, 512 MB DDR Non-ECC SDRAM (2DIMMS), Dell 19-inch M992 color monitor (18.0 viewable), Integrated DVMT video, 40GB EIDE 7200RPM, 1.44 MB 3.5-inch floppy drive, Windows 2000 Professional SP2 with CD using NTFS, Dell PS/2 keyboard, Dell PS/2 2-button mouse, 3COM 10/100 (3C905C) PCI Adapter, 48X Max CDRW, 48X CD-ROM, Integrated Sound Blaster Compatible harman/kardon 206 speakers, Resources CD contains Diagnostics and Driver for Dell OptiPlex Systems, Energy Star Label, 3-year Same Day 4Hr Response Parts + Onsite Labor (M-F 8am-6pm), Mouse Pad.
 - (2) Printers: One (1) Color Printer capable of handling 11" X 17" sheets, compatible with the scheduling software, network ready, and of HP quality or better. Four (4) HP LaserJet 1200 w/cable (C2950A).
 - (3) The Design-Builder shall provide point-to-point computer cabling to the Authority a dedicated, hardwired communication connection to from the PC's from the tie-in location of XXXXX temporary facility to JGB and the network wiring within the temporary facility to connect Authority's PC's to the Authority's WAN/LAN including an adequately sized, secure and ventilated server closet, and the Design-Builder shall coordinate the design and installation with the Authority's Office of Information Technology and Services (ITSV) through the Authority Representative.
- d. The Design-Builder shall maintain the equipment for the duration of this Contract. Upon completion of the work, the equipment shall become the property of the Design-Builder.
- e. Maintenance and services shall be provides by the Design-Builder as follows:
- (1) Repair and cleaning, twice weekly, of the field office, parking area and access road, including complete janitorial services and supplies, and snow removal.
 - (2) The furnishing of all utilities except telephones.
 - (3) During other than normal working hours, provide security measures and area protection equivalent to that normally used by the Design-Builder for its job site shop and office facilities.
- f. Upon completion of this Contract, the complete facility, other than the computer equipment and telephone handsets, will become the property of the Design-Builder who shall remove it and restore the site.

1.08 SANITARY PROVISIONS

- A. The OSHA standard for sanitation, 29 CFR § 1910.141 et. seq. shall be used. Prior to starting work, the Design-Builder shall furnish for use of its force on the work necessary toilet conveniences

secluded from public view. They shall be kept in a clean and sanitary condition and comply with the requirements and regulations of the area in which the work is performed. Potable drinking water shall be provided with individual cups and sanitary conditions for the water dispenser shall be maintained. A common drinking cup or other common utensils shall not be used.

1.09 WORK AND STORAGE/LAYDOWN AREA

- A. The areas designated as the Design-Builder's Work and Storage Area will be provided to the Design-Builder without charge. Additional work and storage space, if required, shall be obtained by the Design-Builder. Laydown areas may have been identified by the Authority. The Design-Builder's use of laydown areas other than those identified by the Authority shall be approved by the Authority Representative prior to their use. The Design-Builder shall submit a materials storage plan as described in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES for approval 60 calendar days prior to the start of construction.
- B. As applicable, no protrusions of materials/tools/equipment/etc. into the dynamic outline of the track or of railcars will be permitted.

1.10 FIRST AID STATION

First Aid Station requirements, if applicable, are specified in Section 00844, SAFETY SUPERINTENDENCE REQUIREMENTS and Section 01114, SAFETY / ENVIRONMENTAL REQUIREMENTS.

PART 2 PRODUCTS	[Not Applicable]
PART 3 EXECUTION	[Not Applicable]

END OF SECTION



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SECTION 01530

TEMPORARY CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies requirements for temporary construction that may be required during the course of the Project. Temporary construction items include temporary decking, and its respective support system over excavated areas for the purpose of maintaining the flow of pedestrian and vehicular traffic during the construction period.
- B. Decking, bridges for pedestrians and temporary grade crossing for vehicular traffic as applicable shall be constructed of suitable materials in accordance with jurisdictional requirements. Pedestrian bridges shall be as specified in Section 01560 TEMPORARY BARRIERS AND ENCLOSURES.
- C. The Design-Builder shall submit the original, six paper copies and one electronic copy no less than 60 calendar days prior to the start of construction for approval, working drawings as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES for all proposed temporary construction to the Authority and also the Design-Builder shall prepare and submit to the Jurisdictional Agency of the area where the work is to be performed, for its approval, working drawings including maintenance of traffic comprehensive staging and decking plans prior to the time public traffic pattern closures and changes are proposed as specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING. Jurisdictional Agency approval must be obtained at least 30 calendar days prior to installation of temporary decking.

1.02 RELATED DOCUMENTS

- Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements;
- Section 01310, General Requirements - Administrative Requirements: Project Management and Coordination;
- Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures;
- Section 01510, General Requirements - Temporary Facilities and Controls: Temporary Utilities;
- Section 01550, General Requirements - Temporary Facilities and Controls: Vehicular Maintenance of Traffic, Construction Sequence and Staging, Access and Parking;
- Section 01560, General Requirements - Temporary Facilities and Controls: Temporary Barriers and Enclosures;
- Section 01580, General Requirements - Temporary Facilities and Controls: Project Signs;
- Section 02205, Technical Requirements Division 2 - Site Construction: Restoration of Miscellaneous Surface Facilities;
- Section 02260, Technical Requirements Division 2 - Site Construction: Support of Excavation;
- Section 02270, Technical Requirements Division 2 - Site Construction: Maintenance, Support and Restoration of Utility Facilities;
- Section 02320, Technical Requirements Division 2 - Site Construction: Grading, Excavating and Backfilling
- Section 02727, Technical Requirements Division 2 - Site Construction: Ballast, as applicable.

Section 02920, Technical Requirements Division 2 - Site Construction: Topsoil, Seeding and Sodding
Section 02930, Technical Requirements Division 2 - Site Construction: Landscaping

1.03 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards and Specifications:

1. Codes and regulations of the jurisdictional authorities.
2. AASHTO: Standard Specification for Highway Bridges.
3. AWS: D1.1.
4. ASTM: D2555, E274.
5. AREA.

B. Design Criteria:

1. Base design on Authority's Design Criteria as a minimum.
2. Design temporary decking and support system for AASHTO HS27 loading and impact, earth pressures, utility loads and other applicable live impact and dead loads including the Design-Builder's equipment.
3. When excavation or construction equipment is to be operated from decking, design decking using actual maximum loads in accordance with design criteria of referenced AASHTO specification, unless otherwise shown.
4. Design supporting members to allow clearance for existing and relocated utilities.
5. Provide suitable openings for access for servicing utilities and fire fighting. Provide flush covers for openings.
6. When the deck beams or other members supporting such deck are required to carry the support of excavation loads, these members to also be in compliance with the requirements of Section 02260, SUPPORT OF EXCAVATION.
7. Design temporary grade crossing, as applicable, in accordance with AREA criteria.
8. All accessible path designs shall comply with ADAAG regulations.

1.04 SUBMITTALS

A. Submit the following for approval in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, and with the additional requirements as specified for each:

1. Working Drawings:
 - a. Prior to installation of elements for support of excavation, submit working drawings and

design calculations.

- b. Show proposed procedures and methods of constructing temporary structures including support system and necessary construction details.
- c. Working Drawings for temporary utilities are specified in Section 01510, TEMPORARY UTILITIES, working drawings for temporary construction facilities are specified in Section 01520, TEMPORARY CONSTRUCTION FACILITIES and working drawings for temporary enclosures are specified in Section 01560, TEMPORARY BARRIERS AND ENCLOSURES.

2. Certification:

If previously used material are utilized, submit certified information concerning each previous use, such information to include, but not be limited to, the following:

- a. Purpose.
- b. Duration.
- c. Type of loading.

1.05 JOB CONDITIONS:

A. Responsibilities:

1. Design, construction, maintenance and removal of temporary construction including decking and support systems are the responsibility of the Design-Builder.
2. Perform work in accordance with construction sequence and maintenance of traffic schedules acceptable to the Authority and requirements of the jurisdictional agencies as specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.
3. Maintain vehicular and pedestrian access to buildings at levels existing prior to start of Contract work. Maintain persons with disabilities access in accordance with ADAAG.
4. Perform work in accordance with specified safety requirements as described in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS.

PART 2 PRODUCTS

2.01 MATERIALS

A. Timber, Steel, Concrete and Other Materials:

1. Used materials are permitted in lieu of new materials provided they are sound and free from defects which might impair their strength.
2. Timber: Structural lumber, visually graded in accordance ASTM D2555, minimum working

stress 1,100 psi.

- B. Welding: Have welding performed by certified welders and in accordance with the requirements of the AWS D1.1.
- C. Ballast, as applicable: Section 02727.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with the requirements of Section 02260, SUPPORT OF EXCAVATION. Install and maintain decking at design elevations. Accessibility and decking surfaces and slopes shall be in accordance with ADAAG regulations.
- B. Mechanically laminate decking elements in panels not less than five feet wide.
- C. Provide and maintain skid-resistant surface.
- D. If asphalt or asphaltic concrete is used on decking, mechanically bond asphalt or asphaltic concrete to decking.
- E. Maintain free of snow, ice, water, mud and debris.
- F. Place premixed asphaltic patching material to provide smooth transitions between existing pavement surfaces and decking and between existing pavement surfaces and pedestrian bridges as specified in Section 01560, TEMPORARY BARRIERS AND ENCLOSURES and elsewhere as required to provide proper drainage and prevent ponding of water.
- G. As removal of pavement and sidewalk progress, furnish and install barricades in accordance with Section 01560, TEMPORARY BARRIERS AND ENCLOSURES and requirements of the jurisdictional agencies.
- H. Along sides of decked areas for pedestrian walkways where such walkways are adjacent to vehicular traffic, install concrete barriers as specified in SECTION 02845, TRAFFIC CONTROL DEVICES and Section 01560, TEMPORARY BARRIERS AND ENCLOSURES and as shown on approved maintenance of traffic plan as specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING.
- I. Install wooden fence as specified in Section 01560, TEMPORARY BARRIERS AND ENCLOSURES along sides of decked areas for pedestrian walkways where such walkways are adjacent to open areas, staging/storage areas and other areas used by the Design-Builder. Paint barricades and fences and maintain in good repair as specified in Section 01560, TEMPORARY BARRIERS AND ENCLOSURES.
- J. Provide walkways or galleries for full length of excavation when excavation reaches depth of approximately 15 feet. Pedestrian Bridges are specified in Section 01560, TEMPORARY BARRIERS AND ENCLOSURES.
- K. Erect and maintain load limit and other signs as specified in Section 01580, PROJECT SIGNS to restrict loading on decking so that it does not exceed maximum design loading.

- L. Remove temporary decking along with any support systems when no longer required. Comply with the requirements of Section 02260, SUPPORT OF EXCAVATION, when removing support system.

3.02 FIELD QUALITY CONTROL

A. Allowable Tolerances:

1. Maintain surface elevations at abutting elements within plus-or-minus 1/4 inch.
2. Do not allow horizontal gaps to exceed 3/8 inch.
3. All profile grades and cross-slopes, curb ramps, ramps or other features required in an accessible path shall be provided and maintained to ADAAG requirements.

- B. Skid-Resistant Surface. Provide skid-resistant surface having a Skid Number at 30 mph (SN 30) of no less than 35 when measured in accordance with ASTM E274, and also, skid resistance shall be in accordance with ADAAG regulations.

- C. Protect Existing Vegetation, Structures, Utilities and Improvements in accordance with Section 02205, REMOVAL AND RESTORATION OF EXISTING LANDSCAPING, Section 02270, MAINTENANCE, SUPPORT AND RESTORATION OF UTILITY FACILITIES, Section 02320, GRADING, EXCAVATING AND BACKFILLING, Section 02920, TOPSOIL, SEEDING AND SODDING, and Section 02930, LANDSCAPING.

3.03 VENTILATION

When excavations are decked, provide ventilation as required by the applicable code requirements and jurisdictional agencies. Provide ventilation which meets specified safety requirements as described in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS.

3.04 ILLUMINATION

- A. In areas covered by decking, supply and maintain illumination of sufficient intensity to permit safe and expeditious conduct of all phases of construction and inspection of support system, lagging, bracing and utilities maintained in place.
- B. Provide illumination which meets specified safety requirements as described in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS.

END OF SECTION



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SECTION 01550

MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING

PART 1 GENERAL

1.01 SUMMARY

This Section specifies requirements for maintenance of existing pedestrian and vehicular traffic onsite and offsite; construction sequence and staging; maintaining access to and from the site including construction areas, haul routes, and temporary roads with traffic control; and for Design-Builder parking.

1.02 RELATED DOCUMENTS

Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements
Section 01310, General Requirements - Administrative Requirements: Project Management and Coordination;
Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures;
Section 01510, General Requirements - Temporary Facilities and Controls: Temporary Utilities;
Section 01520, General Requirements - Temporary Facilities and Controls: Temporary Construction Facilities;
Section 01530, General Requirements - Temporary Facilities and Controls: Temporary Construction;
Section 01560, General Requirements - Temporary Facilities and Controls: Temporary Barriers and Enclosures.

1.03 MAINTENANCE OF TRAFFIC

- A. The Design-Builder shall be responsible for maintaining traffic and for erecting and maintaining traffic control devices, as required by the Jurisdictional Agency of the area where the work is to be performed, including, but not limited to, the following:
1. Temporary directional and electrical warning and detour signs.
 2. Temporary barricades.
 3. Temporary lighting, overhead warning lights, flashing lights and lanterns.
 4. Temporary paving and striping.
- B. Traffic control signs: Traffic control signs shall be standard signs of the Jurisdictional Agency. Each change in location of traffic shall be adequately posted with a minimum of two signs mounted on barricades or standard posts. All signing shall be done in accordance with the requirements of the latest published standard of the jurisdictional agency.

- C. Striping: The Design-Builder shall provide all necessary temporary striping required in connection with all temporary street work. The Design-Builder shall remove or obliterate existing or temporary pavement markings whenever vehicular traffic is moved to newly available pavement areas or to different traffic patterns.
- D. Redirecting traffic: Channeling and shifting of traffic lanes as well as barricading of traffic in connection with this work will be subject to approval of the jurisdictional agency.
 - 1. Activity of the Design-Builder which will interfere with the orderly movement of pedestrians and vehicular traffic will not be permitted from 10:00 AM to 9:00 PM Monday through Saturday in the period from Thanksgiving to Christmas, except in an emergency or when authorized by a special permit issued by the District of Columbia.
- E. Temporary closing: Prior to the temporary closing to traffic of part of any public street, sidewalk or other access or prior to changing traffic patterns from those shown, approval shall be obtained from the appropriate jurisdictional agency by the Design-Builder prior to the time such closures and changes are to be made. Deviations from this will be for a bonafide emergency only and as approved by the Jurisdictional Agency.
- F. Design-Builder's surface operations: The Design-Builder shall schedule its surface operations so as not to be working intermittently throughout the area. Excavation or construction activities shall be carefully scheduled and vigorously pursued to completion as required to permit opening of street areas to traffic as soon as possible without unnecessary delays.
- G. Temporary walkways: In areas where the removal of existing sidewalks is necessary, access to adjacent businesses, entrances and properties shall be maintained by temporary walkways having a width of not less than six feet.
- H. Intersections: Intersections shall be excavated and decked in stages as shown. Construction shall be so phased that the required number of traffic lanes on each street will be provided at all times during these operations. Upon completion of decking, traffic in all intersections shall be fully maintained.
- I. Temporary pavement and patching: The Design-Builder shall construct, maintain and remove temporary pavement and patching required to safely and expeditiously handle vehicular and pedestrian traffic within or adjacent to the Contract site. The temporary pavement composition and patch shall conform to the requirements of the jurisdictional agency. Construction, maintenance or removal required by the Design-Builder's operations off the site shall be included under this Section.
- J. The use of staging, working, storage and laydown areas shall be as approved by the Authority Representative.
- K. Jurisdictional Agency MOT approval must be obtained at least 30 calendar days prior to the time public traffic pattern closures and changes are to be made and Authority MOT approval must be

obtained 60 calendar days prior to start of construction on Authority property. The original, six paper copies and one electronic copy of the Maintenance of Traffic Plan shall be submitted to the Authority in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

- L. Haul Routes: Haul routes shall be subject to approval of the local jurisdictional agency.
 - 1. Greenbelt Yard: Sunnyside Avenue provides the only access to the site. Construction vehicles are prohibited from approaching Greenbelt Yard on Sunnyside Avenue from the East via Edmonston Road (Route 201). All construction vehicles shall approach Greenbelt Yard on Sunnyside Avenue from the West

1.04 CONSTRUCTION SEQUENCE AND STAGING

- A. All work under this Contract shall be performed generally in accordance with the approved detailed plan of the work following a logical sequence developed by the Design-Builder.
- B. The Design-Builder's particular attention is directed to the fact that both vehicular and pedestrian traffic must be maintained on the existing roads adjacent to the project site at all times for the duration of the Contract.
- C. Structures constructed underground by cut-and-cover methods, will require the Design-Builder to provide temporary decking as specified in Section 01530, TEMPORARY CONSTRUCTION over open excavations for the maintenance of vehicular and pedestrian traffic. In order that disruptions to traffic may be kept to a minimum, the Design-Builder shall perform the decking operations, the utility work and the subsequent paving and restoration operations in stages.
- D. A method of staging and requirements pertaining to the number of traffic lanes to be provided during rush hours and non-rush hours, shifting of traffic lanes, the use of working, storage and laydown areas and other requirements pertaining to the maintenance of traffic as previously specified shall be developed by the Design-Builder as part of this Contract.
- E. The particular order in which the various stages are to be performed will be optional with the Design-Builder, provided that stage work within the limits of one stage is completed before work in another stage is commenced; and provided that all other requirements pertaining to maintenance of traffic are complied with. The Design-Builder shall prepare and submit the original, six paper copies and one electronic copy to the Authority and shall submit to the Jurisdictional Agency of the area where the work is to be performed, for its approval, working drawings including comprehensive staging and decking plans including support of excavation and calculations as described in Section 01530, TEMPORARY CONSTRUCTION. No work shall be started prior to approval.
- F. The construction staging part of the SSWP as specified in Section 01142, COORDINATION WITH OCCUPANTS AND OPERATIONS shall be based on the sequencing of construction activities. The plan shall develop a project schedule and a sequence of procedures for the Design-Builder and

subcontractors who will be working on the project. The following types of information shall be incorporated into the plan.

1. Type of work required
 2. Level of coordination/cooperation expected between WMATA and the Design-Builder
 3. Operational details/requirements for the project
 - a. Physical characteristics of project
 - b. Dictated work windows
 - c. Established work procedures, including safety policies/practices
 - d. Manpower and equipment requirements
 - e. Material approvals
 - f. Contingent allowances
 4. Design-Builder and personnel qualification requirements
 5. Planning requirements
 - a. Preliminary
 - b. Implementation
 - c. Post
 6. Quality assurance/quality control plan (QA/QC)
 7. Testing
 8. Safety Certification
- B. In some cases, the above elements may not explicitly defined in the staging plan; however, each element must be considered in the development process, and will ultimately influence the final staging plan.
- C. The general issues that shall influence the development of the staging plan for the project are the overall construction priorities, the work requirements, and the desire to maintain maintenance operations as much as possible. The sequencing of particular sections and contracts was influenced by the civil and structural requirements. Installation and implementation of the new rail, signal, and power systems is also as major factor.
- D. A primary influence on construction staging is available work windows. These windows will depend on maintenance of service. WMATA's primarily concern is the continued safe and efficient operation of maintenance operations.

1.05 ACCESS TO ADJACENT PROPERTY

- A. The Design-Builder shall conduct construction operations in such a manner as to cause as little inconvenience as possible to owners of property affected by such operations. Convenient access to all property from roads and highways along line of work shall be maintained. When access to adjacent properties is temporarily cut off due to the Design-Builder's operations, the Design-Builder shall render every assistance to provide access to the property and the transfer of commodities, including refuse, to and from the property.

1.06 ACCESS TO FIRE HYDRANTS AND FIRE ALARM BOXES

- A. Whenever the work is being carried on, free access must be given to each fire hydrant, fire alarm box and standpipe; when required, hydrants shall be extended by suitable tubes or piping to an accessible point as approved and to the satisfaction of the jurisdictional fire department. Obstructions shall not be piled at any time or placed within 10 feet of any fire hydrant or fire alarm

box and, where materials are placed in the vicinity of a fire hydrant or fire alarm box and to such height as to prevent the same from being readily seen, the position of such hydrants or fire alarm boxes shall be indicated by suitable signs and lights, both day and night.

- B. The Design-Builder shall safeguard, maintain and protect the wires, cables, ducts, manholes, posts and poles, signals, and alarm boxes of fire departments. The Design-Builder shall not cause interruption to the fire department fire alarm telegraph service, and in case of accident, shall promptly notify the fire department. No fire department wire, cable, duct, manhole, post or pole, signal or fire alarm box shall be disturbed, except in the presence of a representative of the Bureau of Fire Alarm Telegraph. In case such wire, cable, duct, manhole, post or pole, signal or fire alarm box is disturbed, the Design-Builder shall immediately notify the Authority Representative, and it shall be restored immediately to its original condition.

1.07 DESIGN-BUILDER'S PERSONNEL AND DESIGN-BUILDER'S SUBCONTRACTORS PARKING

Parking facilities for the Design-Builder's personnel and that of subcontractors shall be the Design-Builder's responsibility. The storage/laydown and work facilities provided for the Authority, if any, shall not be used for parking by the Design-Builder or Design-Builder personnel.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION



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SECTION 01560

TEMPORARY BARRIERS AND ENCLOSURES

PART 1 GENERAL

1.01 SUMMARY

This Section specifies requirements for temporary barricades, fences, protective walkways, and tree and plant protection. This Section also includes facilities for protection of occupants entering or exiting spaces during construction.

1.02 RELATED DOCUMENTS

Section 00739, General Conditions: Protection of Existing Vegetation, Structures, Utilities and Improvements

Section 00744, General Conditions: Protection of Persons and Property

Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements

Section 01510, General Requirements - Temporary Facilities and Controls: Temporary Utilities

Section 01520, General Requirements - Temporary Facilities and Controls: Temporary Construction Facilities

Section 01530, General Requirements - Temporary Facilities and Controls: Temporary Construction

Section 01550, General Requirements - Temporary Facilities and Controls: Vehicular Maintenance of Traffic, Construction Sequence and Staging, Access and Parking

Section 01580, General Requirements - Temporary Facilities and Controls: Project Signs

Section 02205, Technical Requirements - Division 2 Site Construction: Removal and Restoration of Existing Landscaping

Section 02270, Technical Requirements - Division 2 Site Construction: Maintenance, Support and Restoration of Utility Facilities

Section 02320, Technical Requirements - Division 2 Site Construction: Grading, Excavating and Backfilling

Section 02820, Technical Requirements - Division 2 Site Construction: Fencing

Section 02920, Technical Requirements - Division 2 Site Construction: Topsoil, Seeding and Sodding

Section 02930, Technical Requirements - Division 2 Site Construction: Landscaping

1.03 GENERAL

A. Wherever necessary, shown or specified, the Design-Builder shall erect and maintain signs, fences, barricades and pedestrian bridges for the protection of public travel, the work site, adjoining property and adjoining public places.

B. The Design-Builder shall take positive measures to prevent entry into the site of the work and storage areas by children, animals and unauthorized adults and vehicles.

C. Appropriate warning signs and instructional safety signs as specified in Section 01580, PROJECT

SIGNS shall be conspicuously posted in all areas involving construction activities. The Design-Builder shall also furnish signs and attach to, as applicable, the protective devices enclosing the Contractor's work, access, operating, and platform storage and site storage/laydown areas as applicable; pedestrian sidewalks, streets, and parking lots adjacent to the work area; and excavations and openings as specified in Section 01580, PROJECT SIGNS. The storage/laydown areas as designated by the Authority, if any, and as specified in Section 01520, TEMPORARY CONSTRUCTION FACILITIES, shall be fenced and signage shall be provided to prevent unauthorized entry, and stored materials shall be bundled and/or tied down by the Design-Builder.

- D. Protective devices shall be in accordance with codes and regulations of jurisdictional agencies.

1.04 BARRICADES

- A. Barricades shall be substantial in character, neat in appearance, and of approved size and arrangement.
- B. Flashing yellow lights shall be mounted and maintained on barricades at maximum intervals of 25 feet.

1.05 TEMPORARY WOODEN PEDESTRIAN BARRIERS

- A. Wooden barriers for protection of non-construction personnel from the Design-Builder's work and operating areas and to enclose storage areas, as applicable: The location of barriers shall be as shown on the approved Design-Builder's working drawings submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES or as directed.
- B. Temporary wooden barriers shall be substantial in character, neat in appearance, and of approved size and arrangement.
 - 1. Unless otherwise shown, barriers shall be a minimum of six feet high.
 - 2. The type of barrier, whether fixed or movable, shall be as directed or as shown.

1.06 TEMPORARY FENCES

- A. The Design-Builder shall furnish temporary fencing within the construction area to fence off pedestrian sidewalks, streets and parking areas from operating, access and work areas and site storage/laydown areas. The location of fencing for pedestrian sidewalks shall be as shown on the approved Design-Builder's working drawings submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES or as directed.
- B. Temporary fences shall be substantially constructed in a neat appearance.
- C. Working Area Wooden Fencing
 - 1. The Design-Builder shall furnish a minimum six-foot high temporary working area wooden

fencing as shown or as directed and as specified. Working area wooden fencing shall serve two purposes: to fence off pedestrian sidewalks, and to enclose the Design-Builder's work, access, storage and operating areas.

2. The location of fence for pedestrian sidewalks adjacent to the work area and for enclosing Design-Builder's work areas shall be as specified and as shown on the Design-Builder's approved working drawings.

D. Working Area Chain-link Fencing

1. The Design-Builder shall furnish a minimum of six-foot high temporary working area chain-link fencing as specified in Section 02820, FENCING to fence off storage area from operating areas, and if necessary, to fence off pedestrian sidewalks.
2. The location of fence for pedestrian sidewalks adjacent to the work area and to the storage areas shall be as specified and shall be as shown on the Design-Builder's approved working drawings.

1.07 PEDESTRIAN BRIDGES, AS APPLICABLE:

Bridges for pedestrians shall be constructed of approved suitable materials in accordance with local requirements, be provided with handrails or with sides tightly boarded in accordance with such requirements and shall have a minimum width of six feet or such greater minimum width as will accommodate the normal traffic flow at the particular location. Also, accessibility shall be in accordance with ADAAG regulations. Maintain vehicular and pedestrian access to buildings at levels existing prior to start of Contract work. The Design-Builder shall submit for review and approval in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES, working drawings for required bridges. Decking is specified in Section 01530, TEMPORARY CONSTRUCTION.

1.08 TREE AND PLANT PROTECTION

Protect trees and plants not slated to be removed or replaced from construction activities in accordance with Section 00739, PROTECTION OF EXISTING VEGETATION, STRUCTURES, UTILITIES AND IMPROVEMENTS, Section 02205, REMOVAL AND RESTORATION OF EXISTING LANDSCAPING, Section 02920, TOPSOIL, SEEDING AND SODDING and Section 02930, LANDSCAPING.

1.09 PROTECTION OF UTILITIES

Protect existing utilities in accordance with Section 00739, PROTECTION OF EXISTING VEGETATION, STRUCTURES, UTILITIES AND IMPROVEMENTS and SECTION 02270, MAINTENANCE, SUPPORT AND RESTORATION OF UTILITY FACILITIES.

1.10 PROTECTION OF EXISTING STRUCTURES AND IMPROVEMENTS

Protect Existing Structures ,and Improvements in accordance with Section 00739, PROTECTION OF

EXISTING VEGETATION, STRUCTURES, UTILITIES AND IMPROVEMENTS, Section 01723, PROTECTION OF ADJACENT CONSTRUCTION, and Section 02320, GRADING, EXCAVATING AND BACKFILLING.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Barricade and pedestrian bridge materials shall be as approved. Lumber for barriers as applicable and working area wooden fencing shall be exterior grade, treated to be fire-retardant, pressure impregnated with resin salt as approved. Exterior latex paint for barriers and working area wooden fencing shall be as specified in Section 09920, FIELD PAINTING. Color shall be as approved. Provide necessary fencing hardware, locks, gates and all other incidentals as approved.
- B. All chain-link fencing shall be anti-climbing type with barbed wire as specified in Section 02820, FENCING and shall have plastic inserts.
- C. Tree and Plant Protection is specified in Section 02205, REMOVAL AND RESTORATION OF EXISTING LANDSCAPING, Section 02920, TOPSOIL, SEEDING AND SODDING and Section 02930, LANDSCAPING.
- D. Protection of existing utilities is specified in SECTION 02270, MAINTENANCE, SUPPORT AND RESTORATION OF UTILITY FACILITIES.
- E. Existing Structures and Improvements Protection is specified in Section 02320, GRADING, EXCAVATING AND BACKFILLING.
- F. Warning signage is specified in Section 01580, PROJECT SIGNS.
- G. Structural lumber for decking is specified in Section 01530, TEMPORARY CONSTRUCTION.

PART 3 EXECUTION

3.01 INSTALLATION

- A. As removal of pavement and sidewalk progress as applicable and as specified in Section 01530, TEMPORARY CONSTRUCTION, furnish and install barricades in accordance with requirements of the jurisdictional agencies. The Design-Builder shall also, during the prosecution of the work, barricade or close excavations and openings in floors, walls and other parts of the structures and excavations while such openings are not in regular use as applicable. The Design-Builder shall barricade or close such openings before final acceptance of the work. Barricades shall be anchored to the ground on all sides of excavations. Work involving electrical systems or equipment in or near the area to which personnel or the public have access shall be isolated using barricades.
- B. Fabricate and erect in accordance with local requirements pedestrian barriers as applicable and working area wooden fencing with a stud framework and a covering of tightly fitted plywood sheets.

Paint with two coats of exterior latex paint. Install hardware, locks, gates and all other incidentals. Install wooden fence along sides of decked areas for pedestrian walkways as applicable and as specified in Section 01530, TEMPORARY CONSTRUCTION, where such walkways are adjacent to open areas, staging/storage areas and other areas used by the Design-Builder.

- C. Erect chain-link fencing as applicable and as specified in Section 02820, FENCING consisting of a post and rail framework with chain-link fabric; install hardware, locks, gates and all other incidentals; and insert plastic inserts into the chain link fence.
- D. Along sides of decked areas for pedestrian walkways as applicable and as specified in Section 01530, TEMPORARY CONSTRUCTION, where such walkways are adjacent to vehicular traffic, install concrete barriers as specified in Section 02845, TRAFFIC CONTROL DEVICES and as shown on approved maintenance of traffic plan as specified in Section 01550, MAINTENANCE OF TRAFFIC, CONSTRUCTION SEQUENCE AND STAGING, ACCESS AND PARKING and submitted in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
- E. Fabricate, install and maintain pedestrian bridges at design elevations and as shown on the approved shop drawings submitted as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and in accordance with local requirements. All profile grades and cross-slopes or other features required in an accessible path shall be provided and maintained to ADAAG requirements. Place premixed asphaltic patching material as specified in Section 01530, TEMPORARY CONSTRUCTION to provide smooth transitions between existing pavement surfaces and pedestrian bridge decks to provide proper drainage and prevent ponding of water. Maintain free of snow, ice, water, mud and debris. Provide and maintain skid-resistant surface. Decking is specified in Section 01530, TEMPORARY CONSTRUCTION.
- F. Erect Fabricate, attach and maintain safety warning and other signs as specified in Section 01580, PROJECT SIGNS.
- G. Protect Existing Vegetation, Structures, Utilities and Improvements in accordance with Section 02205, REMOVAL AND RESTORATION OF EXISTING LANDSCAPING, Section 02270, MAINTENANCE, SUPPORT AND RESTORATION OF UTILITY FACILITIES, Section 02320, GRADING, EXCAVATING AND BACKFILLING, Section 02920, TOPSOIL, SEEDING AND SODDING, and Section 02930, LANDSCAPING.
- H. The Design-Builder shall provide maintenance for all barricades, barriers, temporary fences, pedestrian bridges, signage and existing vegetation, structures, utilities and improvements protection as applicable during the entire duration of the Contract. Immediately prior to completion of the Contract, the Design-Builder shall completely remove the items and restore the area unless otherwise directed.

END OF SECTION

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SECTION 01570

TEMPORARY CONTROLS

PART 1 GENERAL

1.01 SUMMARY

This Section specifies security, site, environmental and pollution abatement controls required to allow construction to proceed.

1.02 RELATED DOCUMENTS

Section 00701, General Conditions: Definitions

Section 00707, General Conditions: Permits and Responsibilities

Section 00708, General Conditions: Responsibility of the Design-Builder for Design-Related Services

Section 00739, General Conditions: Protection of Existing Vegetation, Structures, Utilities and Improvements

Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements

Section 01141, General Requirements - Summary of Work Requirements: Access to Site

Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures

Section 01410, General Requirements - Quality Requirements: Regulatory Requirements

1.03 SITE SECURITY - [Not Applicable]

1.04 EROSION AND SEDIMENT CONTROL

- A. Erosion and Sediment materials: No erosion or sediment materials shall be allowed to enter natural or man-made water or sewage removal systems. Erosion materials from excavations, borrow areas or stockpiled fill shall be contained within the work area. The Design-Builder shall develop methods to control waste and erosion including such means as filtration, settlement and manual removal.
- B. The Design-Builder shall be responsible for complying with and providing all necessary drawings, specifications, and certifications necessary to comply with local jurisdiction erosion and sediment control statues, ordinances, and requirements in Maryland, Montgomery County, Prince George's County and the Distic of Columbia.
 - 1. Maryland as applicable:
 - a. Chapter 245 of the Acts of the 1970 General Assembly of the State of Maryland which provides for a statewide erosion and sediment control program in Maryland under the guidance of the Department of Natural Resources.
 - b. Prior to the start of the applicable earthwork construction the Contractor Design-Builder shall submit schedules for accomplishment of erosion control work in the State of Maryland as are applicable for earthwork under this Contract. No earthwork operations in the State of Maryland shall be started until the Contractor Design-Builder's erosion control schedules and methods of operation have been approved.

2. Submit to the affected jurisdiction for approval through the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.

1.05 ENVIRONMENTAL CONTROL

- A. The Design-Builder shall maintain temperature and humidity to protect work, in progress and in place, as well as permanent equipment and materials, stored and installed, against damage from heat, cold and dampness and take such steps as necessary to protect such work from other adverse conditions.

1.06 POLLUTION ABATEMENT

- A. The Design-Builder shall by every means possible conduct its operations in a manner to minimize pollution of the environment surrounding the area of work. Specific controls shall be applied as follows:

1. Material transport: Trucks leaving the site and entering paved public streets shall be cleaned of mud and dirt clinging to the body and wheels of the vehicle. Trucks arriving and leaving the site with materials shall be loaded so as to prevent dropping materials and debris on the streets. Trucks carrying dirt from the site shall have their loads covered to minimize fugitive dust. The Design-Builder shall maintain a suitable vehicle cleaning installation and inspection installation with permanent crew for this purpose. Spills of materials in public areas shall be removed immediately.
2. Waste materials: No waste materials shall be allowed to enter natural or man-made water or sewage removal systems. The Design-Builder shall develop methods to control waste including such means as filtration, settlement and manual removal.

- a. District of Columbia

[1] DCDPW Standard Specifications for Highways and Structures (1996), 107.16 (A) "WATER QUALITY" 107.16 (B) "Storm Water Management".

[2] DCDPW Standard Specification for Highways and Structures (1996), 628 "Erosion and Sediment Control".

3. Burning: No burning of waste shall be allowed without written permission. When permission is granted, burning shall be conducted in accordance with the regulations of the Jurisdictional Agency. Submit request to the affected jurisdiction for approval through the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
4. Dust control: The Design-Builder shall, by water sprinkling or by other approved methods, continuously control dust generated by its operations.
5. Noise control: The Design-Builder shall take every action possible to minimize the noise

caused by its operation. When required by agencies having jurisdiction, noise producing work shall be performed in less sensitive hours of the day or week as directed. Noise produced by the work shall be maintained at or below the decibel levels specified and within the time periods specified in Section 01141, ACCESS TO SITE.

6. The Design-Builder, subcontractors and suppliers must submit evidence to the Authority that the governing air pollution criteria will be met. These criteria and related documents will be retained by the Authority for on-site examination by FTA as applicable. Submit to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
7. Design-Builder shall submit a program for pollution control prior to beginning operations. Submit to the Authority Representative in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES.
8. Clean air and water:
 - a. The Design-Builder agrees as follows:
 - (1) To comply with all the requirements of Section 114 of the Clean Air Act, as amended (42 U.S.C. 1857, et seq., as amended by Pub. L. 91-604) and Section 308 of the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq., as amended by Pub. L. 92-500), respectively, relating to inspection, monitoring, entry, reports and information, as well as other requirements specified in Section 114 and Section 308 of the Air Act and the Water Act, respectively, and all regulations and guidelines issued thereunder before the award of this Contract.
 - (2) That no portion of the work required by this prime Contract will be performed in a facility listed on the Environmental Protection Agency List of Violating Facilities on the date when this Contract was awarded unless and until the EPA eliminates the name of such facility or facilities from such listing.
 - (3) To use its best efforts to comply with clean air standards and clean water standards at the facility in which the Contract is being performed.
 - (4) To insert the substance of the provisions of this article into any nonexempt subcontract, including this paragraph.
 - b. The terms used in this article have the following meanings:
 - (1) The term Air Act means the Clean Air Act, as amended (42 U.S.C. 1857 et seq., as amended by Pub. L. 91-604).
 - (2) The term Water Act means Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq., as amended by Pub. L. 92-500).
 - (3) The term clean air standards means any enforceable rules, regulations, guidelines,

standards, limitations, orders, controls, prohibitions or other requirements which are contained in, issued under or otherwise adopted pursuant to the Air Act or Executive Order 11738, an applicable implementation plan as described in Section 110(d) of the Clean Air Act (42 U.S.C. 1857c-5(d)), an approved implementation procedure or plan under Section 111(c) or Section 111(d), respectively, of the Air Act (42 U.S.C. 1857c-6(c) or (d)), or an approved implementation procedure under Section 112(d) of the Air Act (42 U.S.C. 1857c-7(d)).

- (4) The term clean water standards means any enforceable limitation, control, condition, prohibition, standard or other requirement which is promulgated pursuant to the Water Act or contained in a permit issued to a discharger by the EPA or by a State under an approved program, as authorized by Section 402 of the Water Act (33 U.S.C. 1342), or by local government to ensure compliance with pretreatment regulations as required by Section 307 of the Water Act (33 U.S.C. 1317).
- (5) The term compliance means compliance with clean air or water standards. Compliance shall also mean compliance with a schedule or plan ordered or approved by a court of competent jurisdiction, the EPA or an air or water pollution control agency in accordance with the requirements of the Air Act or Water Act and regulations issued pursuant thereto.
- (6) The term facility means any building, plant, installation, structure, mine, vessel or other floating craft, location or site of operations, owned, leased or supervised by Design-Builder or subcontractor, to be utilized in the performance of a contract or subcontract. Where a location or site of operations contains or includes more than one building, plant installation or structure, the entire location or site shall be deemed to be a facility except where the Director, Office of Federal Activities, Environmental Protection Agency, determines that independent facilities are co-located in one geographical area.

1.07 PERMIT AND MITIGATION REQUIREMENTS

The Design-Builder shall obtain all permits and comply with all mitigation requirements of the local jurisdiction's Environmental requirement for all work included in this contract.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

SECTION 01580

PROJECT SIGNS

PART 1 GENERAL

1.01 SUMMARY

This Section specifies the requirements for signage that will be required at the site during the construction of the Project.

1.02 RELATED DOCUMENTS

WMATA Standard Drawings (ST), available from the Authority.
Section 01560, General Requirements - Temporary Facilities and Controls: TEMPORARY BARRIERS AND ENCLOSURES

1.03 PROJECT IDENTIFICATION SIGNS

- A. The Design-Builder shall furnish three (one sign per site) Authority, and as applicable FTA, project identification signs in the locations at the site(s) selected by the Authority Representative.
- B. Sign size, content, lettering and format for the large permanent-mount WMATA sign, and as applicable FTA signs, shall be as shown on the Standard Drawings (or for WMATA sign, shall be as shown on the Design-Builder's Working Drawings).
- C. Signs shall be installed as soon as possible after construction work has commenced, shall be maintained during the work, and shall be removed upon the completion of the Project.

1.04 WARNING SIGNS AND INSTRUCTIONAL SAFETY SIGNS

- A. The Design-Builder shall provide "No Trespassing" signs as described in Section 01560, TEMPORARY BARRIERS AND ENCLOSURES, load limit on decking as described in Section 01530, TEMPORARY CONSTRUCTION, and other warning and instructional safety aluminum signs with minimum two-inch high Helvetica Medium style lettering and mount at locations on fencing/barriers/barricades/pedestrian bridges and on other areas as directed. Sign panel size and thickness shall be as directed. The Design-Builder shall mount the signs with stainless-steel cap screws with hex nuts and lockwashers.

1.05 ALLOWANCE FOR PROJECT SIGNS

- A. Design Builder's Lump Sum Price(s) shall include an allowance for project signs.

PART 2 PRODUCTS

[Not Applicable]

PART 3 EXECUTION

[Not Applicable]

END OF SECTION

SECTION 01610

BASIC PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements governing the Design-Builder's selection of products for use in construction of the Project.
- B. Refer to Section 01420, REFERENCES for applicability of industry standards to products specified.
- C. Administrative procedures for handling requests for substitutions made after award of the Contract are included under Section 01630, PRODUCT SUBSTITUTION PROCEDURES.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions

Section 00800, Supplementary Conditions

Section 01322, General Requirements - Administrative Requirements: Contract Progress Reporting

Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Requirements

01410, General Requirements - Quality Requirements: Regulatory Requirements

01420, General Requirements - Quality Requirements: References

01470, General Requirements - Quality Requirements: Quality System

Section 01630, General Requirements - Product Requirements: Product Substitution Procedures

Section 01723, General Requirements - Execution Requirements: Protection of Adjacent Construction

Section 01732, General Requirements - Execution Requirements: Application, Installation and Erection.

Section 01740, General Requirements - Execution Requirements: Cleaning

Divisions 2 through 16, Standard and Technical Specifications Requirements

1.03 DEFINITIONS

- A. Definitions used in the Section are not intended to change the meaning of other terms used in the Design Builder's Final Design Drawings and Final Design Specifications, such as "specialties," "systems," "structure," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well recognized meanings in the construction industry.
 - 1. The term Product, includes the terms "material", "equipment", "system", and other terms of similar intent. Products are items purchased for incorporation in the Work, whether purchased explicitly for the Contract or obtained from previously purchased stock.
 - 2. The term Named Products, includes items identified by manufacturer's product name, make, or model designation as published in the manufacturer's most current product literature.
 - 3. The term Materials, includes products that are substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.

4. The term Equipment, includes a product that is motorized, with operating parts, and either automatically or manually operated.
- B. As used herein, the term "brand name" includes identification of products by make and model. If items called for in the Final Design Drawings and Final Design Specifications have been identified by a "brand name or equal" description, such identification is intended to be descriptive, but not restrictive, and is to indicate the quality and characteristics of products that will be satisfactory. Proposals offering "equal" products including products of the brand name manufacturer other than the one described by brand name as specified in Section 01630, PRODUCT SUBSTITUTION PROCEDURES will be considered if such products are clearly identified and are determined by the Designer and the Authority to meet fully the salient characteristic requirements of the Final Design Drawings and Final Design Specifications.

1.04 SUBMITTALS

- A. The Builder shall prepare a schedule in tabular form acceptable to the Designer and the Authority showing products specified in the Final Design Drawings and Final Design Specifications. The generic name, manufacturer's name, and proprietary product name for each item in the schedule shall be listed.
- B. The Builder shall coordinate the product list schedule with the Design-Builder's Construction Schedule as specified in Section 01322, CONTRACT PROGRESS REPORTING and Submittal Log as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL REQUIREMENTS. At a minimum, the following information shall be provided:
 1. Related Specification Section number.
 2. Generic name used in the Final Design Drawings and Final Design Specifications.
 3. Proprietary name, model number and similar designation.
 4. Manufacturer's name and address.
 5. Supplier's name and address.
 6. Installer's name and address.
 7. Projected delivery date, or time span of delivery period.
- C. The Builder shall submit to the Designer for review the original and 6 paper copies and an electronic copy of an initial product list schedule within 7 calendar days after date of commencement of the construction work. A written explanation for omissions of data and for known variations from Contract requirements shall be included. Comments will be provided in writing by the Designer to the Builder within 7 calendar days from the receipt of the initial product list schedule. The Builder shall submit the original and 6 paper copies and an electronic copy of the completed product list schedule including a written explanation for omissions of data and for variations from Contract requirements to the Designer for approval within 21 calendar days after date of commencement of the construction work. The Design-Builder shall submit to the Authority Representative for approval the original and 6 paper copies and an electronic copy of the Designer-approved completed product list schedule including a written explanation for omissions of data and for variations from Contract requirements within 30 calendar days after date of commencement of

the construction work. Within 15 calendar days of receipt of the documentation, the Design-Builder will be notified of Authority acceptance or rejection of the documentation.

- D. Acceptance of the product list does not constitute a waiver of the requirement that products comply with the Final Design Drawings and Final Design Specifications.

1.05 QUALITY ASSURANCE

- A. The Design-Builder shall provide products of the same kind from a single source.
- B. When the Design-Builder is given the option of selecting between two or more products for use on the Contract, the product selected shall be compatible with existing or previously selected products, even if previously selected products were also options.
- C. Except for required labels and operating data, the manufacturer's or producer's nameplates or trademarks shall not be attached or imprinted on an exposed surfaces.
 - 1. Labels: Locate required product labels and stamps on a concealed surface or, where required for observation after installation, on an accessible surface that is not conspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. The nameplate shall contain the following information and other essential operating data:
 - a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. All products shall be delivered, stored and handled in accordance with the manufacturer's recommendations so as to prevent damage, deterioration, loss or invalidation of the manufacturer's warranty.
- B. The Design-Builder shall schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction storage and staging areas.
- C. The Design-Builder shall coordinate the time of delivery with the installation schedule to ensure that hazardous, easily damaged, or those items sensitive to deterioration, theft and other losses are stored for a minimum holding period.
- D. Products shall be delivered to the site in the manufacturer's original sealed container or other appropriate packaging, complete with labels and instructions for handling, storing, unpacking, protecting and installing.

- E. Products shall be inspected upon delivery by the Design-Builder to ensure compliance with the Final Design Drawings and Final Design Specifications , and to ensure that products are undamaged and properly protected. Documentation noting the time, date, and manner of delivery shall be maintained by the Design-Builder. A statement attesting to the inspection of the products at time of delivery shall be include in the documentation signed by the Design-Builder's authorized representative.
- F. Products shall be stored at the site in a manner that will facilitate inspection and measurement of quantity or counting of units. Heavy materials are to be stored in a manner that will not endanger supporting construction. Products subject to damage by the elements shall be stored under cover in weather-tight enclosures with adequate ventilation adequate to prevent condensation. Temperature and humidity are to be maintained within range required by manufacturer's instructions.

PART 2 PRODUCTS

2.01 PRODUCT SELECTION

- A. Products shall be provided by the Design-Builder that comply with the Final Design Drawings and Final Design Specifications. All products to be installed in the Work shall be undamaged and, unless otherwise permitted, unused at the time of installation. Products shall include all accessories, trim, finish, safety guards and other devices and details needed for a complete installation and suitable for the intended use.
- B. Unless otherwise specified, the Design-Builder shall provide standard products of the type that have been produced and used successfully in similar situations on other Authority projects of a similar nature.
- C. The product selection shall be governed by the Final Design Drawings and Final Design Specifications and governing regulations. Procedures governing product selection include:
 - 1. Where only a single product or manufacturer is named and the notation, "no substitution is permitted" is included in the specification, the Design-Builder shall provide the product indicated. No substitutions shall be permitted.
 - 2. Where two or more products or manufacturers are named followed by the notation "no substitutions are permitted," the Design-Builder shall provide one of the products indicated. No substitutions will be permitted.
 - 3. Where the Final Design Drawings and Final Design Specifications list products or manufacturers that are available and acceptable for incorporation into the Work, accompanied by the term "...or equal" or "...or approved equal," the Design-Builder may propose any available product that complies with Contract requirements. The Design-Builder shall comply with the requirement of Specifications Section 01630, PRODUCT SUBSTITUTION PROCEDURES, to obtain approval for use of an unnamed product.
 - 4. Where the Specifications Final Design Drawings and Final Design Specifications list the salient features that explicitly describe a product or assembly and a brand name is not included, the Design-Builder shall provide a product or assembly that provides the listed features and otherwise complies with the Contract requirements.

5. Where the Specifications Final Design Drawings and Final Design Specifications explicitly require compliance with performance requirements and the product complies with those requirements based on the manufacturer's recommended use of the product for the application indicated in the Final Design Drawings and Final Design Specifications (as evidenced in published product literature, or by the manufacturer's certification of performance), the Design-Builder may submit the product for incorporation into the Work.
6. Where the Final Design Drawings and Final Design Specifications require only compliance with an imposed code, standard or regulation, the Design-Builder may select a product that complies with the standards, codes or regulations specified.
7. Visual Matching: Where Specifications require matching an established item, the Authority's decision will be final on whether a proposed product matches satisfactorily. Where no product is available that adequately matches complies with the other specified requirements, the Design-Builder shall comply with provisions of Specification Section 01630, PRODUCT SUBSTITUTION PROCEDURES, for selection of an alternate product.
8. Where specified product requirements include the phrase "...as selected from manufacturer's standard colors, patterns, textures..." the Design-Builder shall select a manufacturer that provides a range of colors in a product that meets all other Final Design Drawings and Final Design Specifications requirements. In this situation, "standard" shall imply regularly or routinely produced.

PART 3 EXECUTION

3.01 INSTALLATION OF PRODUCTS

- A. The Design-Builder shall comply with the manufacturer's instructions and recommendations for installation of all products installed under this Contract unless otherwise specified. Products shall be accurately located, aligned with other elements of the Work, and securely installed in place as specified in Section 01732, APPLICATION, INSTALLATION AND ERECTION. All exposed surfaces are to be clean as specified in Section 01740, CLEANING and protected as necessary to prevent damage and deterioration as specified in Section 01723, PROTECTION OF ADJACENT CONSTRUCTION.

END OF SECTION

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SECTION 01630

PRODUCT SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling requests for substitutions made after award of the Contract.
- B. Refer to Section 01420, REFERENCES for applicability of industry standards to products specified.
- C. Other requirements governing the Design-Builder's selection of products and product options are included under Section 01610, BASIC PRODUCT REQUIREMENTS.

1.02 RELATED DOCUMENTS

Section 00211, Proposing Requirements - Brand Name or Equal
Section 00433, Proposing Requirements - Brand Name or Equal Form
Section 00700, General Conditions
Section 00800, Supplementary Conditions
01420, General Requirements - Quality Requirements: References
01610, General Requirements - Product Requirements: Basic Product Requirements
Divisions 2 through 16, Standard and Technical Specifications Requirements

1.03 DEFINITIONS

- A. Definitions used in the Section are not intended to change the meaning of other terms used in the Contract Documents or approved Final Design Drawings and Final Design Specifications Issued for Construction .
- B. Design-Builder requests for changes in products, materials, equipment, and methods of construction as required or specified by Contract Documents after award of the Contract or in approved Final Design Drawings and Final Design Specifications Issued for Construction are considered requests for substitutions. The following are not considered substitutions:
 - 1. Revisions to Contract Documents or approved Final Design Drawings and Final Design Specifications Issued for Construction requested by the Authority.
 - 2. Specified options of products and construction methods included in Contract Documents or in approved Final Design Drawings and Final Design Specifications Issued for Construction. Note that products submitted under an "or equal" or "not limited to" provision are considered to be substitutions as specified in Section 00211, BRAND NAME OR EQUAL.
 - 3. The Design-Builder's determination of and compliance with governing regulations and orders issued by governing authorities.

1.04 SUBMITTALS

- A. Requests for substitution from the Designer during design work will be considered by the Authority if received prior to the intermediate level of review or with the intermediate level review submittal.

Requests received after the intermediate level review submittal may be considered or rejected at the sole discretion of the Authority. Requests for substitution from the Builder during construction will be considered by the Designer if received within 7 calendar days after the commencement of construction work. Requests received more than 7 calendar days after commencement of construction work may be considered or rejected at the sole discretion of the Designer. The Designer shall evaluate the requested substitution and if approved, the Design-Builder shall submit to the Authority Representative for approval within 30 calendar days after commencement of construction.

1. The Design-Builder shall submit six copies of the Brand Name or Equal Form, Section 00433 for each request for substitution to the Authority Representative or the Authority Representative's designee for consideration of the form and in accordance with procedures required for Change Order proposals as specified in Section 00753, CHANGES.
2. In each substitution request, the Design-Builder shall identify the product and fabrication or installation method to be replaced. The related Standard and Technical Specification Sections and Project Drawing numbers or approved Final Design Drawing Issued for Construction Drawing numbers shall be referenced in the submittal. Complete documentation showing compliance with the requirements for substitutions shall also be submitted including the following information as appropriate:
 - a. Product Data, including drawings, fabrication, and installation procedures.
 - b. Samples, where samples of the specified product are requested.
 - c. A detailed comparison of significant qualities/salient features of the proposed substitution with those of the material or work specified. Significant qualities may include elements such as size, weight, durability, performance, visual effect, code compliance, maintenance requirements, energy usage, and environmental considerations.
 - d. Coordination information, including a list of changes or modifications made necessary to other parts of the Work and to construction performed by the Authority or separate contractors.
 - e. A statement indicating the substitution's effect on the Design-Builder's Construction Schedule. Indicate the effect of the proposed substitution on overall Contract Time.
 - f. Cost comparison between the product specified and the requested substitution, including a proposal of the net change, if any in the Contract Sum.
 - g. Certification by the Design-Builder that the substitution proposed is equal-to or better in every respect to that required under the Contract, and that the product will perform as intended. The Design-Builder shall include a waiver of rights to additional payment or time that may subsequently become necessary should the product fail to perform adequately, or because of changes to other work were required as a consequence of the substitution.
 - h. Failure by the Design-Builder to include the above requirements in the submittal may be cause for rejection of the submittal in its entirety.
- B. If deemed necessary and within ten (10) calendar days of receipt of the submittal, the Authority Representative or the Authority Representative's designee may request additional information or documentation that, in their sole judgment is required for the evaluation of the substitution request. Within 15 calendar days of receipt of the original substitution request or of requested additional

information or documentation, the Design-Builder will be notified of acceptance or rejection of the proposed substitution. If a decision on the use of a proposed substitute cannot be made or obtained within the time allocated, the product specified by name in the Contract Specifications or approved Final Design Drawings and Final Design Specifications Issued for Construction shall be used. Acceptance of substitutions will be confirmed in writing by the Authority.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

- A. The Design-Builder's request for substitution may be rejected by the Authority Representative or the Authority Representative's designee if the substitution would involve:
1. Extensive revisions to Contract Documents.
 2. A proposed change not in keeping with the general intent of Contract Documents.
 3. An untimely request, not fully documented when submitted.
 4. A request that is directly related to an "or equal" clause or similar language in the Contract Documents.
 5. A product or method of construction that could not be provided within the Contract Time. (A request will not be considered if the product or method specified is being requested as a result of failure to pursue the Work promptly or coordinate activities properly.)
 6. A product or method of construction that could not be approved by a governing authority.
 7. Additional responsibilities or expense to the Authority (including additional expenses for redesign and evaluation services, increased cost of related construction, and other similar considerations) that outweighs any advantage that is being offered to the Authority as a result of the substitution.
 8. A method of construction that cannot be provided in a manner that is compatible with other materials, the product cannot be coordinated with other materials, and a warranty cannot be provided for the product in accordance with the requirements of the Contract even though the Design-Builder expresses a willingness to certify that the apparent deficiencies can be corrected.
- B. Neither the Builder's submittal nor the Designer's review or approval of shop drawings, product data or samples that relate to a substitution constitutes a final approval of the requested substitution. The submittal of a substitution does not relieve the Builder from fulfilling existing Contract requirements.

PART 3 EXECUTION

[Not Applicable]

END OF SECTION



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SECTION 01711

ACCEPTANCE OF CONDITIONS

PART 1 GENERAL

1.01 SUMMARY

This Section specifies basic requirements for determining acceptable conditions for installation.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions
Section 00800, Supplementary Conditions
Division 01, General Requirements

1.03 PRECONSTRUCTION INSPECTION REQUIREMENTS

- A. Prior to beginning any construction work, the Design-Builder shall inform the Authority of buildings or structures on which it intends to perform work or which performance of the project work will affect.
- B. Conditional inspection of buildings or structures in the immediate vicinity of the project which may reasonably be expected to be affected by the work will be performed jointly by the Authority and the Design-Builder. This inspection will be conducted prior to the commencement of any construction work to determine pre-existing conditions. After this inspection, the Authority will not assume any responsibility for damages arising from the work performed and it shall be the responsibility of the Design-Builder to correct all damages caused by performance of the Contract work.
- C. Examine substrates, areas, and conditions, with Authority personnel present where indicated, for compliance with requirements for installed tolerance and other conditions affecting performance. Record observations from the preconstruction inspection as specified in Section 00716, PRECONSTRUCTION INSPECTION, and submit the original and six copies and one electronic copy of the preconstruction inspection records in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES no later than 10 calendar days after completion of this inspection.
- D. Where an inspection written report requires listing conditions detrimental to performance of the Work, include the following:
 - 1. Description of the Work.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.

1.04 EXAMINATION

- A. General: Dimensions shown on existing work and dimensions required for work that is to connect with work not in place shall be verified by the Design-Builder by actual measurement of the existing work. Discrepancies between the Final Design Drawings and Final Design Specifications and the existing conditions shall be referred to the Authority Representative before work affected thereby has been performed.
1. The Design-Builder shall compare drawings and verify the dimensions before laying out the work and shall be responsible for errors which might have been avoided thereby.
 2. The dimensions and descriptions given on As-Built Information Drawings in the Contract Documents is not guaranteed. It shall be the responsibility of the Design-Builder to verify all as-built conditions and interface information by actual field measurement.
- B. Existing Conditions
- The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the work. Verify the location and point of connection of utility services.
- C. Existing Utilities
- The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning site work, investigate and verify the existence and location of underground utilities and other construction affecting the Work. Design-Builder shall call Miss Utility before beginning any excavation or demolition project.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, water service pipes, and electrical services.
 2. Furnish location data for work related to the Project that must be performed by public utilities serving the Project site.
- D. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- E. Examine rough-in for mechanical and electrical systems to verify actual location of connections before equipment and fixture installation.
- F. Examine new and existing facilities for suitable conditions where products and systems are to be installed.

1.05 ACCEPTANCE OF CONDITIONS

- A. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Proceeding with work will indicate acceptance of surfaces and conditions.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION



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SECTION 01721

LAYOUT OF WORK AND FIELD ENGINEERING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Special Provisions and other Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:

1. General Requirements.
2. Examination.
3. Preparation.
4. Construction layout.
5. Field engineering.
6. Installation.
7. Survey personnel.
8. Equipment and calibration requirements.
9. Survey Standards.
10. Surveys and Procedures.
11. Figures and Report Formats.

- B. Related Sections include the following:

1. Division 1 Section "Submittal Procedures" for submitting surveys.
2. Division 1 Section "Closeout Procedures" for submitting final survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and grades.

1.03 SUBMITTALS

- A. Survey personnel qualification data: Submit resume and proof of certification or registration for all project surveyors. Resumes should include information to demonstrate their capabilities and experience. Include lists of completed projects with owner, project names, project duration, project description, project addresses and phone numbers.
- B. Survey equipment: Submit a list of equipment and instruments to be used on the contract and notify the Authority Representative when changes are made. Include manufacturer specifications, date of purchase and last date of service for all instruments.
- C. Electronic distance measuring instruments: Submit all measurements, computations and results from the required calibration exercise.
- D. All methods, equipment, and procedures for Control Surveys, Structural As-built Surveys, Movement Detection Surveys, Early Alignment As-built Surveys, Hi-Lo Surveys, Post Construction Alignment As-built Surveys and Final Trackway Monumentation Surveys.

- E. All horizontal and vertical alignment revisions with supporting calculations and data.
- F. All supporting documents, calculations and data for required remedial actions.
- G. Numbering sequence for trackway vertical control monumentation.

1.04 QUALITY ASSURANCE

- A. The Design Builder shall verify and maintain records to document personnel certification; equipment maintenance, calibration and adjustment; and use of required procedures for field work and office computations. These records shall be maintained by the surveyor in responsible charge of the work. Verification of compliance shall be included in the Design Builder's overall Quality Assurance program and provided to the Authority Representative quarterly or upon request.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. The Authority has established, or will establish, such general reference points including horizontal control points and vertical bench marks as will enable the Design Builder to proceed with the work. If the Design Builder finds that any previously established reference points have been destroyed or displaced, or that none have been established, he shall promptly notify the Authority Representative.
- B. The Design Builder shall lay out his work from reference points established by previous construction or from established reference points shown in the contract and shall be responsible for all measurements in connection therewith. The Design Builder shall furnish, at his own expense, stakes, templates, platforms, equipment, tools, materials and labor as may be required in laying out any part of the work from the reference points established by previous construction or by the Authority. The Design Builder will be held responsible for the execution of the work to such lines and grades as may be directed.
- C. The Design Builder shall protect and preserve the established reference points and shall make no changes in locations without approval. Reference points lost, disturbed by construction, destroyed or which require shifting because of necessary changes in grades or locations shall, subject to prior approval, be replaced and accurately located at the Design Builder's expense by a registered surveyor in the area where the work is to be performed or a qualified certified survey technician (CST Level IV). Reference points replaced by the Design Builder's surveyor shall be done in accordance with the FGCC "Standards and Specifications for Geodetic Control Networks" using First Order, Class 1 specifications for horizontal control work and Second Order, Class 1 specifications for vertical control work.
- D. For the purpose of this article, the Design Builder shall provide competent engineering services as necessary to execute the work in accordance with the Contract requirements. He shall verify the dimensions shown before undertaking any construction work and shall be responsible for the accuracy of the finished work.

3.02 EXAMINATION

- A. General: Dimensions shown on existing work and dimensions required for work that is to connect with work not in place shall be verified by the Design Builder by actual measurement of the existing work. Discrepancies between the Contract Drawings and Specifications and the existing conditions shall be referred to the Authority Representative before work affected thereby has been performed.
1. The Design Builder shall compare drawings and verify the dimensions before laying out the work and shall be responsible for errors which might have been avoided thereby.
 2. The dimensions and descriptions given on the Contract Drawings for adjacent work are based on the design drawings. It shall be the responsibility of the Design Builder to verify all as-built conditions and interface information by actual field measurements.
- B. Existing Conditions: See Section 01711, ACCEPTANCE OF CONDITIONS, Paragraph 1.04 B.
- C. Existing Utilities: See Section 01711, ACCEPTANCE OF CONDITIONS, Paragraph 1.04 C.
- D. Acceptance of Conditions: Examine substrates, areas, and conditions, with contract personnel present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 4. Examine new and existing facilities for suitable conditions where products and systems are to be installed.
 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.03 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and the Authority Representative that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate and obtain approval from authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify the Authority Representative and utility representative not less than five business days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without written permission from the utility and the Authority.

- C. Field Measurements: Take field measurements as required to fit the work properly. Recheck measurements before installing each product. Where portions of the work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the work.
1. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings
 2. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to the Authority Representative. Include a detailed description of the problem encountered, together with recommendations for changing the Contract Documents. Submit requests on WMATA Form 13.2A, "Request for Interpretation."

3.04 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on the Drawings. If discrepancies are discovered, notify Authority Representative promptly.
- B. General: Engage qualified Certified Survey Technician(s) to lay out the Work using accepted surveying practices.
1. Establish benchmarks and control points to set lines and levels at each stage of construction and elsewhere as needed to locate each element of the Project.
 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 3. Inform installers of lines and levels to which they must comply.
 4. Check the location, level and plumb, of every major element as the Work progresses.
 5. Notify the Authority Representative when deviations from required lines and levels exceed allowable tolerances.
 6. Close site surveys with an error of closure equal to or less than the standard established or referenced herein.
- C. The tolerances generally applicable in setting survey stakes or marks shall be as set forth below. Such tolerances shall not supersede stricter tolerances required by the Contract Drawings or Specifications, and shall not otherwise relieve the Design Builder of responsibility for measurements in compliance therewith. The tolerances listed below are **not** to be used for setting or re-establishing primary and secondary control markers and/or final alignment monumentation.
- D. Tolerances: Tolerances in setting survey stakes or markers shall not exceed the following:

Horizontal survey stakes or markers:	Distance	Tangent
Horizontal marks on hubs on centerline and offset centerlines.	1:35,000	0.02 ft.
Intermediate stakes or hubs on centerlines and offset centerlines.	1:35,000	0.02 ft.
Rough excavation and embankment for roads and other work not otherwise provided.	1:10,000	0.50 ft.
Trimming of excavation and embankment unless otherwise provided.	1:10,000	0.50 ft.
Structures - Building construction.	1:35,000	0.02 ft.
Trimming or preparation of earth sub-grade for trackbeds, roadways, and concrete pipes.	1:20,000	0.04 ft.
Trackbed and roadway sub-base and base, steel pipe and other work not otherwise provided for.	1:20,000	0.04 ft.
Track invert and roadway surfacing, steel reinforcement, concrete pipe and other formed concrete.	1:35,000	0.02 ft.

Vertical grade stakes or markers:	Elevation (Plus/Minus)
Rough excavation and embankment for roads and other work not otherwise provided.	0.20 ft.
Trimming of excavation and embankment unless otherwise provided.	0.20 ft.
Structures - Building construction.	0.01 ft.
Trimming or preparation of earth sub-grade for trackbeds, roadways, concrete pipe and other concrete structures.	0.05 ft.
Trackbed and roadway sub-base and base, steel pipe and other work not otherwise provided for.	0.05 ft.
Track invert and roadway surfacing, steel reinforcement, concrete pipe and other formed concrete.	0.02 ft. (Track invert only - 0.00 ft. high/ 0.04 ft. low)
Equipment Installation.	As required by manufacturer.

- E. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.

- F. Building Lines and Levels: Locate and lay out control lines and grades for structures, building foundations, column grids, and floor grades, including those required for mechanical and electrical work. Transfer survey reference line markings and elevations for use with control lines and grades. Level foundations and piers from two or more locations.
- G. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available to the Authority Representative upon request.

3.05 FIELD ENGINEERING

- A. Identification: WMATA shall provide and identify existing benchmarks and control points to be used for the duration of the contract.
- B. Reference Points: Locate existing and verify by field traverse permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent primary benchmarks, deep benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval by the Authority Representative. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to the Authority Representative before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain permanent secondary control points on Project site, referenced to data established by survey control points. Comply with WMATA Standard Drawing for Survey Monuments, drawing numbers ST-C-3 and ST-C-19 for type and size of monument marker.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. When the Specifications requires Bid Schedule items of work to be measured by surveying methods, the Design Builder shall perform the surveys. Perform all such surveys, including control surveys run for establishing the measurement reference lines. The Design Builder shall perform all survey data reduction and calculations and supply the reduced survey data in an understandable and readable format at the Authority's request or when required to do so in accordance with the contract.

3.06 INSTALLATION

- A. General: Locate the work and components of the work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level unless otherwise specified.

- B. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect.
- C. The Design Builder's surveys are a part of the work and may be checked by the Authority or representatives of the Authority at any time. The Design Builder shall be responsible for any lines, grades, or measurements which do not comply with specified or proper tolerances, or which are otherwise defective, and for any resultant defects in the work. The Design Builder shall be required to conduct re-surveys or check surveys to correct errors indicated by review of the work.

3.07 SURVEY PERSONNEL

- A. The Design Builder shall ensure that all personnel are minimally qualified to perform the work.
- B. The Design Builder shall provide a full time Survey Manager for the duration of the contract to plan execute and verify all survey work.
- C. The Authority may choose to withhold payment for all construction work if the Design Builder fails to provide qualified survey personnel.
- D. All personnel performing and/or assisting in survey activities, including construction layout, shall be Certified Survey Technicians (CST) by and through the National Society of Professional Surveyors (NSPS) - American Congress on Surveying and Mapping (ACSM).
 - 1. Each member of the Design Builder's survey staff shall be certified in one, or more, of the Certified Survey Technician levels when assigned to a WMATA project. There are four (4) levels of certification in the CST program. Certification is by experience and examination. Refer to **Figure 3.7-1** for the levels of the CST Program.
 - 2. The Authority will accept registration as a Land Surveyor or Property Line Surveyor, in Virginia, Maryland or the District of Columbia in lieu of CST certification.
 - 3. Survey consultants hired by the Design Builder to provide survey services are bound by the same CST requirements contained in the contract.
 - 4. Surveyors working under the direction of a Licensed Surveyor or Property Line Surveyor are not exempt from the CST requirement.
 - 5. Use of craft personnel as substitute for temporary survey staff is not acceptable unless they are a Certified Survey Technician.
 - 6. With concurrence by the Authority Representative and WMATA Quality Assurance Manager, a Design Builder's surveyor without CST certification may temporarily work on a WMATA contract prior to taking the CST exam, if the surveyor:
 - a. Fulfills the minimum education and or experience requirements for the position held as described in the CST Program Book.
 - b. Submits a copy of the CST application to the Authority Representative along with other documentation of education and or work experience.
 - c. Is scheduled to take the next available CST exam.
 - d. Requests in writing, a temporary waiver of the CST requirement pending the outcome of the results of the CST exam with the understanding that failure to pass the CST exam will result in said surveyor's removal from the WMATA contract.

3.08 SURVEY EQUIPMENT AND CALIBRATION REQUIREMENTS

- A. Survey Equipment - All electronic distance measuring instruments (or total station theodolites) shall be checked by the Design Builder against a National Geodetic Survey (NGS) range of known distances at least once every six (6) months.
1. All distance measurements shall be computed using the procedures in NOS NGS-10 "Use of Calibration Base Lines". The actual measurements shall be recorded, atmospheric corrections applied, and then adjusted by least squares to compute a constant, as well as, a relative correction factor (scale correction).
 2. National Geodetic Survey has established specific calibration baselines for the purpose of comparing survey equipment to known monumentation to verify the instruments vertical angles, horizontal angles and difference in elevation for compliance with the manufacturer's specifications. Verification of angle measurement and difference in elevation will only be done by the Design Builder if all other methods of verification acceptable to the Authority have been exhausted.
 3. The Design Builder shall bring each electronic distance meter (EDM) or total station theodolite to the Corbin, VA Geo-magnetic observatory (phone 703-373-7605) or similar NGS facility and compare their instrument(s) to known NGS values whenever there is any question as to the correct operation, accuracy and functionality of the Design Builder's survey equipment. Minimally, this will be done every six (6) months or after a damaged instrument has been repaired and before it is put back in service. The Design Builder shall supply the Authority Representative with all appropriate documentation from this exercise.
 4. All total station distance measuring devices and prisms shall be serviced every six months and checked frequently over lines of known distances. Generally, this exercise will be conducted in the spring and fall.
 5. Results of this calibration exercise shall be forwarded to the Authority. Correction factor's shall be posted in the Design Builder's office computing area and applied as required to maintain the desired accuracy.
 6. Adjustment and certification documents from a supplier or manufacture are not allowed as a substitution for the distance calibration exercise at a NGS or similar facility.
 7. Records of instrument calibration and adjustment shall be maintained as a part of the Design Builder's quality control program.
 8. Use of the NGS baseline for checking distances is not intended to take the place of normal maintenance, cleaning and adjustment of the Design Builder's instruments.
 9. Every six months or whenever the difference between direct and reverse readings of the theodolite depart from 180 degrees by more than 30 seconds, the instrument shall be adjusted for collimation error. Readjustment of the cross hairs and level bubble shall be done whenever their mis-adjustments affect the instrument reading by the amount of the least count.
 10. Instruments found to be in disrepair or out of adjustment shall be removed and repaired or replaced.
 11. All steel tapes shall be compared with the Design Builder's EDM at least every six months. The Design Builder shall number all tapes and measuring chains, record comparisons, compute correction factors and forward to the Authority upon request or whenever equipment is changed. In addition, tape correction information shall be posted in the Design Builder's office computing area and applied as required to maintain the desired accuracy.
 12. The Design Builder shall provide and maintain the ability in-house to check and adjust all tribrachs for eccentricity. Adjustment checks shall be made weekly or as necessary. A record of adjustments to all tribrachs shall be kept current and made available to the Authority monthly or upon request. Each tribrach shall be numbered and tagged with the date of the last adjustment.

3.09 SURVEY STANDARDS

A. The Design Builder shall maintain accuracy standards for all control surveys performed under the terms of this Contract in accordance with the following table:

B.

Primary horizontal control surveys	First order
Primary vertical control surveys	Second order, Class I
Secondary horizontal control surveys	Second order, Class I
Secondary vertical control	Second order, Class II

1. Primary control is defined as the original control provided to the Design Builder at the start of the Contract. Secondary control is defined as the control established and used by the Design Builder during construction. All secondary control traverse stations shall be set with permanent markers.
2. Control surveys and computations including surveys of main control lines to determine alignment of major structure components shall be performed in accordance with Second Order Class I requirements.
3. Unless specified, the Design Builder will not be required to perform First-Order survey work unless they destroy primary control points included in the contract documents or set by WMATA after contract NTP. GPS will not be used by the Design Builder to reestablish destroyed primary control unless approved by the Authority Representative.
4. The Design Builder should expect all primary or secondary horizontal control traverses they perform to meet a 1:50,000 distance accuracy closure. All vertical control traverses shall have a closure accuracy that does not fall below that specified for Second Order, Class II surveys.
5. Survey procedures and accuracy are a function of the types of survey that is being performed. The Design Builder is responsible for ensuring the use of proper procedures to maintain accuracy requirements contained in the contract.
6. The Design Builder shall use the closed traverse method in setting controls by starting at and ending at known or previously established traverse stations and benchmarks.
7. All distances over 100 feet shall be measured by the use of electronic distance measuring instrument (EDMI). Critical distances under 100 feet shall be checked with a distance meter.

C. Horizontal Traverse

1. Conventional traverse work shall be performed in accordance with the requirements defined in the **Standards and Specifications for Geodetic Control Networks, Federal Geodetic Control Committee (FGCC), September 1984** or latest version.
2. All survey field data shall be provided to the Authority upon request in a Star*Net digital input file format.
 - a. All reduced horizontal traverse measurements shall be provided in a set reduction report in an ASCII text file format which clearly lists the following data:
 - 1) Individual observations in an orderly format along with the mean angle from each direct and reverse observation.
 - 2) Horizontal angle mean, vertical angle mean and slope distance mean for each set of observations.



- 3) Standard deviation of the observations, and maximum, minimum, range and collimation error for each set of observations. Refer to **Figure 3.9-1** for a sample set reduction report.
3. Accuracy requirements:
 - a. First Order control surveys:
 - 1) Horizontal and vertical angle circle reading observation accuracy (standard deviation) of .5 seconds (DIN 18723) and read to 0.1 of a second.
 - 2) Occupied station centering (eccentricity) accuracy of 1 mm.
 - 3) Electronic distances measuring accuracy (standard deviation) of 1 mm +/- 1 ppm and read to 0.001 feet.
 - b. Second Order control surveys:
 - 1) Horizontal and vertical angle circle reading observation accuracy (standard deviation) of 1.0 seconds (DIN 18723) and read to 1.0 second or less if possible.
 - 2) Occupied station centering (eccentricity) accuracy of 1 mm.
 - 3) Electronic distances measuring accuracy (standard deviation) of 2 mm +/- 2 ppm and read to 0.001 feet.
 4. All horizontal traverse adjustments shall be performed using a minimally constrained Least Squares adjustment method which will produce the following output:
 - a. Summary of unadjusted input observations
 - b. Statistical summary
 - c. Chi Square test
 - d. Adjusted observations and residuals
 - e. Residual summary
 - f. Adjusted bearings and horizontal distances (grid and ground)
 - g. Horizontal unadjusted traverse closures
 - h. Adjusted coordinates
 - i. Convergence angles and grid factors at stations
 - j. Standard deviations, error propagation and error ellipses
 5. All horizontal traverse adjustment results shall be provided to the Authority upon request.
- D. Vertical Traverse
1. Differential leveling shall be performed in accordance with the requirements for Second-Order, Class I geodetic leveling surveys as defined in the Standards and Specifications for Geodetic Control Networks, Federal Geodetic Control Committee (FGCC), September 1984 or latest version and NOAA Manual NOS NGS 3 Geodetic Leveling, National Geodetic Survey (NGS), August 1981 or latest version.
 - a. The survey contractor shall provide documentation of staff calibration which includes certificates for expansion coefficient and length calibration.
 2. All reduced vertical traverse data shall be provided to the Authority upon request in a Star*Lev digital input file format.

- a. All vertical traverse data shall be provided as a data reduction report in an ASCII text file format which clearly lists the following data:
 - 1) Individual observations with the point identifier,
 - 2) Distance from instrument to staff (rod) for each observation,
 - 3) Backsight staff (rod) reading and foresight staff (rod) reading,
 - 4) Number of measurements taken and standard deviation per staff (rod) reading.
 - 5) Cumulative station differences.
3. Accuracy Requirements:
 - a. Differential leveling observation accuracy (standard deviation) of .4 mm and read to 0.0001 feet.
4. The Design Builder may use electronic digital levels and bar coded leveling staffs. The use of leveling staffs with ground plate (turning turtle) is required.
5. The Design Builder shall use calibrated invar staffs (level rods) for all control work including final vertical monumentation installation.
6. The Design Builder shall use semi-precise level rods or equal equipment for level work.
7. All vertical traverse adjustments shall be performed using a minimally constrained Least Squares adjustment method after a vertical traverse meets the minimum closure requirements referenced herein.
8. All vertical traverse adjustment results shall be provided to the Authority upon request.

3.10 SURVEYS AND PROCEDURES

A. Control Surveys

1. Verify Project primary control monumentation and provide adjustment computations to the Authority Representative.
2. Replace primary control monuments that have been destroyed or damaged and provide adjustment computations to the Authority Representative.
 - a. Provide Monument Record Sheets to the Authority Representative.
3. Establish secondary control monumentation along the Authority's construction project and provide adjustment computations to the Authority Representative.
 - a. Horizontal and vertical control discs shall be installed in accordance with the details and requirements shown on Standard Drawings ST-C-3 and ST-C-19.
 - b. Horizontal and vertical control discs set on direct fixation trackways shall be recessed to protect them from disturbance.
 - c. Provide Monument Record Sheets to the Authority Representative.

B. Structural As-builts

1. General Requirements: Structural as-builts are required to check for out-of-tolerance construction which may impact other structures or compromise train clearances along the trackway.

- a. All methods, equipment and procedures used by the Design Builder to perform structural checks shall be approved by the Authority Representative prior to commencement of the work.
 - b. This survey data must be analyzed by the Design Builder and the Authority for compliance with construction and rail tolerances.
 - c. This survey data must be analyzed by the Design Builder and the Authority to determine what remedial action, if any, may be required to address out-of-tolerance construction and the impact of structural mis-alignment on the final placement of other structures and rail.
 - 1) If the survey data reveals out-of-tolerance construction which will impact the placement of other structures along the trackway, the Design Builder shall take appropriate remedial action to comply with the plans and specifications.
 - a) If minimally out-of-tolerance, perform horizontal and vertical alignment revisions to minimize the impact of the misalignment on the future placement of adjoining structures and rail along the trackway.
 - b) If significantly out-of-tolerance and an acceptable alignment revision cannot be used to compensate for out-of-tolerance construction, then demolish and remove the structure and re-install.
 - 2) All alignment revisions and remedial actions shall be approved by the Authority Representative prior to commencement of the work.
2. Verify existing primary horizontal and vertical controls and re-establish, if destroyed or disturbed, and provide adjustment computations to the Authority Representative.
- a. Provide Monument Record Sheets to the Authority Representative.
3. Establish a secondary horizontal and vertical control system on the Authority's structures and reference to the approved project primary horizontal and vertical control system. The secondary control system established on or within trackway structures shall be used for detailed cross sections, Hi-Lo surveys and placement of final trackway monumentation. The secondary control system shall be adequately referenced so it can be readily recovered.
- a. Horizontal and vertical control discs shall be installed in accordance with the details and requirements shown on Standard Drawings ST-C-3 and ST-C-19.
 - b. Horizontal and vertical control discs set on direct fixation trackways shall be recessed to protect them from disturbance.
 - c. Provide Monument Record Sheets to the Authority Representative
4. Verify structural concrete pours for compliance with plans and specifications and provide the final results to the Authority Representative when requested.
5. Routinely verify the horizontal and vertical alignments of the trackbeds, tunnels, shafts, aerial structures and other adjoining or adjacent structures during construction and provide the results to the Authority Representative when requested.
- C. Post Construction Alignment As-built Surveys

1. General Requirements: Post construction alignment as-built surveys are required to check trackway structures for compliance with plans and specifications and to check for out-of-tolerance construction which may impact train clearance tolerances. All methods, equipment and procedures used by the Design Builder to perform post construction alignment as-built surveys shall be approved by the Authority Representative prior to commencement of the work.
 - a. This survey data must be analyzed by the Design Builder and the Authority for compliance with construction and rail tolerances.
 - b. This survey data must be analyzed by the Design Builder and the Authority to determine what remedial action, if any, may be required to address out-of-tolerance construction and the impact of structural mis-alignment on the final placement of the rail.
 - 1) If the survey data reveals out-of-tolerance construction which will impact the placement of other structures along the trackway, the Design Builder shall take appropriate remedial action to comply with the plans and specifications.
 - a) If minimally out-of-tolerance, perform horizontal and vertical alignment revisions to minimize the impact of the misalignment on the future placement of adjoining structures and rail along the trackway.
 - b) If significantly out-of-tolerance and an acceptable alignment revision cannot be used to compensate for out-of-tolerance construction, then demolish and remove the structure and re-install.
 - 2) All alignment revisions and remedial actions shall be approved by the Authority Representative prior to commencement of the work.
2. Verify existing primary horizontal and vertical controls and re-establish, if destroyed or disturbed, and provide adjustment computations to the Authority Representative for approval.
 - a. Provide Monument Record Sheets to the Authority Representative.
3. Establish a secondary horizontal and vertical control system on the Authority's structures and reference to the approved project primary horizontal and vertical control system. The secondary control system established on or within trackway structures shall be used for detailed as-built cross sections, hi-lo surveys and placement of final trackway monumentation. The secondary control system shall be adequately referenced so it can be readily recovered.
 - a. Horizontal and vertical control discs shall be installed in accordance with the details and requirements shown on Standard Drawings ST-C-3 and ST-C-19.
 - b. Horizontal and vertical control discs set on direct fixation trackways shall be recessed to protect them from disturbance.
 - c. Provide Monument Record Sheets to the Authority Representative.
4. As-built of the edge of the platform to address potential out-of-tolerance construction and the impact of structural mis-alignment on the final placement of the tracks.



- a. Horizontal measurements must be taken from the established C/L of track to the existing edge of the platform and compared to plan dimensions as well as the existing rail if installed.
 - b. Vertical measurements must be taken to the top of the edge of the platform and compared to the plan dimension above the top of rail as well as the existing top of rail if installed.
 - c. Sections must be taken on 10 ft. centers through the platform area.
 - 1) Stationing and horizontal offset accuracies must be to 0.01 ft.
 - 2) Vertical accuracy must be to 0.01 ft.
 - d. Provide a platform as-built report to the Authority Representative.
 - 1) This report must compare the horizontal and vertical location of the existing top of the edge of the platform to the plan location from the C/L of Track and the Top of Low Rail as well as the existing rail if installed.
 - a) This data must be analyzed by the Design Builder and the Authority for compliance with construction, rail and train clearance tolerances.
 - b) This data must be analyzed by the Design Builder and the Authority to determine what remedial action, if any, may be required to address out-of-tolerance construction and the impact of structural mis-alignment on the final placement of the tracks.
5. Detailed cross sections of the Authority's structures along the trackbed shall be taken to check for structural misalignment and compliance with plans and specifications.
- a. The methods, equipment and procedures used shall produce detailed cross sections within ½ inch accuracy.
 - 1) Stationing accuracies must be to 0.04 ft.
 - 2) horizontal offset accuracies must be to 0.02 ft.
 - 3) Vertical accuracy must be to 0.02 ft.
 - b. Detailed cross sections of the structures shall be taken at, but shall not be limited to, the following locations.
 - 1) At 50-foot maximum intervals on tangent sections and 25-foot maximum intervals on curved sections.
 - 2) At the following locations on curves with spirals: tangent to spiral (TS), spiral to curve (SC), curve to spiral (CS), spiral to tangent (ST), circular to circular (PCC), spiral to spiral (SCS);
 - 3) At the following locations on curves without spirals: tangent to circular (PC), circular to circular (PCC), and curve to tangent (PT);
 - 4) At vertical curve points: point of vertical curvature (PVC) and point of vertical tangent (PVT).
 - 5) At points of intersection of turnout (PITO).
 - 6) At any changes, breaks, or areas of transitions of the structures adjacent to the trackway.
 - 7) At all construction joints and section midpoints.
 - 8) At drainage slot horizontal transitions.
 - 9) Stake equation stations to ensure proper stationing in the field and take sections 1 ft. down station and 1 ft. upstation from the equation station.

- 10) Additional detailed sections shall be required to determine the magnitude and exact limits of out-of-tolerance construction.
 - c. If automated methods are used to obtain the sections, then conventional field verification of the sections shall be performed on maximum 200 ft. centers and compared to the automated sections and provided to the Authority Representative.
6. Provide a report to the Authority Representative comparing the as-built location of the structure to the plan location as well as the theoretical dynamic outline of the train along the tunnels, retained areas and aerial structures.
 - a. These cross sections must show computed clearances between the as-built location of the structure as well as the theoretical dynamic outline of the train.
 - b. This data must be analyzed by the Design Builder and the Authority for compliance with construction and train clearance tolerances.
 - c. This data must be analyzed by the Design Builder and the Authority to determine what remedial action, if any, may be required to address out-of-tolerance construction and the impact of structural mis-alignment on the final placement of the tracks.
7. The Design Builder shall install and reference all permanent, secondary and final monumentation required for construction, trackwork and other systemwide facilities.
 - a. Provide Monument Record Sheets to the Authority Representative.
8. The Design Builder shall coordinate the post construction alignment as-built survey work with the Authority Representative.

3.11 FIGURES AND REPORT FORMATS

Figure 3.7-1



Levels of the Certified Survey Technician Program

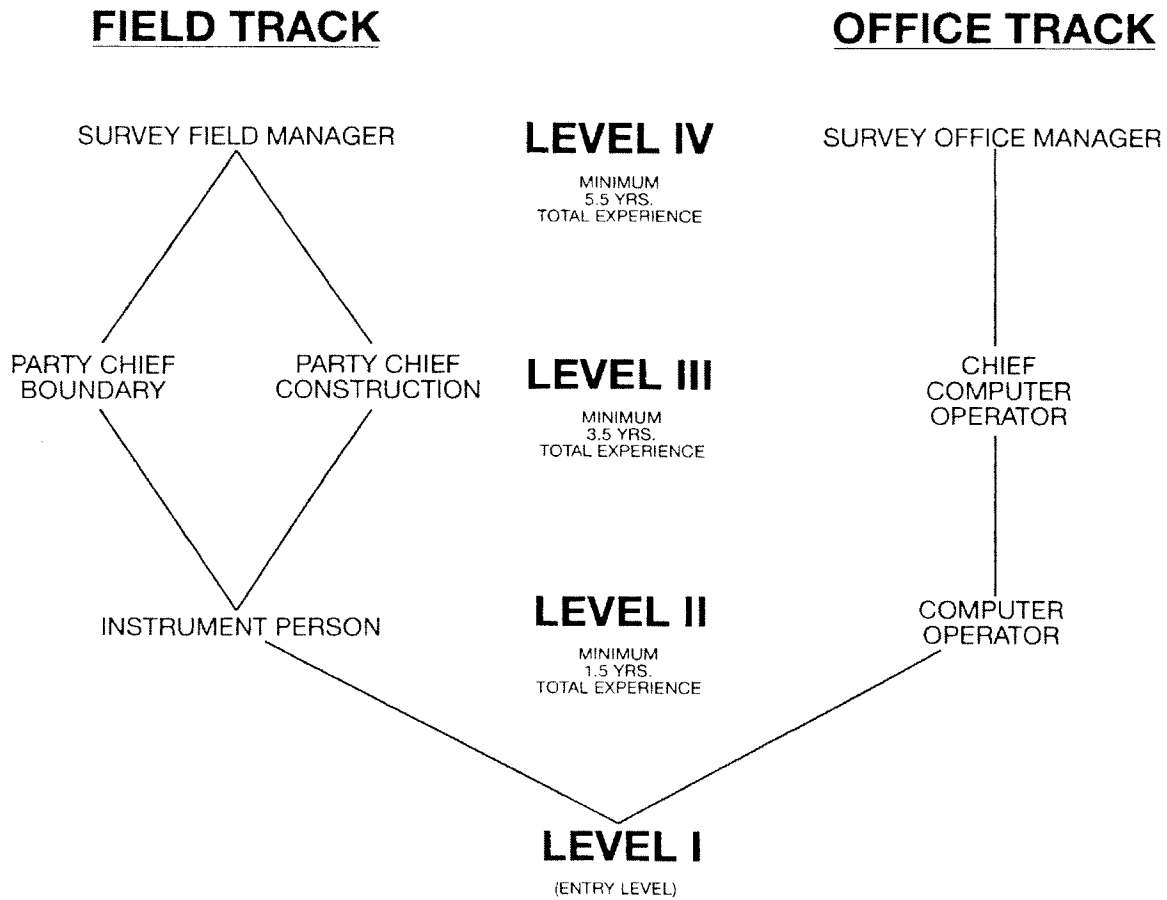


Figure 3.9-1

TRAVERSE SET REDUCTION

PR:METRO2.PRJ DT:05/01/01 ID:METRO CENTER NM:TRAVERSE

Occupied Station: Pt. No. 101, A-101 METRO B/D
 BackSight: Pt. No. 100, A-100 METRO B/D
 ForeSight: Pt. No. 102, A-102 METRO B/D

HORIZONTAL ANGLE REDUCTION

Set Rejection Criterion: Deviation from Mean > 3"

Set No.	Face	BackSight	ForeSight	Horiz. Angle	Mean Dev.
1	1	0-00-00.0	191-05-13.0		
	2	180-00-01.0	11-05-12.4		
	Mean	0-00-00.50	191-05-12.70	191-05-12.20	0-00-01.03
2	1	359-59-59.6	191-05-14.0		
	2	180-00-01.0	11-05-12.1		
	Mean	0-00-00.30	191-05-13.05	191-05-12.75	0-00-00.48
3	1	359-59-59.5	191-05-13.0		
	2	179-59-59.8	11-05-12.2		
	Mean	359-59-59.65	191-05-12.60	191-05-12.95	0-00-00.27
4	1	359-59-57.2	191-05-13.1		
	2	179-59-59.7	11-05-13.8		
	Mean	359-59-58.45	191-05-13.45	191-05-15.00	0-00-01.78

Mean Horiz. Angle: 191-05-13.23
 Std. Deviation (obs): 0-00-01.23
 Std. Deviation (mean): 0-00-00.61
 Maximum: 191-05-15.00
 Minimum: 191-05-12.20
 Range: 0-00-02.80
 Collimation Error: 0-00-02.5

BACKSIGHT ZENITH/SLOPE DISTANCE REDUCTION

Zenith Rejection Criterion: Deviation from Mean > 5"
 Slope Distance Rejection Criterion: Deviation from Mean > 0.01'

Set No.	Face	Zenith	Mean Dev.	Slope Distance	Mean Dev.
5	1	90-27-40.6		215.316	
	2	269-32-20.3		215.316	
	Mean	90-27-40.15	0-00-00.08	215.316	0.00
6	1	90-27-41.7		215.316	
	2	269-32-20.5		215.316	
	Mean	90-27-40.60	0-00-00.53	215.316	0.00
7	1	90-27-40.4		215.316	
	2	269-32-21.5		215.316	
	Mean	90-27-39.45	0-00-00.61	215.316	0.00

Mean Zenith Angle: 90-27-40.07 Mean Slope Distance : 215.316
Std. Deviation (obs): 0-00-00.57 Std. Deviation (obs): 0.000
Std. Deviation (mean): 0-00-00.33 Std. Deviation (mean): 0.000
Maximum: 90-27-40.60
Minimum: 90-27-39.45
Range: 0-00-01.15
Collimation Error: 0-00-02.2

FORESIGHT ZENITH/SLOPE DISTANCE REDUCTION

Zenith Rejection Criterion: Deviation from Mean > 5"
Slope Distance Rejection Criterion: Deviation from Mean > 0.01'

Set No.	Face	Zenith	Mean Dev.	Slope Distance	Mean Dev.
5	1	89-29-50.9		275.692	
	2	270-30-10.5		275.691	
	Mean	89-29-50.20	0-00-01.01	275.692	0.00
6	1	89-29-52.1		275.692	
	2	270-30-09.3		275.691	
	Mean	89-29-51.40	0-00-00.18	275.692	0.00
7	1	89-29-52.6		275.692	
	2	270-30-08.5		275.691	
	Mean	89-29-52.05	0-00-00.83	275.692	0.00

Mean Zenith Angle: 89-29-51.22 Mean Slope Distance : 275.692
Std. Deviation (obs): 0-00-00.93 Std. Deviation (obs): 0.000
Std. Deviation (mean): 0-00-00.54 Std. Deviation (mean): 0.000
Maximum: 89-29-52.05
Minimum: 89-29-50.20
Range: 0-00-01.85
Collimation Error: 0-00-01.4

END OF SECTION

SECTION 01722

MOBILIZATION

PART 1 GENERAL

1.01 SUMMARY

This Section specifies the basic requirements for preparing to install, erect, or apply products.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions

Section 00800, Supplementary Conditions

Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements

Section 01330, General Requirements - Administrative Requirements: Design and Construction Submittal Procedures

Section 01711, General Requirements - Execution Requirements: Acceptance of Conditions

Section 01721, General Requirements - Execution Requirements: Layout of Work and Field Engineering

Section 01723, General Requirements - Execution Requirements: Protection of Adjacent Construction

1.03 ACCEPTANCE OF CONDITIONS

Examination is specified in Section 01711, EXAMINATION: ACCEPTANCE OF CONDITIONS

1.04 SURVEYING

A. Construction layout is specified in Section 01721, PREPARATION: LAYOUT OF WORK AND FIELD ENGINEERING.

B. Detection of Movement

1. In order to detect any movement of buildings or structures that may be affected by its work, the Design-Builder shall, prior to excavation, establish a system of vertical and horizontal control points on or about such buildings or structures, tied to bench marks and indices sufficiently remote so as not to be moved by its operations as specified in Section 01721, LAYOUT OF WORK AND FIELD ENGINEERING.

1.05 MOBILIZATION AND PREPARATORY WORK

A. Mobilization and preparatory work shall include mobilization of construction equipment, materials, supplies, appurtenances and the like, manned and ready for commencing and continuing the work as well as the subsequent demobilization and removal from the site of such equipment, appurtenances and the like upon completion of the work.

B. Mobilization and preparatory work shall also include assembly and delivery to the site of the plant, equipment, materials and supplies necessary for the prosecution of the work; the clearing of and preparation of the Design-Builder's work area; the complete assembly, in working order, of equipment necessary to perform the required work; personnel services and hire of plant on work preparatory to commencing actual work; plus other preparatory work required to permit

commencement of the actual work on construction items for which payment is provided under the terms of the Contract.

- C. The Design-Builder shall conduct its work in accordance with the safety requirements of Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS. In case of a conflict between the various jurisdictional and WMATA or Design-Builder's organizational safety requirements, the more stringent requirements shall apply.
- D. When separate payment for mobilization and preparatory work is provided in the Contract, such payment will be made progressively, up to 100 percent of the fixed lump sum Contract price for mobilization as shown on the UPS, as mobilization occurs. Payment will be made in the form of twelve equal monthly payments, with the first payment beginning 30 calendar days after the start of construction portion of work.

1.06 PREPARATION

A. Existing Utility Information

As applicable, furnish information to local utility and the Authority Representative that it is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, service, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction and affected utilities and secure any required permits and approvals.

B. Existing Utility Interruptions

Do not interrupt utilities serving facilities occupied by the Authority or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated in Section 01510, TEMPORARY UTILITIES:

1. Notify Authority Representative not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Authority Representative's and as applicable, the affected utility's written approval.

C. Field Measurements

Take field measurement as required to fit the Work properly. Check measurements before installing each product. Where portion of the Work are indicated to fit to other construction, verify dimension of other construction by field measurement before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the work.

D. Space Requirements

Verify space requirements and dimensions of items shown diagrammatically on Final Design Drawings.

E. Review of Final Design Drawings and Final Design Specifications and Field Conditions:.

1. Immediately on discovery of the need for clarification of the Final Design Drawings and Final Design Specifications, submit a request for information to the Authority Representative. Include a detailed description of the problem encountered, together with recommendations for interpretation of the Final Design Drawings and Final Design Specifications, or suggested changes to the documents if appropriate. Submit requests on WMATA Form 13.2A, Request for Interpretation which is available from the Authority Representative.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

THIS PAGE NOT USED

SECTION 01723

PROTECTION OF ADJACENT CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

This Section specifies the appropriate methods for protection of adjacent construction when performing installations and improvements in and around existing facilities.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions
Section 00800, Supplementary Conditions
Divisions 02 to 16, Technical and Standard Specifications Requirements

1.03 PROTECTION OF EXISTING SURFACES

A. Existing surfaces shall be carefully protected during placing of concrete and other operations under this Contract to avoid damaging existing surfaces.

1. Existing surfaces shall be protected by the Design-Builder in accordance with Section 00739, PROTECTION OF EXISTING VEGETATION, STRUCTURES, UTILITIES AND IMPROVEMENTS, from all possible damages including chipping, staining and corrosion during performance of the work. If the project includes work at a Metrorail Station, elevators, access routes, storage areas, service rooms and other objects and surfaces within and adjacent to the Metrorail Station subject to Design-Builder contact shall also be protected from any possible damages. Adjacent properties shall be protected from all damages, particularly structural issues and excavation failures.
2. If damage occurs, the Design-Builder shall repair or replace to match original undisturbed conditions as approved by the Authority Representative at no additional cost to the Authority as specified in Section 01731, CUTTING AND PATCHING.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

THIS PAGE NOT USED

SECTION 01731

CUTTING AND PATCHING

PART 1 GENERAL

1.01 SUMMARY

This Section specifies the appropriate methods for performing remedial work when installations occur in existing facilities or improvements including selective demolition, salvage of materials and equipment and pavement and other surfaces and improved areas restoration from damage caused by the Design-Builder's operations.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions
Section 00800, Supplementary Conditions
Divisions 02 through 16, Standard and Technical Specifications Requirements

1.03 SELECTIVE DEMOLITION

As applicable, the Design-Builder shall perform selective demolition in existing facility or improved area to accommodate required new work as shown.

1.04 EMBEDDED ITEMS

A. In a drilling or coring operation, if applicable, when reinforcing steel or other items embedded in the concrete are encountered, the operation shall be stopped and the Authority's Representative immediately notified. The Design-Builder shall also be immediately notified and determination made by the Design-Builder whether the embedded item may be cut through. If it is not permissible to cut through the embedded item, the holes shall be drilled in another location and the original holes patched to the Authority Representative's satisfaction.

1.05 SALVAGE OR MATERIALS AND EQUIPMENT

A. As applicable, the Design-Builder shall maintain adequate property control records for materials or equipment specified to be salvaged. The Design-Builder shall be responsible for the adequate storage and protection of salvaged materials and equipment and shall replace salvage materials and equipment which are broken or damaged during salvage operations as the result of negligence or while in the Builder's care.

B. Salvaged material not specified for reuse shall become the property of the Design-Builder and shall be removed from the site.

1.06 PAVEMENT AND IMPROVED AREAS RESTORATION

A. As applicable, the Design-Builder shall secure permits from the jurisdictional agency for all pavement restoration within the limits of said agency's jurisdiction. The Design-Builder shall submit working drawings of such pavement restoration prepared in accordance with the requirements of the Final Design Drawings and Final Design Specifications and the jurisdictional

agency to the Designer agency through the Authority Representative for approval by the agency.

- B. During construction operations on this Contract, certain areas currently grassed, landscaped or otherwise improved may be disturbed or damaged. The Design-Builder shall restore such areas disturbed or damaged by its operations to the condition prior to being damaged at no additional cost to the Authority and as approved by the Authority Representative and/or the jurisdictional agencies as applicable.
- C. Existing surfaces marred or damaged by operations under this Contract shall be repaired or replaced by the Design-Builder to the condition prior to being damaged and at no additional cost to the Authority and as approved by the Authority Representative and/or the jurisdictional agencies as applicable.
- D. The Design-Builder shall maintain precast concrete protective coverings, as applicable, to the completion of this Contract, at which time it shall remove and dispose of the precast concrete protective covering.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

SECTION 01732

APPLICATION, INSTALLATION AND ERECTION

PART 1 GENERAL

1.01 SUMMARY

This Section specifies the appropriate methods for applying, installing and erecting products and equipment that are new, salvaged for re-use and Authority-furnished as applicable.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions
Section 00800, Supplementary Conditions
Divisions 02 through 16, Standard and Technical Specifications Requirements

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. New and salvaged materials and equipment shall be as specified in Divisions 02 through 16 of the Final Design Specifications and as shown on the Final Design Drawings, the Design-Builder's approved Shop and Working Drawings, and the approved manufacturer's fabrication, assembly, erection and field drawings.
- B. If applicable, the item(s), quantity and when and where available for Authority-furnished property are listed in Section 00836, AUTHORITY-FURNISHED PROPERTY REQUIREMENTS.

PART 3 EXECUTION

3.01 APPLICATION, INSTALLATION AND ERECTION OF NEW, SALVAGED AND AUTHORITY-FURNISHED PRODUCTS AND EQUIPMENT

Materials and equipment shall be applied, installed or erected as specified in Divisions 02 through 16 of the Final Design Specifications; as shown on the Final Design Drawings, the Design-Builder's approved Shop and Working Drawings, and the approved manufacturer's fabrication, assembly, erection and field drawings; and in accordance with the jurisdictional agencies' codes and regulations, manufacturer's instructions, and ADAAG regulations. Design-Builder shall submit certification that all facilities were built in accordance with ADAAG regulations as specified in Section 01780, CLOSEOUT SUBMITTALS.

END OF SECTION



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SECTION 01740

CLEANING

PART 1 GENERAL

1.01 SUMMARY

This Section specifies the basic requirements for maintaining the site in a neat and safe condition during construction.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions

Section 00800, Supplementary Conditions

Section 01114, General Requirements - Summary of Work Requirements: Safety/Environmental Requirements

Divisions 02 through 16, Standard and Technical Specifications Requirements

1.03 CLEANING UP

- A. The Design-Builder shall at all times keep the construction area, including storage areas used by it, free from accumulations of waste material or rubbish and prior to completion of the work remove any rubbish from the premises and all tools, scaffolding, equipment and materials not the property of the Authority. The Design-Builder shall observe all safety requirements as specified in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS.
- B. Upon completion of each shift and of construction, the Design-Builder shall leave the work and premises in a clean, neat and workmanlike condition satisfactory to the Authority Representative.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

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SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes specifications for performing all operations necessary for and incidental to closing out a Contract and assisting in the Authority Representative's final inspection.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions
Section 00800, Supplementary Conditions
Division 01, General Requirements
Divisions 02 to 16, Technical and Standard Specifications Requirements

1.03 CLOSEOUT SCHEDULE AND PROCEDURE

A. Changes from Original Conditions:

1. Upon completion of the work and prior to final substantial completion, the Design-Builder shall examine each property to determine changes from the original conditions established by the preconstruction inspection as specified in Section 00716, PRECONSTRUCTION INSPECTION and Section 01711, ACCEPTANCE OF CONDITIONS and shall furnish a written description to the Authority Representative of any measures taken to correct damage that may have resulted from performance of this Contract, and shall obtain a written release from each owner accepting condition of the building or structure, corrections, or both, thereby relinquishing any claim against the Design-Builder. In the event any owner refuses to furnish a release of claims, the Contractor shall notify the Authority Representative in writing.
2. The Authority will not assume responsibility for alleged damages arising from the work performed under this portion of this Contract.

B. Requirements Preparatory to Final Inspection by the Authority:

1. Notify the Authority Representative to perform a preliminary final inspection for the purpose of determining the state of completion of the Contract work. Notify the Authority Representative at least 14 calendar days in advance of requested inspection. The Authority Representative will perform the inspection within three days of the requested date. From the information gathered from this inspection, the Authority Representative will prepare a "punch list" of work to be performed, corrected, or completed before the Contract work will be accepted. All work on the punch list shall be completed by the Design-Builder prior to final inspection.
2. Temporary facilities excepted as may be required for "punch list work" shall be removed from the site.
3. Clean the site and all applicable appurtenances and improvements as specified in Section 01740, CLEANING.
4. Properly mount operating instructions for equipment and post as specified or required.

C. Final Inspection by the Authority:

1. After all requirements preparatory to the final inspection have been completed as hereinbefore specified, notify the Authority Representative to perform the final inspection as specified in Section 00735, ACCEPTANCE AND INSPECTION OF WORK. Notice shall be given at least 14 calendar days in advance of the time the work will be available for final inspection. The Authority Representative will perform the inspection within three days of the requested date. If the work is accepted at the final inspection, the requested date will be the acceptance date.
2. Design-Builder or its principal superintendent, authorized to act in behalf of the Design-Builder, shall accompany the Authority Representative on the final inspection tour, as well as any principal subcontractors that the Authority Representative may request to be present.
3. If the work has been completed in accordance with the Contract or "Issued for Construction" Documents, and no further corrective measures are required, the Authority Representative will accept the work and will issue a Certificate of Completion as evidence of acceptance.
4. If the work has been substantially completed in accordance with the Contract or "Issued for Construction" Documents, and the work can be used for its intended purpose with only minor corrective measures required, the Authority Representative will conditionally accept the work and will issue a Certificate of Substantial Completion based upon the Design-Builder's assurance that corrective measures will be completed within the shortest practicable time period. A fixed schedule for such corrective measures shall be submitted to the Authority Representative for approval.
5. If the work has not been substantially completed in accordance with the Contract or "Issued for Construction" Documents, and several or many corrective measures are still required, the Authority Representative will not issue a Certificate of Substantial Completion. Instead, a new punch list will be prepared based on the information gathered from the final inspection, and the Design-Builder will be required to complete this work and then call for another final inspection, following the procedure outlined above.

1.04 MEASUREMENT AND PAYMENT

Separate measurement or payment will not be made for work required under this Section. All costs in connection with the work specified herein will be considered to be incidental to the work.

1.05 SUBMITTALS

- A. Submit maintenance manuals; Contract record drawings and As-built specifications; electronic media; as-built CPM schedule; spare parts list, delivery information and distribution of spare parts; certifications, affidavits and warranties and guarantees; releases; vouchers; records for design, inspection, testing or other quality elements; configuration management system; and training manual, lesson plans, student's training manual and electronic media of such, as applicable, as specified in Section 01780, CLOSEOUT SUBMITTALS.
- B. Upon final acceptance of the work by the Authority Representative, the Design-Builder shall submit a request for final payment. Final payment will be made in accordance with Section 00749, METHOD OF PAYMENT and Section 01290, PAYMENT PROCEDURES.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

SECTION 01780

CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SUMMARY

This Section specifies procedures for closeout submittals including operation and maintenance manuals; contract record drawings and contract record specifications; electronic media; as-built CPM schedule; spare parts list, delivery information and distribution of spare parts; configuration management system; training manual, lesson plans, and student's training manual and electronic media of such, as applicable; survey record log; correspondence file; releases; vouchers; records for design, inspection, testing or other quality elements; request for final payment; certifications, affidavits and warranties and guarantees; and correction of deficiencies submittals as applicable. Final payment will be made in accordance with Section 00749, METHOD OF PAYMENT and Section 01290, PAYMENT PROCEDURES.

1.02 RELATED DOCUMENTS

Division 00
Division 01, General Requirements
Divisions 02 to 16, Technical and Standard Specifications Requirements

1.03 OPERATION AND MAINTENANCE MANUALS

- A. The Design-Builder shall furnish manuals for equipment and systems as required by the Specifications.
- B. Data copy included from standard catalogs shall be edited to reflect only conditions pertinent to this Contract.
- C. Data copy shall be suitable for dry-copy reproduction on standard office copy machines.
- D. Manuals shall be prepared using the following materials:
 1. Binder:
 - a. One of following:
 - (1) Loose-leaf; three-ring with elliptical rings; stiff cover with covering resistant to oil, water and wear; reinforced hinges; label holder on spine; mechanical device to open, close and lock rings; and sheet lifters. Size for 8-1/2-inch by 11-inch paper, three-inch maximum capacity.
 - (2) Loose-leaf three-post binder conforming to FS UU-B-320, Type II, Class 2, with covering resistant to oil, water and wear; label holder on spine; size for 8-1/2 inch by 11-inch paper; capacity as required, four-inch maximum thickness.
 - b. When the assembled data exceeds the capacity of one binder, provide additional binders as necessary.
 2. Pages:

- a. Originals: White, 60-pound bond with plastic-reinforced binding edge.
- b. Catalog data: Offset-printed copy on white paper, with plastic-reinforced edge.
- c. Standard: 8-1/2 inches by 11 inches.
- d. Fold-out: 11 inches by 8-1/2 inches for binding portion of page plus 7-1/2 inches for each additional portion of folded page; title and page number visible without unfolding. Provide a filler at the binding edge of fold-out pages, equal in thickness to the folded portion.
- e. Holes punched for standard three-ring binder.
- f. Consecutively numbered.

E. Manuals shall include the following data:

1. Table of contents.
2. Design-Builder's name, address and telephone number, with similar data for its 24-hour service organization.
3. Manufacturer's name, address and telephone number, with similar data for its local representative, distributor and service agency.
4. Catalog, model and serial number of equipment installed. Include WMATA unit numbers where applicable.
5. Description of equipment.
6. Statement of warranty as specified.
7. Description of modification, servicing and repairs performed prior to start of warranty.
8. Dates warranty begins and expires.
9. Standard starting, stopping and operating procedures.
10. Emergency and special operating procedures.
11. Routine maintenance procedures.
12. Servicing and lubrication schedule.
13. Manufacturer's printed operating and maintenance instructions, manufacturer's parts list, illustrations and diagrams.
14. One copy of each wiring diagram.
15. List of spare parts, prices and recommended stock quantities for routine maintenance of the equipment for one year and list of spare parts that are considered critical and for which extended time frames for acquisition would create undesirable down-time for equipment.
16. List of special tools required to perform inspection, adjustment, maintenance and repair.

Special tools are those developed to perform a unique function related to the particular equipment and not available from commercial sources.

17. Copy of each approved shop drawing of equipment and system. Include drawings which show outline dimensions, weights and assembly data. Do not include drawings which show manufacturing details.

F. Submittals: Manuals shall be submitted as follows:

1. Six copies of sample formats and outlines of contents in draft form 120 calendar days prior to the time scheduled for operation inspection, testing, or acceptance of the equipment.
2. Six copies of complete manual in final form 45 calendar days prior to the time scheduled for operation inspection, testing, or acceptance of the equipment.
3. Six bound sets and electronic media of approved manual before the time scheduled for operation inspection, testing, or acceptance of the equipment.
 - a. For the separate set of electronic copy text, files shall be in current WordPerfect electronic file format version. Files shall be submitted on CD-ROM.
 - b. The Design-Builder shall prepare a separate set each of electronic illustrations, diagrams and drawings, as applicable, on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. The latest version of both the AutoCAD (.DWG) and .pdf file formats of the type and quality specified herein shall be the standard formats for all electronic Operation and Maintenance Manual illustrations, diagrams and drawings that are to be forwarded to the Authority for approval. All line work shall be shown in AutoCAD drawings on designated layers in accordance with CAD layering guidelines as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES of these General Requirements and in WMATA's CAD Manual Attachment to this Project Manual. Images shall be clear, sharp and readily legible. The Authority reserves the right to have any illustrations, diagrams and drawings resubmitted until the Authority Representative approves the legibility of the illustration, diagram or drawing contained in the file.
6. In addition to the other requirements of this Section, if manufacturer's hardcopy illustrations, diagrams and drawings are also used in the preparation of Operation and Maintenance manual illustrations, diagrams and drawings, they shall also be furnished in AutoCAD (.DWG) and .pdf file formats.
7. In addition to the retainage specified in Section 00749, METHOD OF PAYMENT of the General Conditions, \$100,000 will be withheld until all approved manuals have been delivered to the Authority Representative.
8. If operation and maintenance training is included in the Contract, the Design-Builder shall provide to each trainee, a copy of approved operation and maintenance manuals for this purpose as specified in Section 01820, DEMONSTRATION AND TRAINING.

1.04 CONTRACT RECORD DRAWINGS AND SPECIFICATIONS:

A. General:

1. Contract Record Drawings and Specifications provided at Contract closeout (Design-Builder Provided): The term Contract Record Drawings means the record set of all final Drawings incorporating as-built drawings prepared by or through the Design-Builder consisting of all the tangible, graphic manifestations of the technical descriptions of materials, equipment, construction systems, standards, and workmanship that were actually applied in construction of the Project including as applicable any revisions to the Design-Builder's approved Final Design Drawings Issued for Construction and to the Authority-provided Standard Drawings and Authority-Provided As-built Informational Detail and Layout Drawings and Record Drawings from previous Authority projects, and also to the Design-Builder provided Shop Drawings, Working Drawings, Manufacturers' Shop Drawings, Field Drawings, and Installation Details. The term Contract Record Specifications means the Design-Builder's approved Final Design Specifications Issued for Construction in CSI format that are annotated by or through the Design-Builder to show any revisions and additions that were actually applied in construction of the Project to materials, equipment, construction systems, standards, and workmanship.

2. In addition to the retainage specified in Section 00749, METHOD OF PAYMENT of the General Conditions, the amount specified will be withheld until all final approved As-Built Contract Record Drawings, As-Built Contract Specifications and As-Built Electronic Media Drawing Files are delivered to the Authority Representative.
 - a. Amount to be withheld: \$200,000.

B. As-built Contract Record Drawings:

1. The Design-Builder shall submit separate sets of electronic Contract Record Drawings on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. The latest version of both the AutoCAD (.DWG) and .pdf file formats of the type and quality specified herein shall be the standard formats for all Contract Record Drawings that are to be forwarded to the Authority for approval. All line work shall be shown in AutoCAD drawings on designated layers in accordance with CAD layering guidelines as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES of these General Requirements and in WMATA's CAD Manual Attachment to this Project Manual. Images shall be clear, sharp and readily legible. The Authority reserves the right to have drawing(s) resubmitted until the Authority Representative approves the legibility of the drawing contained in the file. Also, the Design-Builder shall, unless otherwise directed, submit one set of full-size and six sets of half-size black ink on white paper copies of all Contract Record Drawings to the Authority Representative for approval using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative.

2. One set of full-size black ink on white paper copies of all Contract Record Drawings will be returned to the Design-Builder. Each of the approved Contract Record Drawings will be identified as having received such approval by being so stamped and dated. Contract Record Drawings not approved will be stamped NOT APPROVED and will have required corrections shown. If disapproved, resubmittals shall be in the formats and quantities as specified in a. above. Additions and corrections resulting from Authority review comments shall be incorporated by the Design-Builder. On resubmittals the Design-Builder shall direct specific attention, in writing or on resubmitted Contract Record Drawings, to revisions other than the corrections requested by the Authority Representative on previous submittals.

3. By the date scheduled for receipt of final approved drawing deliverables in the Contract Schedule, the Design-Builder shall submit one separate set each of electronic Contract

Record Drawings reflecting all known changes on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. Also, the Design-Builder shall, unless otherwise directed, submit one set of full-size and six sets of half-size black ink on white paper copies and one set of full-size reproducible and one set of half-size reproducible of all Contract Record Drawings to the Authority Representative for approval using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative.

4. Completed Contract Record Drawings shall bear the signature of an officer of the Design-Builder organization, certifying compliance with as-built conditions, using a stamp as follows:

AS - BUILT

I CERTIFY THAT THIS DRAWING
ACCURATELY DEPICTS THE WORK
CONSTRUCTED AS OF

(DATE)

(AN OFFICER OF THE Design-Builder)

Design-Builder's Name

- C. Six bound sets and one set of unbound originals of As-Built Contract Specifications in CSI format with all revisions to Final Design Specifications annotated.

1.05 ELECTRONIC MEDIA FILES:

- A. Electronic Media Drawing and Specification Files: Following acceptance of the Contract Record Drawings, the Design-Builder shall prepare the Electronic Media Drawing Files as previously specified for all approved As-built Contract Drawings, including as applicable As-built Standard Drawings and As-built Informational Layout and Detail Drawings and Authority Record Drawings from previous projects; Shop, Working, and Manufacturers' Shop As-built Drawings; and As-built Field Installation Details as applicable, and submit six separate sets each of Drawings in both an AutoCAD (.DWG) file format and in a .pdf file format on CD-ROM electronic media of all approved Contract Record Drawings to the Authority Representative using standard submittal forms in accordance with detailed instructions furnished by the Authority Representative. For the six electronic copies of the As-built Specifications, text files shall be in current WordPerfect electronic file format version. Specifications files shall be submitted on CD-ROM.

1. All CD-ROM disks shall be labeled with file name, operating system, file format, contract number and drawing types (i.e. Contract Drawings, Shop Drawings, etc.) or Specifications.

1.06 AS-BUILT CPM SCHEDULE

- A. In addition to the retainage specified in Section 00749, METHOD OF PAYMENT of this Contract, \$50,000 will be withheld until one original and six (6) copies and one electronic copy of the



approved as-built computer printouts and arrow diagrams required by the scheduling requirements as specified in Section 01322, CONTRACT PROGRESS REPORTING are delivered to the Authority Representative.

1.07 SPARE PARTS

- A. This Contract includes the requirement for spare parts, either specifically identified in the price schedule or to be identified later during the term of the Contract. The Design-Builder shall assure that all spare parts required by this Contract are provided and delivered in accordance with the following paragraphs.
- B. The Design-Builder shall submit to the Authority the original and six paper copies plus one electronic copy of the list of required spare parts either specifically identified in the unit price schedule or later identified by the Authority in accordance with a separate provision of this Contract. The list provided by the Design-Builder shall include model numbers, part numbers, component name, manufacturer's name, price, quantities, available packaging, special storage and handling requirements, and anticipated annual usage. In addition, the spare parts listing will include the following additional information as appropriate:
 - 1. Group the list by system and subsystem for stocking identification. Include order and procurement information for subassemblies and components.
 - 2. Correlate the required quantities with the reliability requirements and lead time considering the following classifications:
 - a. Wear: Components which may be expected to require regular replacement under normal maintenance schedule and operations, such as mechanical parts subject to continuous operation within projected mean time between failure levels.
 - b. Consumables or expendables: Components which are consumed, used up, destroyed, or upon failure, are otherwise made unusable for their intended purpose and are economically unrecoverable except for inherent scrap value.
 - c. Recoverable or repairable: Components which, upon failure, are capable of being repaired or remanufactured to a serviceable, operational condition and maintained available for use within their initial intended purpose. Such items should be accounted for via appropriate asset records.
 - d. Long lead: Components which are not available at short notice from commercial distributors or within 48 hours from the manufacturer, such as specially made or selected components.
 - e. Cross referencing: Where replacement components are common to more than one system or subsystem, include a cross reference and indexing system in the replacement components list.
 - f. Non-unique parts: In all components lists, items which are not unique to the system and have been manufactured by others shall be identified by the manufacturer's name and part number, as well as by the proposer's component number, if any.
- C. Within 30 calendar days after the Design-Builder submits the required spare parts listing, the Authority will provide the Design-Builder with shipping instructions and with WMATA stock numbers for each item the Design-Builder is required to furnish. The Design-Builder agrees to ship

the required parts to the destination points specified by the Authority and to include the Contract number, manufacturer part number, quantity, unit price, and WMATA part number on the shipping document.

- D. The identification of the individual manufacturer's part numbers will be cross referenced to the assigned WMATA stock numbers by including a column with appropriate heading adjacent to the manufacturer's part numbers in any parts manual or listing provided in accordance with Paragraph B. above.
- E. Parts furnished in accordance with this provision shall not be used to satisfy replacement needs under any warranty provision of this Contract.
- F. Spare parts will be the same in all respects as their counterparts furnished as part of the assembled equipment to be delivered under the terms of this Contract.
- G. Unless otherwise specified in this Contract, the spare parts are to be delivered at the same time as the counterpart equipment delivery. The spare parts are to be properly packaged or crated so as to prevent damage during shipment and long term storage. The spare parts will be labeled in accordance with the instructions contained in Paragraph C. above.

1.08 CONFIGURATION MANAGEMENT SYSTEM

As applicable, the Design-Builder shall submit to WMATA the original and six (6) paper copies plus one electronic copy of a complete configuration management system fully documented with all required information including the version status of all system components and all documents and all approved submittals and certifications for part of the Project records as described in Section 01112, DESIGN REQUIREMENTS AND PROGRAM CRITERIA, Section 01113, SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.

1.09 TRAINING MANUAL, LESSON PLANS, AND STUDENT'S TRAINING MANUAL

- A. Original and bound sets and electronic media of approved Training Manual, Lesson Plans, and Student's Training Manual before the scheduled date of substantial completion prior to the time scheduled for operation inspection, testing, or acceptance of the equipment.
 - 1. Original and six bound sets of Instructor's Training Manual, Lesson Plans, and Student's Training Manual.
 - 2. For electronic copy of text, files shall be in current WordPerfect electronic file format version. Files shall be submitted on CD-ROM.
 - 3. The Design-Builder shall prepare a separate set each of electronic illustrations, diagrams and drawings, as applicable, on CD-ROM electronic media in both an AutoCAD (.DWG) file format and a .pdf file format, in print quality black and white, with all fonts embedded. The latest version of both the AutoCAD (.DWG) and .pdf file formats of the type and quality specified herein shall be the standard formats for all electronic Manual illustrations, diagrams and drawings. All line work shall be shown in AutoCAD drawings on designated layers in accordance with CAD layering guidelines as specified in Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES of these General Requirements and in WMATA's CAD Manual Attachment to this Project Manual. Images shall be clear, sharp and readily legible. The Authority reserves the right to have any illustrations, diagrams and drawings resubmitted until the Authority Representative approves the legibility of the

illustration, diagram or drawing contained in the file.

- B. In addition to the retainage specified in Section 00749, METHOD OF PAYMENT of the General Conditions, \$100,000 will be withheld until approved Training Manual, Lesson Plans, and Student's Training Manual and electronic media of such have been delivered to the Authority Representative.

1.10 SURVEY FIELD NOTES

- A. As applicable, submit original and six paper copies and electronic media of the following as more fully specified in Section 01721, LAYOUT OF WORK AND FIELD ENGINEERING:

1. Survey Record Log.

1.11 CORRESPONDENCE FILE

Submit complete correspondence file as more fully specified in Section 01310, PROJECT MANAGEMENT AND COORDINATION.

1.12 RELEASES & VOUCHERS

As applicable, submit original and six paper copies and electronic media of releases & vouchers.

1.13 RECORDS FOR DESIGN, INSPECTION, TESTING AND OTHER QUALITY ELEMENTS

Submit original and six paper copies and electronic media of records for design, inspection, testing or other quality elements as more fully specified in Section 01470, QUALITY SYSTEM.

1.14 REQUEST FOR FINAL PAYMENT

Submit original and six paper copies and electronic media of final payment request. Final payment will be made in accordance with Section 00749, METHOD OF PAYMENT and Section 01290, PAYMENT PROCEDURES.

1.15 CORRECTION OF DEFICIENCIES SUBMITTALS

As applicable, submit original and six paper copies and electronic media Schedule of Deficiency Corrections, Recommendation for Corrective Actions, together with supporting information, Data and Reports applicable to any correction, and a Technical and Cost Proposal to amend the Contract to permit acceptance of the affected materials, equipment, systems or subsystems as specified in Section 00763, CORRECTION OF DEFICIENCIES.

1.16 CERTIFICATIONS, AFFIDAVITS AND WARRANTIES AND GUARANTEES

Required Affidavits, Certificates, Written Descriptions and Releases and Warranties and Guarantees provided by the Design-Builder; i.e., Certificates of Acceptance and Compliance, Certification that all facilities were constructed in conformance with ADAAG regulations (Form attached at end of Section), of System Safety and Security, of Substantial Completion, of Final Performance and Completion, and of Final Settlement; Written Description of any measures taken to correct damage that may have resulted from performance of this Contract; Written Releases; Design-Builder's executed Affidavit of Payment of All Applicable Taxes and License Fees in connection with the Contract and Affidavit of Payment of Debts and Claims; Consent of Surety Company to Final Payment; Warranties and

Guarantees as specified in Section 00762, WARRANTY/GUARANTEE OF CONSTRUCTION and Section 00763, CORRECTION OF DEFICIENCIES and various sections of the Specifications as applicable: Submit the original and six (6) copies plus one electronic copy.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION

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ATTACHMENT TO SECTION 01780

The Design-Builders's attention is directed to the fact that the project is subject to FTA **assessment** for ADAAG compliance. The Design-Builder shall complete and submit the following ADAAG Construction Certification with the Closeout Submittals to be provided to the Authority as specified in this Section 01780, CLOSEOUT SUBMITTALS and in accordance with Section 01470, QUALITY SYSTEM:

CERTIFICATE OF CONSTRUCTION COMPLIANCE WITH ADAAG REGULATIONS

The Design-Builder hereby certifies that it's Construction complies with all applicable Regulations of ADAAG.

CONTRACT NO.: _____

DATE: _____

BUILDER'S NAME: _____

DESIGN-BUILDER NAME: _____

CONSTRUCTION MANAGER'S SIGNATURE: _____

OFFICER'S SIGNATURE: _____

TITLE: _____

END OF SECTION



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SECTION 01810

COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

This Section specifies procedures and processes required for commissioning facilities and facility systems and the integration and commissioning of various components of the Project into the operating WMATA system.

1.02 RELATED DOCUMENTS

All Contract Documents.

1.03 GENERAL

Work on a contract will generally fall into one of three contract periods as described below. The focus of this specification is the third period, system start-up and testing.

- A. Civil Construction: Site preparation, followed by construction of roadworks, structures and facilities as applicable.
- B. Systems Installation: Installation of power, mechanical equipment, automatic train control, traction power, trackwork, fire and intrusion alarm and communications as applicable.
- C. Individual elements and complete systems are tested as appropriate as specified in Section 01113, SYSTEMS INTEGRATION, Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS, Section 01470, QUALITY SYSTEM and SECTION 01820, DEMONSTRATION AND TRAINING.

1.04 SUBMITTALS

Submit the following for approval in accordance with the Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and with the additional requirements as specified for each in this Contract:

- A. Test Schedules as specified in Section 01113 SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.
- B. Test Plans as specified in Section 01113 SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.
- C. Test Procedures as specified in Section 01113 SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.
- D. Test Data Sheets as specified in Section 01113 SYSTEMS INTEGRATION and Section 01470, QUALITY SYSTEM.
- E. System Safety Test Plan (per FTA requirements as applicable): The Safety and Security Certification Program Plan Attachment to the Project Manual as specified in Section 00381 and

the System Safety Program Plan Attachment to the Project Manual as specified in Section 00391, and as further specified in the Safety Rules and Procedures Manual, Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS, Section 01113, SYSTEMS INTEGRATION.

F. Personal Protection/Safety Procedures as specified in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS.

G. ORD Checklist as applicable.

H. Authority Support Requirements.

1.05 QUALITY ASSURANCE

All work in support of the commissioning shall comply with the Design-Builder quality assurance plans required by the Contract in Section 01470, QUALITY SYSTEM.

PART 2 PRODUCTS [Not Applicable]

PART 3 PROCEDURES

3.01 SAFETY AND SECURITY

Safety and security is the top priority during the construction of the Project. The Design-Builder's safety and security program as specified in Section 01114, SAFETY/ENVIRONMENTAL REQUIREMENTS shall contain specific provisions related to hazards of working in and around the operating rail system as applicable, and will include specific provisions for the mitigation of these hazards.

3.02 OPERATION READINESS DATE

A. In preparation for ORD, as applicable, the Design-Builder shall prepare a comprehensive ORD Checklist listing all items necessary for completion and testing prior to achievement of the ORD. The purpose of the checklist is to prevent the missing of any critical items that might unexpectedly prevent achievement of the ORD. The Checklist shall be submitted to the Authority Representative for review and approval. It shall include, as applicable, but not be limited to all relevant elements of the following:

1. Structures and facilities
2. Communications
3. All MEP Systems and Fire Alarm Systems
4. Trackwork, Traction Power, and ATC
5. Mechanical Equipment
6. Electrical Equipment

B. The Design-Builder shall provide a safety and security certification to the Authority Representative. The Design-Builder's Safety and Security Certification is a written certification stating, as applicable, that the segment of the Line is ready for passenger operations or the constructed or renovated system or facility is ready for operation and that it complies with all Contract safety and security requirements as specified in Section 01114, SAFETY/ENVIRONMENTAL

REQUIREMENTS, in the Safety and Security Certification Program Plan and the System Safety Program Plan Attachments to the Project Manual and in the Safety Rules and Procedures Manual . The certificate shall be signed by an officer of the Design-Build firm. The safety and security certifications shall confirm that all testing, including dynamic and systems level train control testing as applicable, as specified in Section 01113, SYSTEMS INTEGRATION, Section 01470, QUALITY SYSTEM and Section 01820, DEMONSTRATION AND TRAINING, and in the Safety and Security Certification Program Plan and the System Safety Program Plan Attachments to the Project Manual, and in the Safety Rules and Procedures Manual, is complete, documented, and approved and that certificates for operation of escalators and elevators, and certificates of occupancy, as applicable, have been obtained from the local jurisdiction, and that training of Authority personnel as applicable as specified in Section 01820, DEMONSTRATION AND TRAINING is complete.

- C. The Operations Readiness Date (ORD), as applicable, is achieved when all of the work is:
1. essentially complete.
 2. fully tested as applicable.
 3. The Design-Builder's safety and security certification has been received.
 4. The structure or system, as applicable, is verified safe for and secure by WMATA's Department of System Safety and Risk Protection (SARP), Office of Operations Liaison (OLIA), Office of Systems Maintenance (SMNT), Office of Chief Engineer (CENG), Office of Plant Maintenance (PLNT), and Metro Transit Police Department (MTPD), in accordance with the Safety and Security Certification Program Plan and the System Safety Program Plan Attachments to the Project Manual, and the Safety Rules and Procedures Manual.
- D. Once a facility, as applicable, has achieved Operations Readiness, the control of the segment shall be transferred to WMATA's Department of Operations (OPER).

END OF SECTION



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SECTION 01820

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

This Section specifies the general requirements for Operation and Maintenance Training for facility systems and a Project Performance Demonstration.

1.02 RELATED DOCUMENTS

Section 00700, General Conditions
Section 00800, Supplementary Conditions
Division 01, General Requirements
Section 11001, Equipment General Requirements
Division 15, Technical Requirements - Mechanical
Division 16, Technical Requirements - Electrical and Systems

1.03 OPERATION AND MAINTENANCE TRAINING

A. General:

1. The Design-Builder shall develop and conduct a program to train WMATA selected Authority personnel in the operation and maintenance of each equipment and systems furnished.
2. The Design-Builder shall furnish instructors, instructional materials and audio-visual aids and equipment.
3. The Authority will furnish physical facilities and equipment.

B. Qualification of instructors:

1. Instructors shall have full, precise and detailed knowledge of the design and functional characteristics of all aspects of the equipment and systems furnished with particular emphasis on operational and maintenance considerations and requirements.
2. Instructors shall present the instructional program in an effective manner.
3. Instructors will be subject to approval by the Authority.

C. Program content: As a minimum, instruction will include material covered in the operation and maintenance manual as well as the following:

1. Theory of operation.
2. Practical aspects of operation.
3. Description of system, equipment and components.

4. Functional characteristics of system, equipment and components.
 5. Emergency operating procedures.
 6. Location, removal and reinstallation of components.
 7. Maintenance procedures.
 8. Servicing intervals and schedules.
 9. Diagnosis and problem solving (troubleshooting).
 10. Repair.
 11. Overhaul.
- D. The Design-Builder shall provide WMATA with training in the operation of specific interfaces as a part of the system training program as specified in Section 01113, SYSTEMS INTEGRATION.
- E. Class Duration shall be a nominal 7-½ hour shift, with advantageous combinations of theoretical/classroom and hands-on practice, utilizing operational equipment and test equipment as applicable; and, for On-the-Job Training (OJT) at work locations as applicable, shall include participating in installation activities.
- F. Operating and maintenance training shall be completed prior to the time scheduled for operation inspection, testing, or acceptance of the equipment. In addition to the retainage specified in Section 00749, METHOD OF PAYMENT of the General Conditions, payment may be withheld until training is completed and accepted.
1. Amount to be withheld: \$100,000.
- G. The Design-Builder shall furnish for training, a minimum of (4) O&M Manuals as described in Section 01780, CLOSEOUT SUBMITTALS for each piece of equipment & System, unless otherwise specified.

1.04 PERFORMANCE DEMONSTRATION

The System Performance Demonstration that shall simulate all operations and shall exercise all systems and system elements is specified in Section 01113, SYSTEMS INTEGRATION.

1.05 SUBMITTALS

- A. The Design-Builder shall submit in accordance with Section 01330, DESIGN AND CONSTRUCTION SUBMITTAL PROCEDURES and Section 01780, CLOSEOUT SUBMITTALS as applicable the following at the times stated:
1. Training Preliminary submittal: Six sets not later than 60 calendar days after commencement of construction work.
 - a. Instructional outline: A complete, accurate and detailed listing of topics to be addressed in the instructional program using the specified content list.

- b. Specimens of instructional material to be used.
 - c. Descriptions of audio-visual material and equipment to be used.
2. Training Intermediate submittal: Six sets not later than 60 calendar days after approval of preliminary submittal.
 - a. All material submitted for preliminary submittal incorporating or resolving comments.
 - b. Complete instructional plans including audio-visual aids and descriptions of instructional techniques and procedures.
 3. Training Final submittal: Six sets not later than 30 calendar days prior to scheduled date for operation inspection, testing, or acceptance of the equipment.
 - a. All material submitted for intermediate submittal incorporating or resolving comments.
 4. Training Contract closeout submittal: As specified in Section 01780, CLOSEOUT SUBMITTALS.
 5. System Performance Demonstration submittals: As specified in Section 01113, SYSTEMS INTEGRATION.

PART 2 PRODUCTS [Not Applicable]

PART 3 EXECUTION [Not Applicable]

END OF SECTION



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APPENDIX A
WMATA ADA ACCESSIBILITY CHECKLIST

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**APPENDIX A
WMATA ADA ACCESSIBILITY CHECKLIST**

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**APPENDIX A
WMATA ADA ACCESSIBILITY CHECKLIST**

PARKING AND DROP-OFF AREA							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		<p>Does the parking area have at least one accessible parking space, and at least the required number of accessible parking spaces based on the total number of parking spaces?</p> <p>No. of Accessible Spaces</p> <p>1 1 to 25</p> <p>2 26 to 50</p> <p>3 51 to 75</p> <p>4 76 to 100</p> <p>5 101 to 150</p> <p>6 151 to 200</p> <p>7 201 to 300</p> <p>8 301 to 400</p> <p>9 401 to 500</p> <p>2% of total 501 to 1001</p> <p>1001 & over 20 + 1 for each 100 over 1000</p>	3.1.3.2	4.1.2			

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APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

PARKING AND DROP-OFF AREA						
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMMENTS
			FTA	ADAAG	COMPLIANCE	
			YES	NO	N/A	
		Is at least one parking space and at least one space in 8 accessible parking spaces, an accessible parking space for a van? Is at least one space in 4 accessible parking spaces, an accessible parking space for a van, if the parking facility is located in Maryland?	3.1.3.2	4.2.1 (5)(b)		
		Are accessible parking spaces for cars and vans at least 96 inches wide?	3.1.3.2	4.6.3		
		Do accessible parking spaces for cars have an access aisle at least 60 inches wide adjacent to the parking space?	3.1.3.3	4.2.1 (5)(b)		
		Do accessible spaces for vans have an access aisle at least 96 inches wide adjacent to the parking space?	3.1.3.3	4.2.1 (5)(b)		
		Is a vertical clearance of 98 inches (8' - 2") provided at van accessible space and along a vehicle path to and from them?	3.1.3.3	4.6.5		
		Are all accessible parking spaces located in an accessible route to an accessible facility?	3.1.3.4	4.6.3		

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**APPENDIX A
WMATA ADA ACCESSIBILITY CHECKLIST**

PARKING AND DROP-OFF AREA							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Are the access aisles of accessible parking spaces part of the accessible route?	3.1.3.4	4.6.3			
		Are accessible parking spaces located in the lot closest to the accessible entrance of a facility?		4.6.2			
		Are accessibility symbols (pictogram) provided at each space or each pair of accessible spaces and are located so they cannot be obscured by a vehicle parked in the space?		4.6.4			
		Does pictogram have an additional "Van-Accessible" sign, mounted below?		4.6.4			
		Is the ground surface along accessible route, in accessible space and an accessible drop-off area, stable, firm and slip resistant?		4.5.1			
		Do passenger drop-off areas have an accessible aisle at least 60 inches wide and 20 feet long?	3.1.2.3	4.6.6			
		Do the passenger drop-off areas provide a minimum of 114 inches of vertical clearance?	3.1.2.3	4.6.5			
		Are all accessible passenger drop-off areas located on an accessible path?	3.1.2.1	4.6.6			
		Are accessible passenger loading zones identified by the International Symbol of Accessibility?		4.1.2 (7)(b)			

A-1.3

APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

		ACCESSIBLE ROUTES						
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	N/A	
		Is at least one accessible route provided from public transportation stops, accessible parking and accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance they serve?		4.3.2 (1)				
		Does the accessible route coincide with the route for the general public?		4.3.2 (1)				
		Where the accessible route diverges from the general public route, do signs indicate direction to accessible entrance and route?		10.3.1 (1)				
		Is the accessible route width at least 36 inches wide?		3.1.1.4	4.3.3			
		If an accessible route is less than 60 inches in width, does the route provide passing spaces at least 60 inches by 60 inches at least every 200 feet?		3.1.1.4	4.3.4			
		Is the accessible route clear of obstacles that narrow s it to a width less than 32 inches?		3.1.1.4	4.4.1			
		Do all objects, wall-mounted between 27 and 80 inches from the floor, protrude no more than 4 inches into the accessible route?		4.2.2.2	4.4.1			
		Are all overhead objects above an accessible route at least 80 inches from the floor?		4.2.2.2	4.4.2			

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APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

ACCESSIBLE ROUTES							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		When the accessible route turns around an obstacle less than 48 inches wide, is the corridor at least 42 inches wide as it approaches the obstacle?	4.2.2.1	4.3.3			
		When the accessible route turns around an obstacle 48 inches wide or more, is the corridor at least 48 inches wide as it turns around the obstacle?	4.2.2.1	4.3.3			
		Is the cross slope of the accessible routes 1:50 or less?		4.3.7			
		Do all accessible routes have a stable, firm and slip-resistant surface?	3.1.1.4	4.5.1			
		Are all changes in surface level between 1/4 inch and 1/2 inch beveled to a slope no steeper than 1:2?	3.1.1.4	4.5.2			
		If changes in the surface level of an accessible route is greater than 1/2 inch, has a ramp been added so that the slope is no steeper than 1:12?	3.1.1.4	4.3.8 4.5.2			
		Are bumpy surfaces or abrupt changes in level avoided?	3.1.1.4	4.5.2			
		Are grates avoided on accessible routes?	3.1.1.4	4.5.1			

A-2.2

APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

ACCESSIBLE ROUTES						
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMMENTS
			FTA	ADAAG	COMPLIANCE YES NO N/A	
		On unavoidable grates, are all openings less than ½ inch wide perpendicular to the direction of traffic?	3.1.1.4	4.5.4		
		Where it is necessary to cross tracks to reach boarding platforms, is accessible route surface level and flush with the rail top at the outer edge and between the rails, except for a maximum 2-½ inch gap on the inner edge of each rail?		10.3.1 (13)		

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**APPENDIX A
WMATA ADA ACCESSIBILITY CHECKLIST**

CURB RAMPS							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Are curb ramps installed wherever an accessible path crosses a curb?	3.1.1.5	4.7.1			
		Do all curb ramps have detectable warning surfaces?	3.1.1.5	4.7.7			
		Do all detectable warning surfaces have raised truncated domes with a diameter of 0.9 to 1.4 inches, a height of 0.2 inch, and a center-to-center spacing of 1.6 to 2.4 inches?	3.1.1.5	4.29.2			
		Are all detectable warning surfaces and their surrounding surface in contrasting colors?	3.1.1.5	4.29.2			
		Are all detectable warning surfaces set back 6 to 8 inches from curb line and extending 24 inches in length over the entire width of the curb ramp, excluding flared sides?	3.1.1.5	4.29.2			
		Is a detectable warning surface 36 inches wide installed wherever pedestrian traffic enters vehicle traffic and there is no curb?	3.1.1.5	4.29.5			
		Are all curb ramps entirely included in the width of the crosswalks?	3.1.1.5	4.7.9			

A-3.1

APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG	YES	NO	N/A		
					When curb ramps are located where pedestrians must walk across the ramp or where the ramp is without handrails or guardrails; do the ramps have flared guides with 1:10 maximum slope.	3.1.1.5	4.7.5		
		Do all curb ramps in a position where a pedestrian must cross them have flared sides instead of returned sides?	3.1.1.5	4.7.10					
		Do all curb ramps have a minimum of 36 inches, not including the flared sides?	3.1.1.5	4.7.3					
		Do all curb ramps have a slope no steeper than 1:12?	3.1.1.5	4.7.2					
		Do all flared sides of curb ramps have a slope no steeper than 1:10 and 1:12 if the level landing at the top is less than 48 inches?	3.1.1.5	4.7.2					
		Do all diagonal curb ramps have at least 48 inches of clear space at the foot of the ramp that is in the crosswalk?	3.1.1.5	4.7.10					
		Is the transition of ramps to street or gutter flush and free of abrupt changes?		4.7.2					
		Are curb ramps located or protected to prevent obstruction by parked vehicles?		4.7.8					

A-3.2

**APPENDIX A
WMATA ADA ACCESSIBILITY CHECKLIST**

ENTRANCES							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Is there at least one accessible route from an accessible entrance to those areas necessary for use of the transportation system?		10.3.2 (1)			
		Where an entrance is not accessible, is signage provided indicating direction to the nearest accessible entrance?		10.3.1 (1)			

A-4.1

APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

		DOORS				
ITE M NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMMENTS
			FTA	ADAAG	COMPLIANCE YES NO N/A	
		Are all doors at least 32 inches wide, measured between all hardware with the door opened 90 degrees?	3.2.2.1	4.13.5		
		Are all doors at least 36 inches wide where doorway opening is recessed more than 24 inches in depth?	3.2.2.1	4.13.5		
		For doors with two leaves, does at least one leaf open at least 32 inches wide?	3.2.2.1	4.13.4		
		Does the threshold of the door rise no more than ½ inch (¾ inch for exterior sliding doors) and are all changes in level more than 1/4 inch at accessible doorways beveled or a ramp added?	3.2.2.2	4.13.8		
		Do all doors approached from the <u>front</u> on the <u>pull</u> side have a minimum of 60 inches of depth in front and a minimum of 18 inches of width on the latch side?	3.3.1	4.13.6		
		Do all doors approached from the <u>front</u> on the <u>push</u> side have a minimum of 48 inches of depth in front and a minimum of 12 inches of width if the door closes automatically?	3.3.1	4.13.6		
		Do all doors approached from the <u>latch side</u> on the <u>pull</u> side have a minimum of 48 inches of depth in front and a minimum of 24 inches of width on the latch side?	3.3.2.1	4.13.6		

A-5.1

APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

DOORS							
ITE M NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Do all doors approached from the latch side on the push side have a minimum of 42 inches of depth in front and a minimum of 24 inches of width on the latch side?	3.3.2.1	4.13.6			
		Do all doors approached from the hinge side on the pull side have a minimum of 54 inches of clear depth in front and a minimum of 42 inches of width on the latch side?	3.3.2.2	4.13.6			
		Do all doors approached from the hinge side on the push side have a minimum of 42 inches of depth in front and a total of 54 inches in width?	3.3.2.2	4.13.6			
		If two doors are in series, is the minimum distance between the doors equal to the width of the door swinging into the vestibule plus 48 inches?	3.3.3	4.13.7			
		If two doors are in series, does only one swing into the vestibule between them?	3.3.3	4.13.7			
		Can all door hardware, such as lever-type or U-shaped handles, be used by individuals with disabilities?	3.3.4	4.13.9			
		Is all door hardware mounted no higher than 48 inches from the floor?	3.3.4	4.13.9			
		Do all interior hinged doors open with a maximum force of 5 pounds?	3.3.5.1	4.13.11(2)(6)			
		Do all automatic doors require at least 3 seconds to reach the fully open position?	3.3.5.2	4.13.12			

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APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

DOORS						
ITE M NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMMENTS
			FTA	ADAAG	COMPLIANCE YES NO N/A	
		Do all automatic doors require a maximum of 15 pounds of force to stop?	3.3.5.2	4.13.12		
		Is the floor area in front of the doors level and clear?		4.13.6		
		Are door closures adjusted so that the door will take at least 3 seconds to move from an open position of 70 degrees to within 3 inches from the latch?		4.13.10		

A-5.3

APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

RAMPS							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Is every part of the accessible path equipped with a ramp when a slope is steeper than 1:20?	3.1.1.6	4.8.1			
		Does every ramp in new construction have a slope no steeper than 1:12?	3.1.1.6	4.8.2			
		If ramps change direction at a landing, is the landing size at least 60 inches by 60 inches?		4.8.4 (3)			
		Do all ramps rise no more than 30 inches?	3.1.1.6	4.8.2			
		Do all ramp segments have a minimum clear width of 36 inches between handrails?	3.1.1.6	4.8.3			
		Do all ramps have level landings at the top and bottom of each ramp and each ramp run?	3.1.1.6	4.8.4			
		Do all landings have a width at least as wide as the ramp?	3.1.1.6	4.8.4 (1)			
		Do all landings have a length of at least 60 inches clear?	3.1.1.6	4.8.4 (2)			
		Do landings at doors meet the maneuvering space requirements for the type of door?	3.1.1.6	4.8.4			

A-6.1

APPENDIX A WMATA ADA ACCESSIBILITY CHECKLIST

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG	YES	NO	N/A		
					Are all ramps with a rise higher than 6 inches, or a horizontal run of more than 72 inches, equipped with handrails?	3.1.1.6	4.8.5		
		Are handrails provided on both sides of ramp? Are inside handrails continuous on switch back or dogleg ramp?	3.1.1.6	4.8.5 (1)					
		Do handrails extend at least 12 inches beyond top and bottom of the ramp segment and are they parallel with the ground?	3.1.1.6	4.8.5 (2)					
		Is the clear space between the handrail and the wall at least 1 to 1.5 inches?	3.1.1.6	4.8.5 (3)					
		Is top of handrail gripping surface mounted between 34 and 38 inches above ramp surface?	3.1.1.6	4.8.5 (5)					
		Are ends of handrails rounded or returned smoothly to floor, wall or post?	3.1.1.6	4.8.5 (6)					
		Is the cross-slope on all ramps no steeper than 1:50?	3.1.1.6	4.8.6					

A-6.2

WMATA ADA ACCESSIBILITY CHECKLIST

VERTICAL TRANSPORTATION SYSTEMS

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE			COMMENTS
			FTA	ADAAG	YES	NO	N/A	
		Are elevators located to minimize the travel distance compared to non-accessible routes?		10.3.1 (1)				
		Do elevators have glazing or transparent vision panels to allow unobstructed view both into and out of the car at all levels served?		10.3.1 (17)				
		Are all elevators equipped with an automatic self-leveling device?	4.2.4.1	4.10.2				
		Does the automatic self-leveling device level the car to no more than a 1/2 inch vertical distance?	4.2.4.1	4.10.2				
		Are elevator call buttons centered at 42 inches above the floor?	4.2.4.1	4.10.3				
		Do all elevator call buttons provide a visual and audible signal that the call is registered and answered?	4.2.4.1	4.10.3				
		Are all elevator call buttons at least 3/4 inch in the smaller dimension?	4.2.4.1	4.10.3				
		Is the elevator call button indicating the up direction above the button indicating the down direction?	4.2.4.1	4.10.3				
		Do objects in front of elevator call buttons protrude no more than 4 inches into the hallway?	4.2.4.1	4.10.3				
		Is a hall call button light provided at each elevator entrance?	4.2.4.1	4.10.4				
		Do all hall call button lights provide both a visual and an audible signal that the call is being answered?	4.2.4.1	4.10.4				

A-7.1

WMATA ADA ACCESSIBILITY CHECKLIST

VERTICAL TRANSPORTATION SYSTEMS

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		Does the audible signal distinguish between the up and down directions?	4.2.4.1	4.10.4 (4)					
		Are all hall call light lanterns mounted so that the centerline is 72 inches from the floor?	4.2.4.1	4.10.4 (2)					
		Are all hall call light lanterns at least 2½ inches in the smaller dimension?	4.2.4.1	4.10.4 (2)					
		Can all hall call light lanterns be easily seen from the vicinity of the call buttons?	4.2.4.1	4.10.4 (3)					
		Are Braille and raised-letter floor designations provided on both jambs of all elevator doors?	4.2.4.1	4.10.5					
		Is the centerline of the floor designation on elevator door jambs 60 inches above the floor?	4.2.4.1	4.10.5					
		Are floor designation letters 2 inches high?	4.2.4.1	4.10.5					
		Are the letters raised 1/32 inch?	4.2.4.1	4.30.4					
		For all elevators, is the time between notification and door closing at least 5 seconds?	4.2.4.1	4.10.7					
		For all elevators, is the time between notification and door closing at least the minimum time based on the distance between the call buttons and the elevator doors?	4.2.4.1	4.10.7					
		Is the minimum time for elevator doors to remain fully open in response to a car call 3 seconds?		4.10.8					
		Are all elevator doors equipped with a device that reopens them if they are obstructed?	4.2.4.1	4.10.6					

A-7.2

WMATA ADA ACCESSIBILITY CHECKLIST

VERTICAL TRANSPORTATION SYSTEMS							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Does the reopening device reopen the doors without making contact with objects that are between 5 inches and 29 inches from the floor?	4.2.4.1	4.10.6			
		Do all door reopening devices keep the doors open for at least 20 seconds?	4.2.4.1	4.10.6			
		Does clearance between car platform sill and edge of any hoistway landing 1-1/4 inches or less?		4.10.9			
		Do elevator doors open at least 36 inches wide?	4.2.4.1	4.10.9			
		Are all elevators at least 82 inches deep, measured from the door to the rear wall of the elevator?	0	0			
		Are all elevator car interior dimensions at least 84 wide?	0	0			

0 = Refer to WMATA's Design Criteria

A-7.3

WMATA ADA ACCESSIBILITY CHECKLIST

VERTICAL TRANSPORTATION SYSTEMS

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		Where existing shaft configuration or technical infeasibility prohibits compliance with minimum car dimensions, is the inside car area no smaller than 48 inches by 48 inches?		4.1.6 (3)(c)					
		Do all elevator floors have a slip-resistant surface?	4.2.4.1	4.5.2					
		Are all elevator floors free of sudden changes in level?	4.2.4.1	4.5.2					
		Are cab floor coverings firmly anchored?		4.10.10 4.5					
		Is the level of illumination at the car controls, platform and threshold at least 5 foot candles?		4.10.11					
		Are car control buttons at least 3/4 inch in the smaller dimension?	4.2.4.1	4.10.12 (1)					
		Are all control buttons designated by Braille and by raised 1/32 inch standard characters for letters, Arabic characters for numerals, 5/8 inch to 2 inches high, in upper case with designations immediately to the left of the button?	4.2.4.1	4.10.12 (2)					
		Is the main floor designated by a raised star?	4.2.4.1	4.10.12 (2)					
		If all floor buttons are designed to be approached in a wheelchair from the front, are the buttons placed no higher than 48 inches above the floor?	4.2.4.1	4.10.12 (3)					
		If all floor buttons are designed to be approached from the side in a wheelchair, are the buttons placed no higher than 54 inches above the floor?	4.2.4.1	4.10.12 (3)					

A-7.4

WMATA ADA ACCESSIBILITY CHECKLIST

VERTICAL TRANSPORTATION SYSTEMS							
ITE M NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Are emergency controls grouped at the bottom of the control panel?	4.2.4.1	4.10.12 (3)			
		Is the centerline of the emergency buttons at least 35 inches from the floor?	4.2.4.1	4.10.12 (3)			
		Are car control panels on the front wall if elevators have center-opening doors?	4.2.4.1	4.10.12 (4)			
		In elevators with doors opening near the corner, are car control panels on the front wall or side wall next to the door?	4.2.4.1	4.10.12 (4)			
		Do all elevators include a car position indicator over the door or over the control panel?	4.2.4.1	4.10.13			
		Are all floor numbers on the car position indicator at least ½ inch high?	4.2.4.1	4.10.13			
		Do all car position indicators include either an audible signal sounding at least 20 decibels, with a frequency no higher than 1500 Hz, or an automatic verbal announcement?	4.2.4.1	4.10.13			
		Are all operable parts of the emergency communication system less than 48 inches from the floor?	4.2.4.1	4.10.14			
		Is the emergency communication system identified by raised symbols and lettering adjacent to the device that meets character size and Braille requirements cited for car controls?	4.2.4.1	4.10.14			
		Can a person use the emergency equipment in the elevator without voice communication?	4.2.4.1	4.10.14			

A-7.5

WMATA ADA ACCESSIBILITY CHECKLIST

VERTICAL TRANSPORTATION SYSTEMS

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		Does the emergency communication system call a programmed number if the call is not answered by the Station Manager?	*	*					
		For redundancy in service, are each level of all transit facilities served by a minimum of two (2) elevators?	*	*					
		Is the pre-recorded voice announcement standard with all other elevator announcements throughout the transit system?	*	*					
		Does the elevator have an automatic dispatching feature, where the controller activates the car call button to the next level after a person has entered the car?	*	*					
		At a Light Rail or BRT station where a lift platform is required if a ramp is unfeasible due to a vertical distance or space constraints, is the lift located to minimize travel distance compared to non-accessible route?		10.3.1(1)					
		Do platform lifts facilitate unassisted entry, operation and exiting?		4.11.3					
		Do platform lifts have a minimum 30 inch by 48 inch clear floor space and at each landing?		4.2.4 4.27.2					
		Are platform lifts floor surfaces stable, firm and slip resistant?		4.5.1					
		Do platform lifts have sufficient space to access controls?		4.11.2 4.27.2					

*Refer to WMATA's Design Criteria

A-7.6

WMATA ADA ACCESSIBILITY CHECKLIST

VERTICAL TRANSPORTATION SYSTEMS

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE			COMMENTS
			FTA	ADAAG	YES	NO	N/A	
		Are platform lift controls mounted 15 to 48 inches for forward reach or 9 to 54 inches for side reach?		4.11.2 4.27.3				
		Are platform lift controls operable with one hand without tight grasping, pinching or twisting of the wrist?		4.11.2 4.27.4				
		Is a maximum 5lb force required to operate platform lift controls?		4.11.2 4.27.4				
		Does escalator have a minimum clear width of 32 inches?	*	10.3.1(16)				
		Are there at least two contiguous treads at the top and bottom of escalator run that are level beyond the comb plate before the risers begin to form?	*	10.3.1(16)				
		Do escalator treads have slip-resistant, grooved surfaces?	*	10.3.1(16)				
		Are escalator color strips placed parallel to and on the nose of each tread?	*	10.3.1(16)				
		Are escalator color strips 2 inches wide?	*	10.3.1(16)				
		Are escalator color strips of a clearly contrasting color?	*	10.3.1(16)				
		Are escalator color strips of a material that is at least as slip resistant as the rest of the tread?	*	10.3.1(16)				
		Are the edges of escalator treads apparent from both ascending and descending directions?	*	10.3.1(16)				

A-7.7

WMATA ADA ACCESSIBILITY CHECKLIST

AUTOMATED FARE VENDING AND GATES

ITEM NO.	REFERENCE	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		Is at least one fare vending device located at each accessible entrance?	4.1.1	10.3.1 (1)					
		Does each fare gate array have at least one accessible fare gate for entering and exiting?		10.3.1 (1)					
		Is fare vending equipment located adjacent to an accessible route?		10.3.1 (1)					
		Do all automated accessible gates provide a clear opening of at least 36 inches in width for passage of a wheelchair?	4.1.2	4.2.1 Figure 1					
		Does clear space in front of fare vending equipment allow a forward or parallel approach to the controls, money and card slots, by a person using a wheelchair?		4.27.2					
		Do all fare vending devices provide clear space in front of at least 30 x 48 inches?	4.1.2.1	4.2.4.1					
		Does the clear floor space in front of all fare vending devices overlap or adjoin an accessible route?	4.1.2.1	4.2.4.2					
		Where fare vending equipment is located in an alcove or otherwise confined on all or part of three sides, is additional maneuvering clearance provided of 6 inch width for forward approach or 12 inch additional length for side approach?		4.2.4.2					

A-8.1

WMATA ADA ACCESSIBILITY CHECKLIST

AUTOMATED FARE VENDING AND GATES

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE			COMMENTS
			FTA	ADAAG	YES	NO	N/A	
		If the clear floor space allows the wheelchair to face the fare vending device, are all controls, money and card slots, between 15 inches and 48 inches from the floor?	4.1.2.2	4.2.5				
		Is the maximum side reach over an obstruction less than 24 inches?	4.2.6(6)(c)	4.2.5				
		If a wheelchair space faces a device that has an obstacle in front of the controls, are the controls no higher than 44 inches from the floor?	4.1.2.2	4.2.5				
		If the clear floor space only allows a parallel approach to the fare vending equipment by a person in a wheelchair, is reach depth not more than 10 inches and are all controls, money and card slots between 9 inches and 59 inches from the floor?		4.2.6 4.34.3 (2)(a)				
		If a wheel chair space is parallel to a device that has an obstacle in front of the controls, is the obstacle no higher than 34 inches and no deeper than 24 inches?	4.1.2.2	4.2.6				
		Are all fare vending device controls operable with one hand?	4.1.2.3	4.27.4				

A-8.2

WMATA ADA ACCESSIBILITY CHECKLIST

AUTOMATED FARE VENDING AND GATES						
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMMENTS
			FTA	ADAAG	COMPLIANCE YES NO N/A	
		Are all controls operable without small hand movements, excessive grip strength, pinching or twisting of the wrist?	4.1.2.3	4.27.4		
		Can all controls be operated with no more than 5 pounds of force?	4.1.2.3	4.27.4		
		Are all instructions and all information for the fare vending devices made accessible to and independently usable by persons with vision impairment?		4.34.5		
		Does the accessible fare gate have a 32 inch clear opening?	*	4.13.5		

A-8.3

WMATA ADA ACCESSIBILITY CHECKLIST

THIS PAGE NOT USED

A-8.4

WMATA ADA ACCESSIBILITY CHECKLIST

PLATFORMS AND MEZZANINES

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		Is a minimum width of 36 inches provided between platform or mezzanine elements, such as parapets or pylons?		4.3.3					
		If clear width is less than 60 inches, are passing areas of 60 inches by 60 inches provided at intervals of no more than 200 feet apart?		4.3.4					
		Is the walking surface on platforms and mezzanines stable, firm and slip resistant?		4.5.1 A4.5.1					
		Do all platform edges have a detectable warning surface?	5.2.1	10.3.1					
		Does the detectible warning surface extend the full length of the platform and conform to the WMATA standard design with lighted granite strip backed by truncated dome tile?	0	0					

0 = Refer to WMATA's Design Criteria

A-9.1

WMATA ADA ACCESSIBILITY CHECKLIST

PLATFORMS AND MEZZANINES							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Is a list of stations, routes or destinations served by the station located on each platform and mezzanine and is at least one tactile sign provided complying with the accessibility guidelines for raised and Braille characters, mounting height and approach?		10.3.1 (6) 4.30.1 4.30.2 4.30.3 4.30.4 4.30.5 4.30.6			
		Are station identification signs placed at frequent intervals along the platform and clearly visible from within the train car on both sides when not obstructed by another train?		10.3.1 (5)			
		Where station identification signs are close to train car windows on the opposite side of the platform, is the top of the highest letter below the top of the car window and the bottom of the lowest letter above the horizontal mid-line of the car window?		10.3.1 (5)			
		Do the station identification signs comply with accessibility guidelines for character proportion, height, finish and contrast?		10.3.1 (5) 4.30.2 4.30.3 4.30.5			

A-9.2

WMATA ADA ACCESSIBILITY CHECKLIST

PLATFORMS AND MEZZANINES

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		Are illumination levels in the platform and mezzanine areas, where signage is located, uniform and minimize glare on signs?		10.3.1 (11)					
		Is the vertical gap distance, measured between the train car floor and the platform surface, within plus or minus 1 1/2 inches under all normal passenger load conditions?		10.3.2 (4)					

A-9.3

WMATA ADA ACCESSIBILITY CHECKLIST

COMMUNICATION SYSTEMS							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Do visual alarm indicators accompany the emergency warning system in areas of common use?	4.3.6	4.28.3			
		Do audible alarms produce a sound that is louder than the surrounding sound level by at least 15 dbA, for a duration of 60 seconds?	4.3.6	4.28.2			
		Is the emergency visual alarm a xenon strobe or equivalent lamp type?	4.3.6	4.28.3 (1)			
		Is the light a clear color or clear filtered white?	4.3.6	4.28.3 (2)			
		Is the pulse duration 0.2 second?	4.3.6	4.28.3 (3)			
		Is the light intensity at least 75 candela?	4.3.6	4.28.3 (4)			
		Is the flash rate a minimum of 1 Hz and a maximum of 3 Hz?	4.3.6	4.28.3 (5)			
		Is the alarm placed 80 inches above the floor or 6 inches below the ceiling, whichever is lower?	4.3.6	4.28.3 (6)			
		Are the alarms placed in rooms or passageways, so that any person is no more than 50 feet horizontally from a signal?	4.3.6	4.28.3 (8)			
		Where public address systems are provided, are there means to convey the same or equivalent information to persons with hearing loss or who are deaf?		10.3.1 (14)			

A-10.1

WMATA ADA ACCESSIBILITY CHECKLIST

TELEPHONES

ITE M NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		If public phones are provided, does each level have one text telephone?	4.3.3	4.1.3 (17) 10.3.1 (12)(a)					
		Where four or more public pay telephones serve an entrance and at least one is in an interior location, is at least one interior text telephone provided to serve that entrance?		10.3.1 (12)(b)					
		If two or more banks of public telephones are provided, is at least one telephone in each bank a text telephone?	4.3.3	4.1.3 (17)					
		Does the location of the operable parts of the text telephone comply with the requirements for reach ranges for people in wheelchairs?	4.3.3	4.2.4.1					
		Is a clear space of 30 x 48 inches available in front of the text telephones?	4.3.3.1	4.2.4.1					
		Does the clear space for a person in a wheelchair in front of the accessible telephone adjoin or overlap an accessible route?	4.3.3.1	4.2.4.2					
		Is the telephone directory located within the requirements for range reaches?	4.3.3.1	4.3.1.7					
		Are all accessible telephones and 25% of all other telephones equipped with volume controls?	4.3.3.1	4.31.5					

A-11.1

WMATA ADA ACCESSIBILITY CHECKLIST

TELEPHONES							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Do all accessible telephones have push-button controls?	4.3.3.1	4.31.6			
		Are all accessible telephones equipped with a cord at least 29 inches long?	4.3.3.1	4.31.8			

A-11.2

WMATA ADA ACCESSIBILITY CHECKLIST

SIGNAGE

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG	YES	NO	N/A		
		Are all letters on signs sized for the distance from which they should be viewed?	3.1.1.1	4.30.3					
		Do all signs have backgrounds that contrast well with letters and characters?	3.1.1.1	4.30.5					
		Do all signs have a non-glare finish?	3.1.1.1	4.30.5					
		Do all signs indicating accessibility include the International Symbol of Accessibility?	3.1.1.1	4.30.7					
		Do elevator hoistway numbers have raised letters and Braille?		4.10.5					
		Do elevator button sign designations have raised letters and Braille?		4.10.12					
		Does emergency communication signage on elevator control panels have raised letters and Braille?		4.10.14					
		Does the station entrance have a centrally located tactile entrance sign with raised letters and braille mounted at 60 inches from the ground to the centerline of station name?		10.3.1					
		Are tactile signs identifying permanent rooms or spaces mounted to the centerline of signs 60 inches from the floor or ground and located where approachable to within 3 inches?	3.1	4.30.6					

A-12.1

WMATA ADA ACCESSIBILITY CHECKLIST

SIGNAGE							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Does each accessible entrance have accessibility signs?	3.1.1.1	10.3.1			
		If an entrance is not accessible, are there signs directing to the nearest accessible entrance?		10.3.1			
		Do accessibility signs indicate the direction of the accessible path when it diverges from the general public's circulation path?	3.1.1.1	10.3.1			
		Are there station name signs, with raised letters and Braille, provided on each platform or boarding area?	*	10.3.1 (6)			
		Does fare vending machine equipment provide raised letters, Braille and audio instructions?	*	10.3.1 (7) 4.3.5			
		Does the "Van Accessible" signs, "Station Identification" signs and other identification signs meet character proportions, height contrast and finish requirements?		4.1.2 (5) 4.30.2 4.30.3 4.30.5			
		Does directional or informational signage about functional areas, meet character proportion, height contrast and finish requirements?		4.1.3 (16) 4.30.2 4.30.3 4.30.5			
		Does identification signage located, where accessible routes diverge from the route used by the general public, and meet character proportions, height, contrast and finish requirements?		10.3.1 (1) 4.30.2 4.30.3 4.30.5			

*Refer to WMATA's Design Criteria

A-12.2

WMATA ADA ACCESSIBILITY CHECKLIST

SIGNAGE

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		Does signage for station lists, routes or destinations located on platforms, boarding areas and mezzanines, meet character proportions, height and finish and contrast requirements?		10.3.1(6) 4.30.2 4.30.3 4.30.5					
		Does station entrance signage meet character proportions, height and finish and contrast requirements?		10.3.1 (4) 4.30.2 4.30.3 4.30.5					
		Are signs, designating permanent rooms/spaces, accompanied by an equivalent verbal description directly below the pictogram?		4.30.4					
		Do pictograms have border 6 inches in height?		4.30.4 4.1.2(7) 4.1.3(16)					
		Do the character colors of the signs designating permanent rooms/spaces, contrast with their backgrounds?		4.30.5					
		Are tactile signs designating permanent rooms/spaces, mounted 60 inches above the finish floor and located where a person can approach to within 3 inches and mounted on the latch side of the door where applicable?		4.30.6 4.1.2(7) 4.1.3(16)					
		Do pictograms providing direction to or information about functional spaces, have the proper character proportions?		4.30.2 4.1.2(7) 4.1.3(16)					

A-12.3

WMATA ADA ACCESSIBILITY CHECKLIST

SIGNAGE							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Are signs providing direction to or information about functional spaces have the proper character height?		4.30.3 4.1.2 (7) 4.1.3 (16)			
		Are accessible parking spaces identified by the International Symbol of Accessibility and located so that it is not obscured by a vehicle parked in the space?		4.1.2 (7)(2) 4.30.7 (1) 4.6.4			
		Are accessible passenger loading zones identified by the International Symbol of Accessibility?		4.1.2 (7)(6) 4.30.7 (1)			
		Are accessible entrances, when not all entrances are accessible, identified by the International Symbol of Accessibility?		4.1.2 (7)(6) 4.30.7 (1)			
		Are all public text telephones identified by the International Text Telephone (TTY) Symbol?		4.30.7 (3) 10.3.1 (12) 4.1.3 (17)			
		At all banks of telephones, which do not contain a text telephone, are directional signs provided, identified by the TTY symbol, indicating the location of the nearest text telephone?		4.30.7 (3) 10.3.1 (12) 4.1.3 (17)			
		If there are no banks of pay telephones, are directional signs identified by the TTY symbol provided at the entrance?		4.30.7 (3) 10.3.1 (12) 4.1.3 (17)			
		Does all accessible signage have the proper character proportions?		4.30.2 4.1			

A-12.4

WMATA ADA ACCESSIBILITY CHECKLIST

SIGNAGE

ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMPLIANCE			COMMENTS
			FTA	ADAAG		YES	NO	N/A	
		Does all accessible signage have the proper character height, sized according to the viewing distance from which they are to be read?		4.30.3 4.1 4.4.2					
		Are raised and braille characters and pictograms raised at least 1/32 of an inch, in uppercase, san serif or simple serif type, accompanied with Grade 2 Braille and between 5/8 inch and 2 inches in height?	3.1	4.30.124					
		Does all accessible signage have the proper character proportions ratio for width to height?		4.30.2 4.1					
		Does all accessible signage have the proper character height, sized according to distance?		4.30.3 4.1					
		Is the international symbol of Accessibility provided along the platform wall at 25 foot intervals?	*	*					
		Is there an elevator accessibility sign mounted to the right of the elevator?	*	*					
		Are PIDS installed on each side of the platform at a height of over 80 inches above the finished floor?	*	*					

* Refer to WMATA's Design Criteria

A-12.5

WMATA ADA ACCESSIBILITY CHECKLIST

AREAS OF RESCUE ASSISTANCE							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES		COMPLIANCE		COMMENTS
			FTA	ADAAG	YES	NO	
		Is there at least one rescue assistance area on each level of the building?	4.3.6.1	4.3.11.2			
		Do the enclosures of the rescue assistance areas meet the fire protection rating requirements?	4.3.6.1	4.3.11.2			
		Does each rescue assistance area have at least two 30 x 48 inch accessible areas?	4.3.6.1	4.3.11.2			
		Is there at least one 30 x 48 inch accessible area for every 200 persons of calculated occupancy?	4.3.6.1	4.3.11.2			
		Do the 30 x 48 inch areas allow the exits to be the full required width?	4.3.6.1	4.3.11.2			
		Do the stairways adjacent to rescue assistance areas have at least 48 inches clear width between the handrails?	4.3.6.1	4.3.11.3			
		Is there any means of two-way communication between each rescue assistance area and the main entry?	4.3.6.2	4.3.11.4			
		Does the two-way communication system use both visual and audible means?	4.3.6.2	4.3.11.4			
		Are the rescue assistance areas identified by illuminated signs with the International Symbol of Accessibility and the words "Area of Rescue Assistance"?	4.3.6.3	4.3.11.5			

A-13.1

WMATA ADA ACCESSIBILITY CHECKLIST

AREAS OF RESCUE ASSISTANCE							
ITEM NO.	REFERENCE DWG. NO.	DESCRIPTION	REFERENCES			COMMENTS	
			FTA	ADAAG	COMPLIANCE		
			YES	NO	N/A		
		Are there signs at inaccessible exits and elsewhere in the building indicating the location of rescue assistance areas?	4.3.6.3	4.3.11.5			
		Are there instructions for the use of the rescue assistance areas posted adjacent to the communication equipment?	4.3.6.3	4.3.11.5			

END OF SECTION



PROJECT MANUAL

BOOK 2

(DESIGN CRITERIA AND
DIVISIONS 2-11)

METRO MATTERS

SHOPS EXPANSION PROGRAM

GREENBELT YARD CONSOLIDATED HEAVY REPAIRS,

BRENTWOOD SHOP EXPANSION and

SHADY GROVE SHOP EXPANSION

**Contract FN5008
December 3, 2004**

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PROGRAM CRITERIA

ARCHITECTURAL

1.01 SUMMARY:

A. General:

1. The Design-Builder will provide architectural and engineering design services for Service and Inspection (S&I) Shops. The shop facilities shall be designed to support maintenance operations on revenue vehicles. The facilities will be designed to facilitate scheduled inspections, minor repairs, car cleaning, truck repair and replacement, and minor painting. The shop systems will provide for segregation of work functions into designated areas to minimize interference between functions and time lost in material or equipment handling evolutions. The shop may also include spaces and equipment for expansion of the Systems.
2. Design and layout of all rooms and functional spaces to conform to the reference standards, drawings, and criteria. Room locations as shown and room areas as listed are approximate. Coordinate actual room dimensions and locations by functional relationships, local code and ADA requirements, equipment requirements including vertical and horizontal clearance requirements, with user requirements and with maintenance requirements.
3. Provide doors and partitions with consideration to use and space utilization. Materials, room finishes and doors shall be provided as indicated. Provide doors and partitions in UL rating required by local code. Provide door numbering system in a door schedule to coordinate with the room numbering system.
4. Provide signage for each room at each door as shown on the signage drawings. Provide building identification sign (type 5) and additional signage as required, with location and lettering coordinated with the Authority Representative. Coordinate exterior signage, traffic control signs, and directional signage with track work, existing exterior signs, the Information Drawings and the Authority Representatives requirements.
5. To conform to area constraints at the site, the car maintenance shops must maintain both the clear interior and exterior building shell limits illustrated in the drawings for the placement and movement of equipment, vehicles and personnel. The interior clearances illustrate the limits of clear floor area devoid of exterior walls, partitions and structural elements and vertical clearance to bottom of roof structure or heights to match on the existing buildings.

B. Greenbelt:

1. The existing Greenbelt S & I Shop First Floor is comprised primarily of open shop rail car repair and inspection areas as well as various rail car component repair shops. The Second Level of the facility is a mezzanine comprised of administrative/employee spaces, Employee Lunch Room, Yard Control Room, Train Control Room, and Mechanical Room. This Mezzanine area is located in the northeast corner of the existing building.
2. The existing exterior construction is a double-wythe cavity wall construction of 4 inch face brick, air space, and rigid insulation with 8 inch concrete masonry unit backup. The top of the masonry wall is capped with a pre-cast concrete coping and parapet running continuously at the top of the wall. The roofing system is a ballasted built up membrane over rigid insulation board,

- over metal deck. The roof system is penetrated by skylights, smoke relief vents, and roof drains spaced throughout the roof area.
3. The existing structural system is wide-flanged steel beams and columns, and corrugated metal deck supported on steel bar-joists.
 4. The interior of the existing repair shop and inspection areas are comprised of concrete unit masonry construction and concrete floor slabs with epoxy paint finish. The interior partitioning of the existing office area is gypsum board on metal stud framing.
 5. The new work within the existing building includes but is not limited to track work, systems and equipment relocation.
 6. The existing Machine and Sheet Metal Shops, Gear Case Rebuild, Truck Shop and Wheel Shop will be relocated and expanded within the existing main facility.
 7. Areas to be relocated, (and possibly expanded in size), from the existing building to the new Annex include: Component Parts Storage, Motor Repair, Mechanical Component, Parts Office, Electrical Component, Pneudraulics Shop, and HVAC Shop. The existing Lube Oil Room shall be relocated to the exterior of the existing building and is identified in the new work as the Oil Storage Room.
 8. The new work is comprised of a new Annex building which will house functions including but not limited to: Wheel and Axle Shop, Gear Box Rebuild, Machine Shops, a Lathe Room, Motor Repair Shop, Mechanical Component Repair Shop, Pneudraulics, Component Parts Storage, Steam and Degreasing Room, Air Compressor Repair Shop, HVAC Unit Repair Shop, Component Paint Room, Office suite, Employee Locker and Toilet rooms, High Voltage Electronic Repair Shop, Electronic Repair Shop, Electrical Component Repair Shop, and Mechanical and Electrical rooms.
 9. The new Annex building envelope shall match the existing building in appearance.

C. Brentwood:

1. The existing Brentwood Major Repair Shop has a Main Ground Level comprised primarily of open shop repair areas with a secondary Administrative/employee welfare area. The administrative office area occupies two levels one on top of each other extending from the Ground Level to the Mezzanine Level. The basement level contains employee welfare functions which consists of Locker / Shower Rooms, Lunch Room, and additional office areas. The entire three floors in this area is completely fire protected and separated along the walls and roof with a 2-1/2 hour fire rated gypsum board construction and spray-on fire proofing at all exposed structural steel elements. The Design/Build contractor shall preserve the integrity of this fire separation when performing the new work in this area.
2. The existing Basement Level occupies approximately two-third the area beneath the Main Ground Level with a finish floor elevation of 14'-0" below the Main Ground Level. The partial Mezzanine Level has a finish floor elevation of 13'-4" above the Main Ground Level. The roof is composed of varying finish elevations with the highest elevation point at 31'-0" above the Main Ground Level.
3. The existing exterior shop envelope is a double-wythe wall construction, comprised of 4 inch face brick with 8 inch concrete masonry unit backup with an approximate 4'-2" insulated metal panel band running continuously at the top of the wall. The exterior envelope at the office area is the same with the inclusion of fire rated gypsum board furring on the interior finish.

- The Basement Level foundation walls are comprised of reinforced concrete construction.
4. The existing shop floor construction is comprised of reinforced concrete and epoxy paint finish.
 5. The existing structural system is comprised of wide-flanged steel beam, girders and posts.
 6. The existing interior partitioning of the repair shop areas are composed of 8 inch concrete masonry unit construction with epoxy paint finish. The interior partitioning of the office area is of gypsum board and metal stud construction.
 7. The existing roof construction has no parapet projection. The top of roof elevation varies around the facility. The roofing system is comprised of a rubber membrane roofing system on 1-1/2" rigid insulation on 1-1/2" corrugated metal deck, supported on steel bar-joist construction. . The roof system is penetrated by fire relief skylights and interior roof drains spaced throughout the roof area.
 8. The existing roof construction above the office area is comprised of a rubber membrane roofing system on 1-1/2" rigid insulation on composite 2-1/2" concrete on corrugated metal deck, supported on steel bar-joist construction.
 9. The proposed new shop work will extend three tracks identified on the drawings as 9A, 9B, 9C through the building interior. The new work shall consist of but not limited to; track work, systems and required structural improvements to accommodate new track work, mezzanine structural design to accommodate minimum train clearance, partial existing façade reconstruction and building addition, new vehicle lifts and lift pits, receiving area and new freight elevator, installation of a new wheel truing machine, reprogramming of administrative office and employee welfare areas, upgrade of existing passenger elevator, modification of egress requirements, relocation and reconnection of existing utilities, installation of new utilities to support the new shop equipment, functions and operations, continuous roof skylights and roofing.
 10. The demolition as a result of the new work shall result in but not limited to the following; partial demolition of ground level office space, slab, and associated systems, the partial demolition of the basement level employee welfare and associated systems, the demolition and infill of the existing ramp down receiving area and ramp, exterior façade alterations, wheel truing machine, freight elevator, and site parking.
 11. The existing interior equipment located within the shop expansion area, (generally between column lines D through H on the ground floor and throughout the basement), shall be relocated to the Greenbelt Shop and the remaining equipment and space shall be reconfigured to be coordinated with the three track extension through the building. The existing floor slab shall be saw-cut and trenched for installation of the new tracks. New foundations shall be required at the Basement level for track and lift supports. The roof shall be modified as required for installation of new skylights.
 12. The Mezzanine level structure shall be modified to increase the structural clearance required for the passenger trains to pass under, maintaining a minimum of 11'-2" clearance. This minimum clearance is a variance from WMATA's standard. New structural columns will be added as required and existing columns shall be demolished as required to accommodate the new track work. The office space and functions that are displaced due

to the track extension shall be relocated into the adjacent space vacated by the existing Electronics Lab. The Electronics Lab shall be relocated to the Greenbelt Shop. The Basement level space shall be reconfigured to coordinate with the new structural elements.

D. Shady Grove:

1. The existing Shady Grove S & I Shop has a Ground Floor comprised primarily of open shop repair and inspection areas with administrative/employee spaces. The office area is in the center of the building on both the Ground Floor and Mezzanine. On the Second Floor is the Yard Control Room including access to the roof. The Basement Floor is primarily storage, mechanical rooms, electrical rooms and hoist enclosure space. The Mezzanine at the Ground Floor also has spaces for administrative, employee support and mechanical.
2. The existing exterior construction is a double-wythe wall construction of 4 inch face brick with 8 inch concrete masonry unit backup with a pre-cast concrete fascia and parapet running continuously at the top of the wall. The roofing system is rigid insulation board, lightweight concrete fill, and built up roofing sloped to drains. The roof system is penetrated by fire relief skylights and interior roof drains spaced throughout the roof area. The Basement Floor foundation walls are reinforced concrete with waterproofing and protection boards.
3. The remaining structural system is wide-flanged steel beams and columns, tube steel columns, and corrugated metal deck supported on steel bar-joists.
4. The interior of the repair shop and inspection areas are composed of 8 inch concrete masonry unit construction and concrete slab with epoxy paint finish. The interior partitioning of the office area is of gypsum board and metal stud construction.
5. The new work includes but is not limited to; track work, systems and equipment, installation of two (2) sets of married pair vehicle lifts with car body hoists and motorized turntables positioned for ease of access to adjacent truck repair area, installation of two (2) sets of married pair vehicle lifts with spinning posts, two tracks holding two married pairs each track with posted rail and pitted to a depth of 5' 0" from the top of the posted rail & platforms installed at vehicle floor height to access the interior of the vehicles, Blow Pit remodeling and expansion, relocation of existing Small Parts Storage, rooms and chases for existing mechanical and electrical modifications, employee restrooms, building shell to match the existing building appearance and function, continuous roof skylights, roofing, and miscellaneous existing structural improvements.

1.02 CODES, REGULATIONS, REFERENCE STANDARDS AND SPECIFICATIONS:

- A. WMATA Design Criteria
- B. WMATA Standard Drawings
- C. WMATA Standard Specifications
- D. Metro Matters Shops Program Drawings
- E. Local Code Amendments

- F. IBC 2000
- G. Americans With Disabilities Act 2002
- H. American National Standards Institute (ANSI)
- I. Building Reference Drawings
- J. Existing Building As-Built Drawings
- K. NFPA 101 Life Safety Code 2003
- L. Fire/Life Safety
 - 1. Greenbelt:
 - a. The use group classification for both the existing building and new addition is F-1, Factory Industrial moderate hazard. Both the existing building and the new addition shall be considered collectively as an unlimited area building. The Construction Type is IIB, noncombustible, with automatic sprinkler system throughout.
 - b. The existing building height of 34 feet, one-story, (with a mezzanine), is within the allowable building height of 55 feet and 2 stories. The new annex shall be a two story building constructed within the height limitations established by applicable codes.
 - c. The existing building square footage and the added square footage of the new annex shall be within the allowable square footage for an unlimited area building. An unlimited area building must be surrounded and adjoined by at least 60 feet of public ways or yards. In this regard the existing paint shop represents the the tightest site constraint. The new annex shall be located a minimum of 60 feet from the existing paint shop.
 - d. Replace missing fire extinguishers in the existing building as required to meet code requirements.
 - e. All new work in the existing building shall incorporate all current applicable code requirements.
 - f. It is anticipated that the fire command center required for the new addition will be provided in the fire command center lobby of the existing building, verify with fire marshal and all applicable codes and standards.
 - g. The Design Build Contractor shall coordinate with local building officials and the fire marshal to implement any and all additional requirements requested by the fire marshal and code review agencies prior to submitting the Design Build Proposal.
 - 2. Brentwood:
 - a. The design/build contractor shall perform an independent code analysis and implement any additional restriction that may be required by the local building officials. The information contained in this code analysis is for informational use only.
 - b. The primary use group classification is an F-1, moderate hazard factory & industrial. The incidental non-separated uses are B, Business, and A-2, Lunch Room / Vending. Reference Section 306.2, of the IBC 2000.
 - c. The Construction Type is IIB, noncombustible, unprotected with automatic sprinkler system throughout. Reference Table 601.1, of the

IBC 2000.

- d. The existing building height of 31 feet, one-story is with-in the allowable building height of 55 feet and 4 stories. An additional 20 feet and one-story increase is permitted for a building which is provided with an automatic sprinkler fire system throughout. Reference Table 503.0, Section 504.2, of the IBC 2000.
- e. The new building footprint of 115,000 square feet is with-in the allowable unlimited building area. A one-story, storage building which is provided with an automatic sprinkler system throughout and is surrounded and adjoined by at least 60 feet of public ways or yards, the maximum building area shall not be limited. Reference Sections 507.2, and 507.3, of the IBC 2000.
- f. With a 60 foot building and fire separation distance and type IIB construction; there are no fire-resistance-rated construction requirements for building elements. Reference Table 601.0, of the IBC 2000.
- g. Minimum dead-end corridor distance of 50 feet. Reference Section 1004.3.2.3, of the IBC 2000.
- h. Exit access travel distance of 250 feet. Reference Table 1004.2.4, of the IBC 2000.
- i. Exit access travel distance may be increased to 400 feet. Reference Section 1004.2.4.1

3. Shady Grove:

- a. The existing building and addition use group classification is F-1. The construction classification is Type IIB, noncombustible, unprotected with automatic sprinkler system throughout.
- b. The existing building height of 33 feet is with-in the allowable building height of 55 feet and 4 stories. An additional 20 feet and one-story increase is permitted for a building which is provided with an automatic sprinkler system throughout.
- c. The existing building footprint of 74,736 square feet is with-in the allowable unlimited building area for a two-story storage building which is provided with an automatic sprinkler system throughout and is surrounded and adjoined by at least 60 feet of public ways or yards.
- d. With a 60 foot building and fire separation distance and Type IIB construction there are no fire-resistance-rated construction requirements for building elements.
- e. A further review of the preliminary code analysis with the local building officials and fire marshal may be required.

M. ADA Accessibility Compliance:

- 1. Greenbelt:
 - a. All new construction shall be compliant with IBC 2000 and standards referenced by that code, along with the District of Columbia Construction Code Supplement of 2003 to IBC 2000.
 - b. Where alterations affect the accessibility to an area of primary function, the route to the primary function area shall be accessible and in accordance with Section 3408.6 of the IBC, 2000.
- 2. Brentwood:
 - a. All new construction shall be compliant with IBC 2000 and standards referenced by that code.
 - b. Where alterations affect the accessibility to an area of primary function, the route to the primary function area shall be accessible and

- in accordance with Section 3408.6 of the IBC, 2000.
3. Shady Grove:
- a. All new construction shall be compliant with IBC 2000 and standards referenced by that code.
 - b. Where alterations affect the accessibility to an area of primary function, the route to the primary function area shall be accessible and in accordance with Section 3408.6 of the IBC, 2000.

1.03 GREENBELT PROGRAM:

- A. General Building Requirements:
- a. Coordinate location of equipment, room layouts, system connections and space functional requirements with WMATA Standards and RAIL Operations through the Authority Representative. The Design Build Contractor shall include a complete installation of the items identified in this document with the notation of "provide".
 - b. All doors and frames shall be primed and epoxy painted hollow metal, unless noted otherwise.
 - c. All doors in the office suite shall be stained wood doors with primed and painted hollow metal frames.
 - d. The entire second floor office suite shall receive acoustical ceiling tiles at 10'-0" above finish floor; all other areas are to be painted exposed structure, unless noted otherwise.
 - e. The entire second floor office suite shall have partitions constructed of metal studs and gypsum board with a 4" resilient base; all other interior partitions are to be constructed of concrete masonry units.
 - f. The entire second floor office suite shall be carpeted unless noted otherwise.
 - g. All interior walls are to be concrete masonry units, unless noted otherwise.
 - h. All interior concrete and concrete masonry units exposed to view shall receive epoxy paint, unless noted otherwise.
 - i. All interior gypsum board surfaces exposed to view shall receive latex paint and a 4" vinyl base.
 - j. All interior concrete floor surfaces shall receive epoxy paint.
 - k. All exposed interior structural columns, beams, steel joists and metal deck shall receive epoxy paint.
 - l. Provide signage near the doorway of all enclosed rooms. Signage shall be placed on the latch side of the door. Signage shall meet the accessibility requirements set forth in the above referenced codes and standards.
 - m. Provide (1) electric water cooler at the first floor central to the shop work areas. Provide (2) electric water coolers at the second floor; (1) central to the shop work areas and (1) near the open office area.
 - n. Provide (1) eyewash station at each of the first and second floors central to the shop work areas, in addition to eyewash stations identified elsewhere in the drawings or criteria.
 - o. A minimum of 8% of the exterior building envelope shall receive glazing.
 - p. A minimum of 5% of the second floor shop areas shall receive skylights at the roof.
 - q. All forklift aisles located outside the building envelope shall be designed for the weight of the forklift in addition to the forklift's maximum load capabilities.

- r. Provide exterior trench drains at the exterior side of all new construction overhead service doors, and at the base of the dock.
 - s. All new roofs shall be a single ply membrane roof system.
- B. Basement floor: Not applicable.
- C. First Floor:
- 1. Existing Building Space Requirements:
 - a. Truck Repair & Rebuild Shop – G101 & G102: The Truck Repair and Rebuild Shop (Truck Shop) shall be expanded in size from its current configuration. The Truck Shop shall include the existing complement of four truck hoists and also include eight (8) new Truck Hoist systems. One new 2-ton jib crane shall be provided for each pair of new truck hoists to lift and maneuver truck rebuild components. Motorized turntables and associated connecting trackwork shall be provided to allow for movement of trucks throughout the Truck Shop and onto each Truck Hoist station. New trackwork shall be provided to connect the Truck Shop directly to three (3) tracks within the Truck Storage area located south of column line 8. Tracks within the Truck Storage area shall be reconfigured as required to align with the Truck Shop tracks. Three (3) new 15-ton (unless otherwise noted) capacity bridge cranes shall be provided for the Truck Shop and Truck Storage areas, all operating on the same crane rails. The bridge crane systems shall have appropriate safety features to prevent collision of bridge cranes. Truck Shop benches and equipment shall be relocated from Brentwood and the existing Greenbelt Shops and installed as required. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Electrical receptacles for portable welding equipment shall be provided throughout the area.
 - b. Tool Room (Existing) – G102A: Install a new pass through window to allow for the distribution of tools and materials from the Tool Room. The window shall be located above a sturdy stainless steel shelf to support tools on either side of the window. The window shall have locking capabilities to secure the room.
 - c. Oil Storage Room – 400 s.f.; G103: The existing interior Oil Storage Room located along column line 10 between column lines B-C shall be demolished. A new Oil Storage Room shall be constructed outside but attached to the existing facility. The Oil Storage room shall be accessible via forklift through double-doors to the interior of the shop. Provide galvanized steel floor grates. The Oil Storage Room shall comply with all applicable codes and regulations.
 - d. Welding Room – 200 s.f.; G104: A new Welding Room shall be constructed outside the existing facility, adjacent to the new Oil Storage Room (G103). The room shall be forklift accessible. The room shall be equipped with adequate electrical capacity and receptacles to operate WMATA's welding equipment. Compressed air supply shall be provided. The room shall be appropriately ventilated to the outside to eliminate welding fumes from entering the general shop area.
 - e. Wheel & Axle Shop – 8700 s.f.; G105: The existing Brentwood and Greenbelt Wheel and Axle Shops shall be relocated and combined into one shop area. This shall include the relocation and of existing equipment and the purchase of new equipment. This includes but is not limited to the relocation of the existing Greenbelt wheel press and wheel boring mill and the relocation of the existing Brentwood wheel boring mill.

In addition, a new wheel press shall be procured for the area. Foundations required for wheel presses and wheel boring machines shall be provided as required. New trackwork and motorized turntables shall be provided to enable movement of wheel sets throughout the area. A minimum of four (4) wheel set storage tracks shall be provided. Track access to the Steam and Degreasing Room (G108) shall be provided to enable the cleaning of trucks or wheel sets. Two (2) new 5-ton bridge cranes shall be installed within the Wheel & Axle Shop spanning column lines A-C and operating between column lines 10 and 16, with both cranes on the same tracks. The bridge crane systems shall have appropriate safety features to prevent collision of bridge cranes. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.

- f. Supervisor (Existing room) – 180 s.f.; G106: Refurbish the Wheel Shop Supervisor Office. Epoxy paint the walls and floors. Remove the existing ceiling and provide a new acoustical tile ceiling system.
- g. Gear Box Rebuild – 1700 s.f.; G107: Relocate the existing Gear Box Rebuilding Shops currently located at the Brentwood and Greenbelt Shops into one consolidated Gear Box Rebuild area at the Greenbelt Main Shop. Construct new floor to ceiling concrete masonry unit walls to completely enclose the new Gear Box Rebuild Area. This room shall be enclosed to permit HVAC of the space. Provide two sets of (2) new 4 ft. wide doors to provide access to the area. The doors shall have a clear opening height of 12 ft. Two (2) new man doors shall be provided for the area. Provide appropriate HVAC for the area. Remove existing equipment located within the space. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Gear Box Rebuild area. The existing bridge crane system in the area shall be retained and refurbished. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Electrical receptacles for portable welding equipment shall be provided throughout the area.
- h. Steam and Degreasing Room – 1400 s.f.; G108: The existing Steam and Degreasing Room shall remain in its current location. Replace the existing vertical parts washer with a new washer. Install tracks into the steam cleaning pit area to allow for the washing of trucks and wheel sets. Replace the grating as required to accommodate the tracks.
- i. Grit Blast & Parts Washroom (Existing room) – 180 s.f.; G109: Relocate and install existing Brentwood and Greenbelt equipment into the room. Provide appropriate equipment venting and HVAC for the area. Provide sink and floor drains with oil water separation. Provide an eyewash station.
- j. Machine Shop #2 – 2300 s.f.; G110: The existing Brentwood and Greenbelt Machine Shops shall be consolidated into various spaces within the Greenbelt Main Shop area. Within space G110, remove the existing wall separating the existing Pneudraulics and Electromechnical Shops located 8 ft. south of column line 21 to create one open room between column lines B-C. Remove a portion of the existing wall along column line B, between column lines 21-22 to provide an opening between spaces G110 and G111. Install a coiling overhead door into the room at column line 18. Remove existing equipment located with the

- space. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Machine Shop area. Provide equipment pads or foundations, as required. Provide appropriate HVAC for the area. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
- k. Storage Cage – 220 s.f.; G110A: Construct a galvanized steel wire mesh secured storage cage within room G110 for the storage of sheet and bar stock metal and other materials for the Machine Shop. Provide a wire mesh wall and double 3'-0" wide x 10'-0" high wire mesh doors. Extend the wire mesh walls to the existing structure above.
 - l. Machine Shop #1 – 1900 s.f.; G111: The existing Brentwood and Greenbelt Machine Shops shall be consolidated into various spaces within the Greenbelt Main Shop area. Within space G111, construct a new wall to completely enclose the room along column line 18 and provide new double doors for access to the room. Remove existing equipment, as required from the space. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Machine Shop area. Provide equipment pads or foundations, as required. Provide appropriate HVAC for the area. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
 - m. Portable Weld Room (Existing space) – 120 s.f.; G112: This space remains in service. Provide venting to the outside for welding equipment and processes.
 - n. Lathe Room – 800 s.f.; G113: The existing Brentwood and Greenbelt Machine Shops shall be consolidated into various spaces within the Greenbelt Main Shop area. Within space G113, remove existing equipment located in the space. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Machine Shop Lathe Room. Provide equipment pads or foundations, as required. Provide appropriate HVAC for the area. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
2. New Annex Space Requirements:
- a. Vestibule - 470 s.f.; G114: Entry Vestibule into the New Annex.
 - b. Passenger Elevator - Provide a hydraulic 2500 pound ADA compliant passenger elevator with two stops that vertically connect the first and second floors. Adjacencies with first floor building entries and the second floor office areas are essential.
 - c. Elevator Equipment Room – G115: The elevator equipment room shall be sized, and conditioned or ventilated, as required by the elevator manufacturer. The ceiling is to be exposed structure.
 - d. Electrical Panel Room - 350 s.f.; G116: Electrical service shall enter the building at this room. Electrical panels shall be located in this room. The ceiling is to be exposed structure.
 - e. Stair #1 - 200 s.f.; GS-1: Quadruple run concrete filled metal pan stairs. Epoxy paint handrails, stairs, and all associated ferrous metal components.
 - f. Motor Repair Shop – 7000 s.f.; G117: Relocate the existing Motor Repair Shops currently located at the Brentwood and Greenbelt Shops

- into one consolidated shop area within the Greenbelt Annex facility. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Motor Repair Shop. Provide suitable equipment and/or jib crane foundations. Install three (3) new 3-ton, 30 ft. span, 75 ft. cranes within the area spanning column lines 29-30, 30-31 and 31-32, providing crane access from the center aisle to the west wall of the facility. The bridge crane must clear all shop equipment within the area. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
- g. (M.R.S.) Secure Tool Storage – 120 s.f.; G118: This room shall be located in the Motor Repair Shop next to the (M.R.S.) Office and is to be constructed of concrete masonry unit walls and cast in place concrete ceiling at 10'-0" above finished floor. Provide a galvanized steel wire mesh wall and locking door facing the shop functions.
 - h. (M.R.S.) Office – 120 s.f.; G119: This room shall be located in the Motor Repair Shop and shall be constructed of concrete masonry unit walls and cast in place concrete ceiling at 10'-0" above finished floor. Provide a window on the exterior wall. Provide two borrow lites, (12) square feet each, adjacent to the entry door. Provide voice, power, and data.
 - i. Mechanical Component Repair Shop – 4300 s.f.; G120: Relocate the existing Mechanical Component Repair Shops currently located at the Brentwood and Greenbelt Shops into one consolidated shop area within the Greenbelt Annex facility. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Mechanical Component Repair Shop. Provide suitable equipment and/or jib crane foundations. Install one (1) new 3-ton, 30 ft. span, 75 ft. crane within the area spanning column lines 33-34, providing crane access from the center aisle to the west wall of the facility. The bridge crane must clear all shop equipment within the area. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
 - j. (M.C.R.S.) Secure Tool Storage – 120 s.f.; G121: This room shall be located in the Mechanical Component Repair Shop next to the M.C.R.S. Office and shall be constructed of concrete masonry unit walls and a cast in place concrete ceiling at 10'-0" above finished floor. Provide a galvanized steel wire mesh wall and locking door facing the shop functions.
 - k. (M.C.R.S.) Office – 120 s.f.; G122: This room shall be located in the Mechanical Component Repair Shop and is to be constructed of concrete masonry unit walls and a cast in place concrete roof/ceiling at 10'-0" above finished floor. Provide a window on the exterior wall. Provide two borrow lites, (12) square feet each, adjacent to the entry door. Provide voice, power, and data.
 - l. (Pneudraulics) Office – 120 s.f.; G123: This room shall be located in the Pneudraulics Repair Shop and is to be constructed of concrete masonry unit walls and a cast in place concrete roof/ceiling at 10'-0" above finished floor. Provide a window on the exterior wall. Provide two borrow lites, (12) square feet each, adjacent to the entry door. Provide voice, power, and data.
 - m. (Pneudraulics) Secure Tool Storage – 120 s.f.; G124: This room shall

be located in the Pneudraulics Repair Shop next to the (Pneudraulics) Office and is to be constructed of concrete masonry unit walls and a cast in place concrete roof/ceiling at 10'-0" above finished floor. Provide a galvanized steel wire mesh wall and locking door facing the shop function.

- n. Pneudraulics Repair Shop – 3000 s.f.; G125: Relocate the existing Mechanical Component Repair Shops currently located at the Brentwood and Greenbelt Shops into one consolidated shop area within the Greenbelt Annex facility. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Mechanical Component Repair Shop. Provide suitable equipment and/or jib crane foundations. Install one (1) new 3-ton, 30 ft. span, 75 ft. crane within the area spanning column lines 33-34, providing crane access from the center aisle to the west wall of the facility. The bridge crane must clear all shop equipment within the area. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
- o. Brake Valve Clean Room – 900 s.f.; G126: This room shall be located in the Pneudraulics space and is to be constructed of double wythe concrete masonry unit walls with an stc rating of 50. Provide sound attenuation insulation between the two wyths of concrete masonry units. The roof/ceiling shall be a cast in place concrete ceiling at 10'-0" above finished floor. Relocate existing Pneudraulics Repair Shops currently located at the Brentwood and Greenbelt Shops into consolidated shop areas within the Greenbelt Annex facility, which includes the Pneudraulics Repair Shop (G125), the Brake Valve Clean Room (G126) and the Air Compressor Repair Shop (G137). Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Pneudraulics Repair Shop. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. High pressure compressed air (180 psi, minimum), shall be available within this room (in addition to normal shop compressed air supply) from the High Pressure Air Compressor Room (G127). Provide a wash-up sink and counter and an emergency eye wash station.
- p. High Pressure Air Compressor Room – 120 s.f.; G127: This room shall be located in the Pneudraulics space and is to be constructed of double wythe concrete masonry unit walls with an stc rating of 50. Provide sound attenuation insulation between the two wyths of concrete masonry units. Install a high pressure (180 psi minimum) air compressor to be relocated from the Greenbelt Main Shop to this room. Provide an eyewash station. The roof/ceiling shall be a cast in place concrete ceiling at 10'-0" above finished floor.
- q. Stair #2 - 200 s.f.; GS-2: Quadruple run concrete filled metal pan stairs. Epoxy paint handrails, stairs, and all associated ferrous metal components.
- r. Component Parts Storage – 7200 s.f.; G128: Procure and install a component parts storage system comprising a combination of pallet rack shelving, cantilever rack systems, bin type shelving, secure shelving systems and vertical carrousel shelving systems, as defined by WMATA. Secure the room with concrete masonry unit walls and (2)

interior sliding gates 8ft. wide x 12 ft. high constructed of galvanized steel wire mesh. Provide (2) galvanized steel wire mesh locking man doors next to each sliding gate. Provide a 12 foot wide x 12 foot high overhead coiling door and adjacent man door at the eastern wall of the storage room; these doors will serve the dock area. Provide a dock leveler and dock bumpers. Provide a 12 foot wide x 12 foot high overhead coiling door and adjacent man door at the southern wall of the storage room; the coiling door will serve as entry for fork lift traffic. The ceiling will be exposed structure.

- s. Communications Room – 100 s.f.; G129: Provide concrete masonry unit walls and a cast in place concrete roof/ceiling at 10'-0" above finished floor. Provide protected cable trays between the first and second floor Communications Rooms.
- t. Elevator Equipment Room – G130: The elevator equipment room shall be sized, and conditioned or ventilated, as required by the elevator manufacturer. Provide concrete masonry unit walls and a cast in place concrete roof/ceiling at 10'-0" above finished floor.
- u. Freight Elevator - Provide a hydraulic 12,000 pound ADA compliant freight elevator with two stops that vertically connect the first and second floor component part storage rooms. Provide front and rear loading on the elevator at both floor levels. The freight elevator shall be sized to safely accommodate at least one forklift with a 4 ft. by 4 ft. loaded pallet and an operator.
- v. Janitor Closet – 60 s.f.; G131: Provide mop sink, mop holder and shelving. Provide concrete masonry unit walls and a cast in place concrete roof/ceiling at 10'-0" above finished floor.
- w. Men's Toilet – 200 s.f.; G132: Provide regular and ADA compliant fixtures and toilet accessories as follows: (1) toilet and toilet compartment with toilet paper dispenser, (1) ADA compliant toilet and toilet compartment with side and back grab bars for the toilet, and ADA compliant toilet paper dispenser, (1) ADA compliant urinal, (1) ADA compliant lavatory and trap protection, (1) ADA compliant mirror, (above ADA compliant lavatory), (1) ADA compliant soap dispenser, (above ADA compliant lavatory), (1) ADA compliant paper towel dispenser, Finishes are as follows: The ceiling finish shall be a latex painted suspended gypsum board ceiling system. The wall finish shall be glazed concrete masonry units. The floor finish shall be epoxy paint on concrete.
- x. Women's Toilet – 200 s.f.; G133: Provide regular and ADA compliant fixtures and toilet accessories as follows: (2) toilets and toilet compartments with toilet paper dispensers, (1) ADA compliant toilet and toilet compartment with side and back grab bars for the toilet, and ADA compliant toilet paper dispenser, (1) ADA compliant lavatory and trap protection, (1) ADA compliant mirror, (above ADA compliant lavatory), (1) ADA compliant soap dispenser, (above ADA compliant lavatory), (1) ADA compliant paper towel dispenser, Finishes are as follows: The ceiling finish shall be a latex painted suspended gypsum board ceiling system. The wall finish shall be glazed concrete masonry units. The floor finish shall be epoxy paint on concrete.
- y. Clerk – 150 s.f.; G134: This room shall be constructed of concrete masonry unit walls and a cast in place concrete roof/ceiling at 14'-0" above finished floor. Provide an acoustical tile ceiling at 10'-0" above finished floor.

- z. Supervisor – 150 s.f.; G135: This room shall be constructed of concrete masonry unit walls and a cast in place concrete roof/ceiling at 14'-0" above finished floor. Provide an acoustical tile ceiling at 10'-0" above finished floor.
- aa. Steam and Degreasing Room – 1400 s.f.; G136: Relocate the existing Steam and Degreasing Room currently located at the Brentwood Shop into a new Steam and Degreasing Room within the Greenbelt Annex facility. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Steam and Degreasing Room. Provide suitable equipment foundations. Provide galvanized steel floor grates as required for cleaning operations. Provide stainless steel sheets at the walls above the floor grating for wall protection. Provide floor drains and trench drains with oil water separation. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Provide a wash-up sink and counter and an emergency eye wash station.
- bb. Air Compressor Repair Shop – 1400 s.f.; G137: Relocate existing Pneudraulics Repair Shops currently located at the Brentwood and Greenbelt Shops into consolidated shop areas within the Greenbelt Annex facility, which includes the Pneudraulics Repair Shop (G125), the Brake Valve Clean Room (G126) and the Air Compressor Repair Shop (G137). Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Pneudraulics Repair Shop. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. High pressure compressed air (180 psi, minimum), shall be available within this room (in addition to normal shop compressed air supply) from the High Pressure Air Compressor Room (G127). Provide an emergency eye wash station.
- cc. HVAC Unit Repair Shop - 1400 s.f.; G138: Relocate the existing HVAC Unit Repair Shop currently located at the Greenbelt Main Shop into a new shop within the Greenbelt Annex facility. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new HVAC Shop. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
- dd. Component Paint Room – 1150 s.f.; G139: Relocate the existing Component Paint equipment currently located at either Brentwood or Greenbelt Main Shops into a new shop within the Greenbelt Annex facility. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new HVAC Shop. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Explosion proof fixtures shall be used. Provide an emergency eyewash station.
- ee. Storage – 250 s.f.; G140: General storage room. The ceiling shall be exposed structure.

D. Second Floor:

- 1. Existing Building Space Requirements:

- a. Selectively demolish the existing exterior wall to allow second floor circulation between the new and existing buildings.
2. New Annex Space Requirements:
- a. Elevated Walkway connecting the New Annex and the Existing Building – 600 s.f.; G201: Glass walled elevated walkway. Provide a floor, wall, ceiling, and roof expansion joint system and cover at the location where the new Annex meets the existing building. Finishes are as follows: The ceiling finish shall be a painted gypsum board system suspended 10'-0" above finished floor. The wall finish shall be a glass and aluminum frame window system. The floor finish shall be vinyl composition tile.
 - b. Elevator Lobby - Finishes are as follows: The ceiling finish shall be acoustical ceiling tile. The wall finish shall be painted gypsum board and vinyl base. The floor finish shall be vinyl composition tile.
 - c. Corridor adjacent to offices - Finishes are as follows: The ceiling finish shall be acoustical ceiling tile suspended 10'-0" above finish floor. The wall finish shall be painted gypsum board and vinyl base. The floor finish shall be vinyl composition tile.
 - d. Stair #1 - 200 s.f.; GS-2: Quadruple run concrete filled metal pan stairs. Epoxy paint handrails, stairs, and all associated ferrous metal components.
- e. Office Suite - 3,600 s.f.: Walls surrounding the office suite shall have an STC rating of 50. Spaces required are:
- (1) Reception – 400 s.f.; G202: Provide power, voice and data connections. Walls enclosing this room shall have an STC rating of not less than 45, unless noted otherwise.
 - (2) Storage – 170 s.f.; G203: General storage/Future office. Provide power, voice and data connections.
 - (3) Office – 150 s.f.; G204: Provide power, voice and data connections. Walls enclosing this room shall have an STC rating of not less than 45, unless noted otherwise.
 - (4) Office – 150 s.f.; G205: Provide power, voice and data connections. Walls enclosing this room shall have an STC rating of not less than 45, unless noted otherwise.
 - (5) Office – 230 s.f.; G206: Provide power, voice and data connections. Walls enclosing this room shall have an STC rating of not less than 45, unless noted otherwise.
 - (6) Office – 230 s.f.; G207: Provide power, voice and data connections. Walls enclosing this room shall have an STC rating of not less than 45, unless noted otherwise.
 - (7) Copy Room – 150 s.f.; G208: Provide a minimum of 20 feet of upper and lower cabinets with a plastic laminate counter top. Provide power, voice and data connections.
 - (8) Open office – 300 s.f.; G209: Provide space for four work stations. Work stations shall be integrally wired for power, voice and data connections.
 - (9) Conference Room – 500 s.f.; G210: Provide a minimum of 15 feet of upper and lower cabinets with a plastic laminate counter top, back and side splash. Provide a refrigerator with ice maker. Provide a 9" deep double bowl stainless steel sink. Provide (1) paper towel dispenser. Provide (1) upper cabinet microwave. Provide power, voice and data connections. Walls enclosing the Conference Room shall have an STC rating of not less than 50. Provide a sound attenuated operable partition with an STC rating

of not less than 50. The operable partition shall divide the Conference Room and Multipurpose Room.

- (10) Multipurpose Room – 750 s.f.; G211: Provide a minimum of 15 feet of upper and lower cabinets with a plastic laminate counter top, back and side splash. Provide a refrigerator with an ice maker/dispenser at the door. Provide a double bowl stainless steel sink. Provide (5) power, voice and data connections to serve temporary workstations. Walls enclosing the Multipurpose Room shall have an STC rating of not less than 50.
 - (11) Telephone Closet – 60 s.f.; G212: Provide ¾" fire treated plywood telephone boards. Finishes are as follows: The ceiling finish shall be a latex painted suspended gypsum board ceiling system at 9'-0" above finished floor.
 - (12) Men's Toilet – 70 s.f.; G213: Provide ADA compliant fixtures and toilet accessories as follows: (1) toilet, (1) lavatory with trap protection, side and back grab bars for the toilet, (1) mirror, (1) soap dispenser, (1) paper towel dispenser, (1) toilet paper dispenser. Finishes are as follows: The ceiling finish shall be a latex painted suspended gypsum board ceiling system at 9'-0" above finished floor. The wall finish shall be ceramic tile at 6'-8" above finished floor and latex painted gypsum board above the tile. The floor finish shall be ceramic tile with metal trim at the threshold.
 - (13) Women's Toilet – 70 s.f.; G214: Provide ADA compliant fixtures and toilet accessories as follows: (1) toilet, (1) lavatory with trap protection, side and back grab bars for the toilet, (1) mirror, (1) soap dispenser, (1) paper towel dispenser, (1) toilet paper dispenser. Finishes are as follows: The ceiling finish shall be a latex painted suspended gypsum board ceiling system at 9'-0" above finished floor. The wall finish shall be ceramic tile at 6'-8" above finished floor and latex painted gypsum board above the tile. The floor finish shall be ceramic tile with metal trim at the threshold.
- f. Employee welfare Women's Locker and Shower Room Facilities – 500 s.f.; G215: Provide (18) 72" high x 18" wide x 21" deep metal lockers; (4) of the (18) lockers shall be ADA compliant. Provide ADA compliant benches with ADA compliant clearances to serve all lockers. Provide regular and ADA compliant fixtures and toilet accessories as follows: (1) toilet and toilet compartment, (1) ADA compliant toilet and toilet compartment with side and back grab bars for the toilet, and ADA compliant toilet paper dispenser, (1) lavatory, (1) ADA compliant lavatory and trap protection, (1) mirrors, (1) ADA compliant mirror, (above ADA compliant lavatory), (1) soap dispensers, (1) ADA compliant soap dispenser, (above ADA compliant lavatory), (1) ADA compliant paper towel dispensers, (1) toilet paper dispenser. Finishes are as follows: The ceiling finish shall be a latex painted suspended gypsum board ceiling system at 12'-0" above finished floor. The wall finish shall be glazed concrete masonry units. The floor finish shall be ceramic tile on the concrete substrate.
- g. Employee welfare Men's Locker and Shower Room Facilities – 1300 s.f.; G216: Provide (102) 72" high x 18" wide x 21" deep metal lockers; (21) of the (102) lockers need to be ADA compliant. Provide ADA compliant benches with ADA compliant clearances to serve all lockers. Provide

regular and ADA compliant fixtures and toilet accessories as follows: (2) toilets and toilet compartments, (2) toilet paper dispensers, (1) ADA compliant toilet and toilet compartment with side and back grab bars for the toilet, and ADA compliant toilet paper dispenser, (1) urinal, (1) ADA compliant urinals, (2) lavatories, (1) ADA compliant lavatory and trap protection, (2) mirrors, (1) ADA compliant mirror, (above ADA compliant lavatory), (2) soap dispensers, (1) ADA compliant soap dispenser, (above ADA compliant lavatory), (2) ADA compliant paper towel dispensers. Finishes are as follows: The ceiling finish shall be a latex painted suspended gypsum board ceiling system at 12'-0" above finished floor. The wall finish shall be glazed concrete masonry units. The floor finish shall be ceramic tile on the concrete substrate.

- h. High Voltage Electronic Repair Shop – 2800 s.f.; G217: Relocate the existing Brentwood Electronics Shop into new spaces within the Greenbelt Annex facility, including the High Voltage Electronics Repair Shop (G217) and the Electronic Repair Shop (G219). Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new High Voltage Electronic Repair Shop. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Provide an anti-static floor within the space suitable for protecting electronic circuitry during handling and repair.
- i. (E.R.S.) Supervisor Office – 200 s.f.; G218: This room is to be located in the Electronic Repair Shop and is to be constructed of concrete masonry unit walls and cast in place concrete ceiling. Provide (1) door with access to the High Voltage Electronic Repair Shop and Provide (1) door with access to the Electronic Repair Shop. Provide a window on the exterior wall. Provide two borrow lites, (12) square feet each, adjacent to each entry door. Provide voice, power, and data.
- j. Electronic Repair Shop – 7200 s.f.; G219: Relocate the existing Brentwood Electronics Shop into new spaces within the Greenbelt Annex facility, including the High Voltage Electronics Repair Shop (G217) and the Electronic Repair Shop (G219). Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Electronic Repair Shop. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Provide an anti-static floor within the space suitable for protecting electronic circuitry during handling and repair. Provide a wash-up sink area.
- k. Component Part Washing – 320 s.f.; G220: Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the Component Part Washing Room. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Provide an anti-static floor within the space suitable for protecting electronic circuitry during handling and repair. Provide drains and floor drains with oil water separation. Provide an eyewash station.
- l. Stair #2 - 200 s.f.; GS-2: Quadruple run concrete filled metal pan stairs. Epoxy paint handrails, stairs, and all associated ferrous metal

- components.
- m. Mechanical Room – 4500 s.f.; G221: Mechanical Equipment will be located in this room. The size of this space can vary as required to sufficiently house the H.V.A.C. equipment necessary to support the New Annex.
 - n. Component Part Storage – 2500 s.f.; G222: Procure and install a component parts storage system comprising a combination of pallet rack shelving, cantilever rack systems, bin type shelving, secure shelving systems and vertical carrousel shelving systems, as defined by WMATA.
 - o. Communications Room – 110 s.f.; G223: This room houses communication and telephone equipment boards. The ceiling shall be exposed structure.
 - p. Janitor Closet – 50 s.f.; G224: Provide mop sink, mop holder and shelving. The ceiling shall be exposed structure.
 - q. (E.C.R.S.) Secure Storage – 120 s.f.; G225: This room is to be located in the Electrical Component Repair Shop next to the E.C.R.S. Office and is to be constructed of concrete masonry unit walls and a cast in place concrete ceiling at 10'-0" above finished floor. Provide a galvanized steel wire mesh wall and locking door facing the shop functions.
 - r. (E.C.R.S.) Office – 120 s.f.; G226: This room is to be located in the Electrical Component Repair Shop and is to be constructed of concrete masonry unit walls and a cast in place concrete roof/ceiling at 10'-0" above finished floor. Provide a window on the exterior wall. Provide two borrow lites, (12) square feet each, adjacent to the entry door. Provide voice, power, and data.
 - s. Electrical Component Repair Shop – 6200 s.f.; G227: Relocate the existing Electrical Component (Electromechanical) Repair Shops currently located at the Brentwood and Greenbelt Shops into one consolidated shop area within the Greenbelt Annex facility. Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the new Electrical Component Repair Shop. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
 - t. Grit Blast Room – 360 s.f.; G228: Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the Grit Blast Room. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Soundproofing shall be provided within the interior walls of this room. Provide drains and floor drains with oil water separation. Provide an eyewash station.
 - u. Parts Washing Room – 320 s.f.; G229: Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the Parts Washing Room. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. The room shall be well ventilated to prevent the accumulation or dispersion of solvent fumes. Provide drains and floor drains with oil water separation. Provide an eyewash station.

- v. Component Paint Room – 320 s.f.; G230: Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment within the Parts Washing Room. Provide suitable equipment and/or jib crane foundations. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. The room shall be well ventilated to prevent the accumulation or dispersion of solvent fumes. Provide drains and floor drains with oil water separation. Provide an eyewash station.

1.04 BRENTWOOD PROGRAM:

A. Basement Floor:

1. Coordinate location of equipment, room layouts, system connections and space functional requirements with WMATA Standards and RAIL Operations through the Authority Representative.
2. Provide floor drainage in areas of new work required to capture water that may enter through new vehicle lift pits and shower facilities.
3. The basement level is to be connected to the upper floors with existing and new egress stairs, a new passenger elevator, and a new freight elevator.
4. Provide means of egress access aisles and corridors from all areas of the basement to rated exits, providing a continuous protected and unobstructed common path of travel from the basement to exit discharge and public way.
5. All existing floors, ceilings and partitions to receive new finishes shall be leveled, filled and patched by the Design/Build Contractor with appropriate compound required to provide a sound, clean substrate suitable for installation of new work.
6. Receive prior approval from the Authority Representative before cutting and patching. Use materials identical to existing materials. If identical materials are not available, or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal or better performance characteristics.
7. Men's Shower & Locker Room - 1,660 s.f.; B001, B002, B003: Provide fixture count for (1) ADA compliant toilet compartment, (4) standard toilet compartments, (1) ADA compliant urinal, (2) standard urinals, (8) ADA compliant lavatories, (2) 36" x 36" ADA compliant shower stalls, (6) 36" x 36" standard shower stalls, (129) 15"w x 18"d x 72"h single tier louver lockers, with sloped tops. Mount lockers to 4 in. high concrete curb. Provide adequate linear bench space to accommodate the maximum number of men working in one shift with number to be verified by the Design/Builder through the Authority Representative. Finishes are as follows; Ceramic tile floor finish, sloped to drain. Wall finish to be full height glazed CMU construction. Ceiling finish to be painted water resistant gypsum board construction. All entry doors to this space are to be of painted hollow metal frame and louver door construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
8. Stair #2 - 175 s.f.; B004: Provide fire rated exit enclosure with an area of refuge. Stair system to be a prefabricated and pre-finished metal stair system with equally spaced risers and treads with two 180 degree intermediate landings per floor. Finishes are as follows: Floor finish to be epoxy paint on concrete substrate. Wall finish to be epoxy paint on full height CMU construction. Ceiling finish to be painted gypsum board

- construction. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
9. Offices - 144 s.f. each; B005, B006: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be carpet on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 10. Open Office #1 - 675 s.f.; B007: Finishes are as follows: Floor finish to be epoxy paint on concrete substrate. Wall finish to be paint on gypsum board & metal stud or furring construction. Ceiling finish to be painted gypsum board construction. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 11. Corridor; B008: Finishes are as follows: Floor finish to be vinyl composite tile on concrete substrate. Wall finish to be epoxy paint on full height CMU construction. Ceiling finish to be suspended acoustical tile system. All doors in this space to be of painted hollow metal door and frame construction. Provide ADA compliant high/low electric water cooler. Provide fire rated assemblies where required. Provide ADA compliant signage at each door leading into adjacent spaces. Provide HVAC.
 12. Lunch Room & Vending - 1,415 s.f.; B009, B010: Provide a designated vending area within this space. Finishes are as follows: Floor finish to be vinyl composite tile on concrete substrate. Wall finish to be epoxy paint on full height CMU construction. Ceiling finish to be suspended acoustical tile system. All doors in this space to be of painted hollow metal double door and frame construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 13. Custodial Room #1 - minimum 25 s.f.; B011: Floor finish to be epoxy paint on concrete substrate. Wall finish to be epoxy paint on CMU construction. Ceiling finish to be open to above. Provide mop sink and shelving. All doors in this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
 14. Women's Shower & Locker Room - 540 s.f.; B012: Provide fixture count for (1) ADA compliant toilet compartment, (2) standard toilet compartments, (3) ADA compliant lavatories, (1) 36" x 36" ADA compliant shower stalls, (2) 36" x 36" standard shower stalls, (38) 15"w x 18"d x 72"h single tier louver lockers, with sloped tops. Mount lockers to 4 in. high concrete curb. Provide adequate linear bench space to accommodate the maximum number of women working in one shift with number to be verified by the Design/Builder through the Authority Representative. Finishes are as follows; Ceramic tile floor finish, sloped to drain. Wall finish to be full height glazed CMU construction. Ceiling finish to be painted water resistant gypsum board construction. All entry doors to this space are to be of painted hollow metal frame and louver door construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 15. Car Wash Room - 350 s.f.; B014: Provide space for car wash equipment. Finishes are as follows; Wall finish to be epoxy paint on full height CMU construction. Ceiling finish is open to above. All entry doors to this space are to be of painted hollow metal frame and louver door construction. Provide

ADA compliant signage at each door leading into this space. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.

16. General Storage Area: B015: Open storage space separated by mesh partition enclosure and gates. In addition, secure areas around all vehicle lifts within the general storage areas with mesh partition enclosures and gates. Maintain an unobstructed path of travel for egress purposes and designated forklift aisle. Provided painted yellow floor striping to identify designated egress paths.
17. Existing Unisex Restroom #1; B016: This space to receive new finishes as follows; Vinyl composite tile floor finish. Painted wall finish. Painted ceiling finish. Patch wall, ceiling and floor as required providing a sound, clean substrate suitable for installation of new work. Base board finish to be 4 inch rubber base. All entry doors to this space are to be of painted hollow metal frame and louver door construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
18. Existing Storage - B017: This space to receive new finishes as follows; Vinyl composite tile floor finish. Painted wall finish. Patch wall, ceiling and floor as required providing a sound, clean substrate suitable for installation of new work. Painted ceiling finish. Base board finish to be 4 inch rubber base. All entry doors to this space are to be of painted hollow metal frame and door construction. Provide ADA compliant signage at each door leading into this space.
19. Existing Drug Testing; B018: This space to receive new finishes as follows; Vinyl composite tile floor finish. Painted wall finish. Painted ceiling finish. Patch wall, ceiling and floor as required providing a sound, clean substrate suitable for installation of new work. Base board finish to be 4 inch rubber base. All entry doors to this space are to be of painted hollow metal frame and door construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
20. Existing Elevator Lobby; B019: This space to receive new finishes as follows; Vinyl composite tile floor finish. Painted wall finish. Painted ceiling finish. Patch wall, ceiling and floor as required providing a sound, clean substrate suitable for installation of new work. Base board finish to be 4 inch rubber base. All entry doors to this space are to be of painted hollow metal frame and door construction. Remove existing passenger elevator and provide a new front loading with three stops, ADA compliant, 2500 lb. passenger elevator. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
21. Existing Elevator Equipment Room; B020: All entry doors to this space are to be of painted hollow metal frame and door construction. Provide ADA compliant signage at each door leading into this space.
22. Existing Office, Graphics; B021, B024, B025: This space to receive new finishes as follows: Ceiling finish to be suspended acoustical tile system. Painted wall finish. Floor finish to be carpet on concrete substrate. Patch wall, ceiling and floor as required providing a sound, clean substrate suitable for installation of new work. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.

23. Existing Custodial Room; B022: All entry doors to this space are to be of painted hollow metal frame and door construction. Provide ADA compliant signage at each door leading into this space.
24. Existing Stair #2; B023: Floor finish to be epoxy paint on concrete substrate. Wall finish to be epoxy paint on full height CMU construction, patch as required to like new condition. Ceiling finish to be painted gypsum board construction, patch as required to like new construction. Patch wall, ceiling and floor as required providing a sound, clean substrate suitable for installation of new work. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
25. Existing Communication, Tele & Server Rooms; B026, B027, B028: All entry doors to this space are to be of painted hollow metal frame and door construction. Provide restricted access to this space. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
26. Electrical Room - 100 s.f.; B031: Provide restricted access to this space. Finishes are as follows: Floor finish to be sealed concrete substrate. Wall finish to be epoxy paint on full height CMU & concrete construction. Ceiling finish to be open to above. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
27. Stair #3; B032: Provide fire rated exit enclosure with an area of refuge. Stair system to be reinforced poured concrete with equally spaced risers and treads with two intermediate landings. Finishes are as follows: Floor finish to be sealed concrete substrate. Wall finish to be epoxy paint on full height CMU & concrete construction. Ceiling finish to be painted gypsum board construction. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
28. Freight Elevator; B033: Provide ADA compliant 12,000 lb, hydraulic, front and rear opening freight elevator with center doors, three stops, freight elevator that vertically connects the receiving area with the ground floor shop area and basement general storage area. Adjacencies with receiving, ground floor open shop area, and basement general storage. The freight elevator shall be sized to safely accommodate at least one forklift with a 4 ft. by 4 ft. loaded pallet and an operator.
29. Freight Elevator Equipment Room; B034: Size per manufacturer's recommendations and per ASME. Finishes are as follows: Floor finish to be sealed concrete substrate. Wall finish to be epoxy paint on full height CMU & concrete construction. Ceiling finish to be open to above. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
30. Existing Hoist Equipment / MCCT Room – 675 s.f.; B035: As a result of extensive structural demolition required in this area to accommodate the new rail extension, all existing utilities in this space shall be rerouted with as minimum interruption as possible to existing active services. This work shall be coordinated and performed with prior written approval from the Authority Representative. Floor finish to be sealed concrete. Wall finish to be epoxy paint on concrete. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
31. Electrical Equipment Room: - 760 s.f.; B036: Provide space for a new electrical motor-control center and equipment. Floor finish to be sealed

- concrete. Wall finish to be full height CMU. Entry door to this space to be of painted hollow metal double door and frame construction. Provide restricted access to this space. Provide ADA compliant signage at each door leading into this space.
32. DC Switchgear Room - 200 s.f.; B037: Floor finish to be sealed concrete. Wall finish to be full height CMU. Entry door to this space to be of painted hollow metal door and frame construction. Provide restricted access to this space. Provide ADA compliant signage at each door leading into this space.
33. Storage Room – 510 s.f.; B038: Floor finish to be sealed concrete. Wall finish to be epoxy paint on concrete. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.

B. Ground Floor:

1. Coordinate location of equipment, room layouts, system connections and space functional requirements with WMATA Standards and RAIL Operations through the Authority Representative.
2. Reprogram space functions for open shop, and administrative support as a result of new lifts and track work.
3. Provide a rated means of egress from the basement and mezzanine levels to an exit discharge and public way.
4. ADA Passenger Elevator: Remove existing elevator and associated systems and replace with new ADA compliant passenger elevator.
5. All existing floors, ceilings and partitions to receive new finishes shall be leveled, filled and patched by the Design/Build Contractor with appropriate compound required to provide a sound, clean substrate suitable for installation of new work.
6. Receive prior approval from the Authority Representative before cutting and patching. Use materials identical to existing materials. If identical materials are not available, or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal or better performance characteristics.
7. All partitions that separate the office space functions from the shop space functions shall be of cmu construction. Where gypsum board is identified in office spaces that are adjacent to shop areas, the intent is for interior walls to be gypsum board and metal stud construction and the perimeter walls that are adjacent to shops are of cmu construction with gypsum board furring occurring at the office side only.
8. Stair #2 - 205 s.f.; B101: Provide fire rated exit enclosure. Stair system to be a prefabricated and pre-finished metal stair system with equally spaced risers and treads with two 180 degree intermediate landings per floor. Finishes are as follows: Floor finish to be vinyl composite tile on concrete substrate. Wall finish to be epoxy paint on full height CMU construction. Ceiling finish to be painted gypsum board construction. Entry door to this space to be of painted hollow metal door and frame
9. Vestibule - 110 s.f.; B102: Provide fire rated exit enclosure. Finishes are as follows: Floor finish to be vinyl composite tile on concrete substrate with recessed entry floor matting system. Wall finish to be epoxy paint on full height CMU and gypsum board furring construction. Ceiling finish to be painted gypsum board construction. Base board finish to be 4 rubber base. Exterior entry door to this space to be of a pre-finished metal store front system to match existing exterior windows with perimeter weather seal and

- threshold. Provide HVAC.
10. Lan Server Room - 95 s.f.; B103: Finishes are as follows: Floor finish to be anti-static vinyl composite tile on concrete substrate. Wall finish to be paint on full height CMU and gypsum board furring construction. Base board finish to be 4 rubber base. Ceiling finish to be suspended acoustical tile system. Entry door to this space to be of painted hollow metal door and frame. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 11. Chief Operation Room - 165 s.f.; B104: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be padded carpeting on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide mini-blinds at exterior window. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 12. Supervisor of Rail Transportation - 192 s.f.; B105: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be padded carpeting on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide mini-blinds at exterior window. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 13. Rail Supervisor - 173 s.f.; B106: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be padded carpeting on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide mini-blinds at exterior window. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 14. Corridor #2; B107: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be padded carpeting on concrete substrate. Base board finish to be 4 inch rubber base. Door to this space to be of painted hollow metal door and frame construction with sidelight. Provide weather seal and threshold at doors leading into the open shop area. Provide ADA compliant signage at each door leading into adjacent spaces. Provide HVAC.
 15. Copy Clerk - 125 s.f.; B108: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be padded carpeting on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 16. Office #3 - 145 s.f.; B109: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be padded carpeting on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide ADA compliant signage at each

- door leading into this space. Provide HVAC.
17. Elec/Tele Room - 32 s.f.; B110: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be vinyl composite tile on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
 18. Office #4 - 145 s.f.; B111: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be padded carpeting on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 19. Elevator Lobby - 325 s.f.; B112: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted full height gypsum board construction. Floor finish to be vinyl composite tile on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide perimeter weather seal and threshold at doors leading into the open shop area. Remove existing passenger elevator and provide a new ADA compliant, 2500 lb. passenger elevator. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 20. Men's Room – 215 s.f.; B113: Provide fixture count for (1) ADA compliant toilet compartment, (1) ADA compliant urinals, (1) standard urinal, (2) ADA compliant lavatories, Finishes are as follows; Ceramic tile floor finish, sloped to drain. Wall finish to be full height glazed CMU construction. Ceiling finish to be painted water resistant gypsum board construction. Base board finish to be 4 inch rubber base. All entry doors to this space are to be of painted hollow metal frame and louver door construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 21. Women's Room - 215 s.f.; B114: Provide fixture count for (1) ADA compliant toilet compartment, (2) standard toilet compartments, (2) ADA compliant lavatories, Finishes are as follows; Ceramic tile floor finish, sloped to drain. Wall finish to be full height glazed CMU construction. Ceiling finish to be painted water resistant gypsum board construction. Base board finish to be 4 inch rubber base. All entry doors to this space are to be of painted hollow metal frame and louver door construction. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 22. Assistant Supervisor Car Inspector 1 & 2; - 125 s.f. each; B115, B117. Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be vinyl composite tile on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide ADA compliant signage at each door leading into this space. Provide HVAC. Adjacencies with Inspection Office.
 23. Custodial Room #2 - 35 s.f.; B116: Floor finish to be vinyl composite tile on epoxy paint on concrete substrate. Wall finish to be epoxy paint on gypsum board construction. Where partition separates space interior from adjacent shop interior, wall finish to be painted gypsum board furring on full height CMU. Ceiling finish to be open to above. Provide mop sink and shelving. All

- doors in this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
24. Inspection Office - 282 s.f.; B118: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Where partition separates office space interior from adjacent shop interior, wall finish to be painted gypsum board furring on full height CMU. Floor finish to be vinyl composite tile on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Provide built-in counter with sliding glass opening into shop area. Provide ADA compliant signage at each door leading into this space. Provide HVAC. Adjacencies with Assistant Supervisor Car Inspector 1 & 2.
 25. Coat Closet #1 - 12 s.f.; B119: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Floor finish to be padded carpeting on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted bi-folding wood door and frame construction with built-in shelving. Provide ADA compliant signage at door leading into this space.
 26. Corridor #3; B120: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted full-height gypsum board construction. Where partition separates office space interior from adjacent shop interior, wall finish to be painted gypsum board furring on full height CMU. Floor finish to be vinyl composite tile on concrete substrate. Base board finish to be 4 inch rubber base. Entry doors to this space to be of painted hollow metal door and frame construction. Provide ADA compliant high/low electric water cooler. Provide perimeter weather seal and threshold at doors leading into the open shop area. Provide ADA compliant signage at each door leading into adjacent spaces. Provide HVAC.
 27. Operator's Lounge - 662 s.f.; B121: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Where partition separates office space interior from adjacent shop interior, wall finish to be painted gypsum board furring on full height CMU. Floor finish to be vinyl composite tile on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction. Adjacencies with Depo-Clerk and interior corridor with visual (borrow-life) connection between both. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 28. Depo Clerk Office - 270 s.f.; B122: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted gypsum board construction to underside of suspended grid system. Where partition separates office space interior from adjacent shop interior, wall finish to be painted gypsum board furring on full height CMU. Floor finish to be vinyl composite tile on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame construction with sidelight. Adjacencies with Operator's Lounge. Provide built-in counter with sliding glass opening into Operators Lounge. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
 29. Storage #1 - 80 s.f.; B123: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be painted full-height

- gypsum board construction. Floor finish to be vinyl composite tile on concrete substrate. Base board finish to be 4 inch rubber base. Entry door to this space to be of painted hollow metal door and frame. Provide ADA compliant signage at each door leading into this space.
30. S & I Bench Work; B124: Remove all work benches and equipment from existing shop areas B128 and B126 and relocate to new S & I Bench Work area B124. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Finishes are as follows: Ceiling finish to be open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor finish to be epoxy paint on concrete substrate.
31. S & I Shop; B125: Remove all existing equipment from the area and relocate to Greenbelt, other locations within Brentwood, other locations as defined by WMATA, or scrap as programmed. Install three (3) new Service and Inspection (S & I) tracks (designated as track 9A, 9B and 9C) within column lines D-F. All new tracks shall align and connect with existing track within the Brentwood Yard as required. Provide the installation of six (6) sets of married pair vehicle lifts with spinning posts on the three (3) new tracks, with each track holding two married pairs. Provide two (2) new east-west tracks connecting the existing truck release tracks from Track 9 near column lines D11 and D15 to the Truck Dismantling area (B129). Install two (2) new overhead rail car stinger systems between the new tracks with one system centered between Tracks 9A and 9B and the other centered between Tracks 9B and 9C. The stinger systems shall extend from column lines 1 to 18. The new Service and Inspection track area is to be provided with sufficient lighting, compressed air outlets, electrical and welding receptacles to support the equipment and shop functions within the S & I Area. Finishes are as follows: Ceiling finish to be open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor finish to be epoxy paint on concrete substrate. Provide a minimum clearance of 11'-1" from finish ground floor elevation to the lowest obstacle beneath the mezzanine level between column grid lines D & F. Provide (3) overhead coiling doors, center on track work & mounted on the exterior face of the South Elevation. Provide (3) overhead sectional doors, center on track work at the North Elevation. All overhead doors to match existing overhead door requirements. Provide 6 in. diameter concrete filled steel bollards at both sides of overhead doors on interior and exterior side of door. Provide vehicle lifts as shown on the drawings.
32. Open Shop Area; B126: Remove existing equipment from this area and relocate according to the Program. Repair flooring as required and install equipment within this area as directed by WMATA. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Finishes are as follows: Ceiling finish to be open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor finish to be epoxy paint on concrete substrate.
33. Open Shop Area; B127: Remove existing equipment from this area and relocate according to the Program. Repair flooring as required and install equipment within this area as directed by WMATA. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Finishes are as follows: Ceiling finish to be open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor

- finish to be epoxy paint on concrete substrate.
34. Machine Shop; B128: Remove existing equipment from this area and relocate according to the Program. Repair flooring as required and install equipment within this area as directed by WMATA. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Finishes are as follows: Ceiling finish to be open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor finish to be epoxy paint on concrete substrate.
35. Truck Dismantling; B129: Remove existing equipment and trackwork from the area as required. Install two (2) new motorized turntables within this area connecting to the new east-west truck release tracks installed in area B125, and the two existing truck release tracks from Track 11, as shown on the Plan views. Install a new north-south track adjacent to column line G to provide a direct connection between the two new turntables. Install equipment within the area as directed by WMATA. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Finishes are as follows: Ceiling finish to be open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor finish to be epoxy paint on concrete substrate.
36. Receiving – 2,100 s.f.; B131: Finishes are as follows: Ceiling finish to be open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor finish to be epoxy paint on concrete substrate. Provide (2) 8 foot wide by 10 foot high overhead section doors at dock receiving. Provide (1) 10 foot wide by 10 foot high overhead coiling door at ramp entrance. Provide 6 in. diameter concrete filled steel bollards at both sides of overhead coiling doors on interior and exterior side of door. All overhead doors to match existing overhead door requirements. Provide (2) in pit dock levelers, center levelers with overhead section doors. Provide ADA compliant high/low electric water cooler. Provide exterior dock bumpers. Provide a prefabricated exterior stair system of equal risers and treads that leads from the receiving area to grade for easy parcel driver access. Provide interior stairs that connects the ground floor receiving area with the basement general storage area. Exterior entry door to this space to be of painted hollow metal door and frame construction with a 24"w. x 36"h. glass light vision panel.
37. Unisex Restroom #2 – 68 s.f.; B132: Provide fixture count for (1) ADA compliant toilet compartment, (1) ADA compliant urinal, (1) ADA compliant lavatory. Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be full height glazed CMU construction. Floor finish to be epoxy paint on concrete substrate. Entry door to this space to be of painted hollow metal door and frame construction. Adjacencies with receiving. Provide ADA compliant signage at each door leading into this space.
38. Stair #3; B133: Provide fire rated exit enclosure. Stair system to be reinforced poured concrete with equally spaced risers and treads with two intermediate landings. Finishes are as follows: Floor finish to be sealed concrete substrate. Wall finish to be epoxy paint on full height CMU & concrete construction. Ceiling finish to be painted gypsum board construction. Entry door to this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.

39. Waste Oil Storage; B134: Finishes are as follows: Ceiling finish open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor finish to be epoxy paint on concrete. Provide area of full containment with a 2 inch curb or recessed slab according to applicable environmental regulations. Provide proper venting and explosion proof electrical fixtures, as required by applicable building codes and regulations. Finishes are as follows: Entry door to this space to be of painted hollow metal door and frame. Provide ADA compliant signage at each door leading into this space.
40. Custodial #3 – min. 45 s.f.; B135: Floor finish to be epoxy paint on concrete substrate. Wall finish to be epoxy paint on full height CMU construction. Ceiling finish to be open to above. Provide mop sink and shelving. All doors in this space to be of painted hollow metal door and frame construction. Provide ADA compliant signage at each door leading into this space.
41. Receiving Office – 160 s.f.; B136: Finishes are as follows: Ceiling finish to be suspended acoustical tile system. Wall finish to be epoxy paint on full height CMU construction. Floor finish to be epoxy paint on concrete substrate. Entry door to this space to be of painted hollow metal door and frame construction. Adjacencies with receiving with visual (borrow-lite) connection between. Provide ADA compliant signage at each door leading into this space.
42. Ramp; B137: Floor finish to be epoxy paint on concrete substrate. Wall finish to be epoxy paint on CMU construction. Ceiling finish to be open to above. Provide 42 inch minimum wall height when there is no adjacent room.
43. Battery Room; B138: Finishes are as follows: Ceiling finish open to structure above. Wall finish to be epoxy painted full-height CMU construction. Floor finish to be epoxy paint on concrete. Entry door to this space to be of painted hollow metal door and frame. Provide restricted access to this space. Provide ADA compliant signage at each door leading into this space. Provide area of full containment with a 2 inch curb or recessed slab. Provide proper venting and explosion proof fixtures, as required by applicable regulations. Provide floor drain and eye wash station. Floor drain to connect to a separate collection system required by code.
44. Open Shop Area; B139: Remove existing equipment and refinish the floor as required. Floor finish to be epoxy paint on concrete.
45. Freight Elevator; B140: Provide ADA compliant freight elevator 12,000 lb, hydraulic, front and rear opening with center doors, three stops, freight elevator that vertically connects the receiving area with the ground floor shop area and basement general storage area. Adjacencies with receiving, ground floor open shop area, and basement general storage. The freight elevator shall be sized to safely accommodate at least one forklift with a 4 ft. by 4 ft. loaded pallet and an operator.
46. Wheel Truing Machine (WTM): Provide equipment and man-power to assist the manufacturer with the installation of a new lathe-type, single axle, underfloor wheel truing machine system on Track 9A at approximately column line 11. The wheel truing machine shall be a new Hegenscheidt Model U-2000. The Contractor shall develop machine location and pit configuration designs to maximize machine and machine pit clearance from Track 9B and rail cars located on Track 9B. Provide the electrical, grounding rods, handrails and pit stairs to support the equipment and the operation. Wheel truing chips shall be directed to and accumulated in easily accessible hoppers located in the basement of the facility. The Wheel Trueing Machine will require 480V- 3 Phase power. The WTM weighs approximately 37,500

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lbs. and will require a machine pit depth of 7.9'. Space allocation required for the WTM is 20' x 21.5' minimum.

C. Mezzanine Floor:

1. Coordinate location of equipment, room layouts, system connections and space functional requirements with WMATA Standards and RAIL Operations through the Authority Representative.
2. The mezzanine level is to be connected to the ground level with existing and new egress stairs, and a new ADA compliant passenger elevator.
3. The entire mezzanine level is to have the following work provided: Existing ceiling grid system to remain, replace all existing ceiling tile with new. Patch and repair all gypsum board finishes to like new construction, prime and paint. Replace all existing base with new 4 inch rubber base. Replace existing carpeting and pad system with new. In offices with exterior windows, replace all window treatment with new. Prime and paint all metal doors and frames. Provide new light fixtures and mechanical diffusers. Provide ADA compliant signage at each door. HVAC.
4. All existing floors, ceilings and partitions to receive new finishes shall be leveled, filled and patched by the Design/Build Contractor with appropriate compound required to provide a sound, clean substrate suitable for installation of new work.
5. Receive prior approval from the Authority Representative before cutting and patching. Use materials identical to existing materials. If identical materials are not available, or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal or better performance characteristics.
6. Train Control Equipment Room Annex - 610 s.f.; B204A: Expand existing Train Control Equipment room towards the East as shown on the drawings. Entry door to this space to be of painted hollow metal double door and frame. Provide restricted access to this space. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
7. Stair #2 - 205 s.f.; B212: Provide fire rated exit enclosure. Stair system to be a prefabricated and pre-finished metal stair system with equally spaced risers and treads with two 180 degree intermediate landings per floor. Finishes are as follows: Floor finish to be vinyl composite tile on concrete substrate. Wall finish to be epoxy paint on full height CMU construction. Ceiling finish to be painted gypsum board construction. Entry door to this space to be of painted hollow metal door and frame. Provide ADA compliant signage at each door leading into this space. Provide HVAC.
8. Open Office Space; B213: Recover square footage of open office space as result of Train Control Equipment Room Annex by demolishing existing partition and associated systems along column line 2 at the existing area originally identified as Supervisor of Material Control on the existing conditions - reference set of drawings.

1.05 SHADY GROVE PROGRAM:

A. Basement Floor: not applicable

B. Ground Floor:

1. Coordinate location of equipment, room layouts; system connections and

- through the Authority Representative.
2. Inspection/Repair Area - 41,333 s.f.: Provide fire equipment cabinets as required by code. Provide the installation of two (2) sets of married pair vehicle lifts with car body hoists and motorized turntables positioned for ease of access to adjacent truck repair area, installation of two (2) sets of married pair vehicle lifts with spinning posts, two tracks holding two married pairs each track with posted rail and pitted to a depth of 4' 6" from the top of the posted rail & platforms installed at vehicle floor height to access the interior of the vehicles. The inspection track pits shall be provided with sufficient ventilation, lighting, compressed air outlets, electrical and welding receptacles, to support the equipment and shop functions throughout the Inspection /Repair Area. Truck Repair hoists shall be installed as shown and new trackwork and motorized turntables shall be provided to enable truck movement throughout the area and into the storage area and the loading dock. Additionally, track shall be installed from the truck repair area to a new motorized turntable between column lines 8 and 9. Track shall extend from this new turntable into the existing building to existing Track 6 such that trucks or wheel sets can be moved between the existing and new shop areas. All new track shall align with existing track as required. A 15 ton overhead crane shall be installed to service the truck repair hoist area. A new jib crane shall be provided at the existing truck hoist located at Shop Area 121. Install two (2) new rail car stinger systems, one located between and servicing cars on the two new hoist tracks, and one system located between and servicing cars on the two new posted rail tracks. Provide appropriate equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions. Provide trench drains at exterior in front of all overhead service doors. Provide floor drains throughout Inspection/Repair Areas, hoist pits and access chases. Provide bridge crane over truck repair area. Provide six (6) LAN connections for workstations distributed in separate locations where directed by the Authority Representative.
 3. Office – 900 s.f.: General offices enclosed with concrete masonry unit walls and borrow lites to observe the Inspection/Repair space. Provide lighting, power, phone and data connections to serve cubicle style layouts.
 4. Small Parts Storage - 4,290 s.f.: Secure with wire mesh partition and 6 ft. wide gates. Procure and install a component parts storage system comprising a combination of pallet rack shelving, cantilever rack systems, bin type shelving, secure shelving systems and vertical carousel shelving systems, as defined by WMATA.
 5. Men's Toilet - 210 s.f.: Provide ADA compliant layout, fixtures and toilet accessories in quantity to accommodate the maximum number of men working day shift. Slope tile floors to drain to floor drain(s) in toilet area. Use glazed CMU units at interior side of room.
 6. Women's Toilet - 225 s.f.: Provide ADA compliant layout, fixtures and toilet accessories in quantity to accommodate the maximum number of women working day shift. Slope tile floors to drain to floor drain(s) in toilet area. Use glazed CMU units at interior side of room.
 7. Elevator Equipment Room – 50 s.f.: Room for enclosure of elevator controls and hydraulic pump. Provide vent to exterior.
 8. Boiler Room - 400 s.f.: New room for location of additional boiler equipment and controls. Provide 42" entry door for access and removal of equipment.
 9. Relocated Fan Room - 480 s.f.: New room similar to existing and utilizing existing equipment if possible with new intake chase routed to exterior.

10. Blow Pit (Expansion) - 3,140 s.f.: Extend the existing blow pit facility to the south-east such that the new combined blow pit facility can accommodate two (2) married pairs of cars, one married pair on each track. The expanded blow pit facility shall be designed to be similar in configuration to the existing blow pit area. Provide restricted access to this space. Extend the existing rail car stinger system from the existing blow pit into the new blow pit facility. Provide continuous removable railings along perimeter of pit areas and stairs to pits. Remodel existing space as indicated with lower pit slab, elevated working platforms, access doors and overhead doors to the exterior and replacing existing units at the interior. Provide continuous pit slab and trench drains below tracks from existing to addition. Provide appropriate lighting, equipment venting, electrical service, water supply/drainage, natural gas supply and compressed air supply to support the equipment and shop functions.
11. Storage - 275 s.f.: Space for general storage and Blow Pit equipment.
12. Loading Dock: replace existing Loading Dock with new layout including dock leveler as indicated.
13. Passenger Elevator: Hydraulic 2500 pound minimum, two-stop unit to be ADA compliant.

C. Mezzanine Floor:

1. Women's Lockers: Remodel Women's Lounge within the locker space to expand layout for new locker and bench units. Provide one locker for each employee. Mount lockers to 4 in. high concrete curb. Provide adequate linear bench space to accommodate the maximum number of women working in one shift with number to be verified by the Design/Builder through the Authority Representative.
2. Men's Lockers: Remodel the locker space to expand layout for new locker and bench units. Provide one locker for each employee. Mount lockers to 4 in. high concrete curb. Provide adequate linear bench space to accommodate the maximum number of men working in one shift with number to be verified by the Design-Builder through the Authority Representative.
3. Lunch/Meeting Room – 1300 s.f.: Provide an open room for arrangement of tables and chairs. Walls shall be painted gypsum board assemblies, ceiling to 9'-0" high minimum lay-in acoustical tile type. Provide lighting, power, phone and data connections to serve layout.

1.06 CAR MAINTENANCE EQUIPMENT SYSTEMS:

- A. The DB shall coordinate the procurement of equipment for the shops with WMATA that is responsible for the purchasing of such equipment. The following equipment for each location shall be purchased using the specifications that follow, and as included within the Contract Documents.
- B. Greenbelt:
 1. 8 – Truck Repair Hoist System – single truck with spinning posts. Systems to be installed per preferred vendor installation specifications.
 2. 15 – Turntables – motorized. Turntables to be installed per preferred vendor installation specifications.
 3. 2 – Vertical Parts Washer – Better Engineering - #F-6000LX-P. Equipment to be installed per preferred vendor installation specifications.
 4. 4 – Bridge Cranes – 3 ton. Cranes to be installed per preferred vendor installation specifications.

5. 2 – Bridge Cranes – 5 ton. Cranes to be installed per preferred vendor installation specifications.
6. 3 – Bridge Cranes – 15 ton. Cranes to be installed per preferred vendor installation specifications.
7. 6 – Jib Cranes – 2 ton. Jib Cranes to be installed per preferred vendor installation specifications.
8. 4 – Jib Cranes – 5 ton. Jib Cranes to be installed per preferred vendor installation specifications.
9. 1 – Wheel Press – 600 ton double ended – Simmons # SF-620. Wheel Press to be installed per preferred vendor installation specifications.
10. 1 – Tool Room Mill – Haas 30" - # VMC 30. Equipment to be installed per preferred vendor installation specifications.
11. 2 – Tool Room Lathe – Haas 10" - # TL-2. Equipment to be installed per preferred vendor installation specifications.
12. 1 – Vertical Milling Center – Haas - # VF-4. Equipment to be installed per preferred vendor installation specifications.
13. 1 – Grinder 24" – Cone-Blanchard. Equipment to be installed per preferred vendor installation specifications.
14. 1 – Lathe – CNC – American Turnmaster - # CNL-1740-A. Equipment to be installed per preferred vendor installation specifications.
15. 1 – Pressure Washer – Better Engineering - # T-700P. Equipment to be installed per preferred vendor installation specifications.
16. 1 – Storage Equipment System - Systems to be installed per preferred vendor installation specifications.
17. 1 – Dock Lift System - System to be installed per preferred vendor installation specifications.
18. 1 - Fork Lift – Electric with Battery Charger - Systems to be installed per preferred vendor installation specifications.
19. 1 – Shop Work Station - Systems to be installed per preferred vendor installation specifications.
20. 1 – Car Component Repair and Test Equipment System - Systems to be installed per preferred vendor installation specifications.

C. Brentwood:

1. 6 – Car Hoist Systems - Married Pairs with Spinning Posts Systems to be installed per preferred vendor installation specifications.
2. 2 – Turntables – motorized turntables to be installed per preferred vendor installation specifications.
3. 1 – Wheel Truing Machine (WTM) – Underfloor – Hegenscheidt # U-2000 machine will be provided by the Owner and installed by the manufacturer. The Design-BUILDER is required to provide equipment and manpower as required to assist the manufacturer with the installation of the Wheel-Truing Machine at Brentwood Shop. The Owner will provide a design of the foundation plan to the Design Builder showing the arrangement of the machine and the equipment, all interfaces, i.e. dimensions and position of the lathe pit, main supplies, and rail track connection. The structural drawings for the construction of the foundation are the responsibility of the Design Builder.
Considerations need to be established for clearances with existing track, vehicles and walkways.
4. 1 – Fork Lift – Electric with Battery Charger - Systems to be installed per preferred vendor installation specifications.
5. 2 – Dock Lift System - Systems to be installed per preferred vendor

installation specifications.

6. 1 – Storage Equipment System - Systems to be installed per preferred vendor installation specifications.
7. 1 – Cleaning Equipment System – For additional bays - Systems to be installed per preferred vendor installation specifications.
8. 1 – Steam Pressure Washer System – For additional bays - Systems to be installed per preferred vendor installation specifications.
9. 4 – Prefabricated Storage Building Systems - Systems to be installed per preferred vendor installation specifications.
10. 2 – Material Lift Systems - Systems to be installed per preferred vendor installation specifications.
11. 1 – Shop Work Station - Systems to be installed per preferred vendor installation specifications.
12. 1 – Car Component Repair and Test Equipment System - Systems to be installed per preferred vendor installation specifications.
13. 1 – Jacking Carriage System - Systems to be installed per preferred vendor installation specifications.

D. Shady Grove:

1. 2 – Car Hoist Systems - Married Pairs with car body posts. Systems to be installed per preferred vendor installation specifications
2. 2 – Car Hoist Systems - Married Pairs with spinning posts. Systems to be installed per preferred vendor installation specifications.
3. 9 – Turntables – motorized. Turntables to be installed per preferred vendor installation specifications.
4. 1 – Jib crane – 5 ton. Jib Crane to be installed per preferred vendor installation specifications.
5. 2 – Truck Repair Hoist Systems – Single truck with spinning posts. Systems to be installed per preferred vendor installation specifications.
6. 1 – Steam Cleaner Pressure Washer System – For expanded Blow Pit. Systems to be installed per preferred vendor installation specifications.
7. 1 – Storage Equipment System - Systems to be installed per preferred vendor installation specifications.
8. 1 – Bridge Crane – 3 ton - Systems to be installed per preferred vendor installation specifications.
9. 1 – Fork Lift – Electric with Battery Charger - Systems to be installed per preferred vendor installation specifications.
10. 1 – Dock Lift System - Systems to be installed per preferred vendor installation specifications.
11. 1 – Shop Work Station - Systems to be installed per preferred vendor installation specifications.
12. 1 – Car Component Repair and Test Equipment System - Systems to be installed per preferred vendor installation specifications.
13. 1 – Jacking Carriage System - Systems to be installed per preferred vendor installation specifications.

1.07 ARCHITECTURAL SYSTEMS:

- A. Design-Builder to coordinate specifications for architectural systems with the WMATA Standard Specifications, the Authority Representative, codes and regulations of the jurisdictional authorities, and with the following criteria:

1. 03450 - Architectural Precast Concrete: Precast concrete panels shall match appearance of the existing building. The details for matching the existing

- appearance will be developed during the design phase of the Design-Build contract.
2. 04215 - Brick Masonry: Face brick system to match appearance of the existing building. The details for matching the existing appearance will be developed during the design phase of the Design-Build contract.
 3. 04222 - Concrete Unit Masonry: Provide CMU partitions typically at interior walls, exterior cavity walls, and column surrounds where indicated. Provide units in size and rating as required.
 4. 05500 - Miscellaneous Metal: Provide 6 in. dia. steel bollards both sides of overhead coiling doors on interior and exterior side of door. Provide bollards at gas meters and one bollard on each side of shop floor control stations parallel to track. Provide 48 in high, steel corner guards on all corners of CMU partitions and column covers.. Provide stair nosings at all concrete stair threads. Provide ladder to roof hatch.
 5. 05521 - Handrails and Railings: Provide painted steel handrails and railings with at stairs. Provide painted steel removable safety railings without insert panels along edge of platforms, Inspection Pits and Equipment Lifts; refer to WMATA Design Directive Drawings for details.
 6. 05531 - Gratings and Floor Plates: Provide galvanized steel grating at air wells and non-skid, non corrosive steel plates at shop floor. Provide access floor hatches were required for shop equipment.
 7. 05810 - Expansion Joint Cover Assemblies: At exposed concrete floors, provide flat recessed abrasive cover plate. At finished floors, provide recessed plate to receive full thickness of flooring material.
 8. 05811 - Expansion Joint Systems: At precast concrete and CMU walls, provide extruded preformed seals in color selected by the Authority Representative.
 9. 06100 - Rough Carpentry: Provide wood framing, furring, nailers, and blocking as required.
 10. 06402 - Interior Architectural Woodwork: Interior Architectural Woodwork: High-pressure decorative laminate counter tops and cabinets, coordinate pattern and color with the Authority representative. Provide satin finish, stainless steel hardware.
 11. 07125 - Waterproof Membrane: At basement foundation walls, equipment pits, and pit access chases install membrane waterproofing system with insulating protection board. Also provide inspection report as well as patching of existing waterproofing system in the existing building Basement. Membrane waterproofing system shall come with the manufacturer's standard warranty to keep basement dry and free from water infiltration for a twenty (20) year period.
 12. 07210 - Building Insulation: Provide tapered insulation board if roof decking is flat; slope 1/4" per foot. Provide rigid insulation in total thickness to provide R-30 rating. Install loose-fill insulation or block fitted rigid insulation into CMU walls between conditioned spaces and unconditioned spaces. Provide 1" rigid board insulation with proper air space at masonry cavity walls.
 13. 07415 - Metal Wall Panels: Metal wall panels finished to match existing building panels requirements. The details for matching existing panels will be developed during the design phase of the Design-Build contract.
 14. 07535 - EPDM Roofing: Provide watershed and overflow designs and drains to eliminate ponding and standing water on roof surfaces. Provide specifications and installation of EPDM roofing system which shall come with the manufacturer's standard fifteen (15) year warranty.
 15. 07730 - Roof Accessories: Provide roof access hatch and smoke/heat vents

- as shown or as required; high-performance organic coated aluminum finish.
16. 07900 - Seals and Sealants: Color of sealant to match color of the adjacent curtain wall, window or doorframe.
 17. 08110 - Hollow Metal Doors and Frames: Provide galvanized steel doors and frames on exterior and interior as indicated. Provide insulated exterior doors. Provide vision lites as directed by Authority's Representative.
 18. 08305 - Access Doors and Frames: Wall, ceiling, and floor units as required.
 19. 08331 - Overhead Coiling Doors: Insulated service doors, galvanized steel panels with baked-on enamel finish. Coordinate color with the Authority's Representative. Provide automatic door operation.
 20. 08360 - Upward-Acting Sectional Doors: Provide specifications and installation of insulated service doors, manufacturer's standard glass lites, galvanized steel panels with baked-on enamel finish. Coordinate color with the Authority's Representative. Provide automatic door operation.
 21. 08710 - Finish Hardware: Coordinate door hardware and finish requirements with the Standard Specifications and the Authority Representative.
 22. 08630 - Metal Framed Skylights: Provide aluminum-framed insulated skylights with extruded cellular UV polycarbonate panels where indicated on the drawings.
 23. 08800 - Glass and Glazing: Insulated glass at exterior vision lites and safety glass at interior vision lites; non-tinted. Insulated glass at exterior curtain wall and storefront systems; blue-green tint. Provide opaque glass at spandrel with blue-green tint.
 24. 09255 - Drywall Systems: Interior gypsum board partition, ceiling and framing systems as required.
 25. 09265 - Gypsum Board Shaft wall Assemblies: Vertical shaft and horizontal duct enclosures including metal framing.
 26. 09320 - Tile: Provide specification section and installation of ceramic mosaic wall and floor tile, marble thresholds and miscellaneous trim. Apply tile system at the following areas; Men's Toilet and Shower Rooms, Women's Toilet and Shower Rooms, Men's Locker Room, and Women's Locker Room.
 27. 09511 - Acoustical Panel Ceilings: Mineral base and glass fiber base tile with exposed suspension system as required.
 28. 09650 - Resilient Flooring: Vinyl composition floor tile and base system.
 29. 09680 - Carpet: Tufted and woven commercial carpet and carpet cushion.
 30. 09920 - Field Painting: Paint all CMU surfaces exposed to view, paint interior face of precast concrete panels exposed to view, paint all structural steel and miscellaneous steel exposed to view. Do not paint galvanized steel surfaces, exposed or unexposed unless noted otherwise. Prepare existing surfaces to receive paint finish in remodeled areas as required.
 31. 09971 - Epoxy Mastic Flooring: Provide specification section and installation of epoxy mastic flooring. Floor finish shall be two (2) coats of Gulf Coast Paint PC-636 Low Temperature Curing Epoxy Mastic or approved equal applied to shot blasted concrete slab. Install mastic flooring per the manufacturer's written instruction. Coordinate color selection for the manufacturer's standard colors with the Authority Representative. Apply flooring at the following areas; Inspection/Repair Area, Blow Pits, and hoist pits.
 32. 10155 - Toilet Partitions, Compartments and Screens: Floor-and-ceiling-anchored compartments in stainless steel sheets. Stainless steel anchors, brackets, and hardware. Tile shower compartments with vinyl curtains, stainless steel rods, hooks, grab bars. Provide fold-up shower seat at ADA compliant stalls.

33. 10200 - Metal Louvers: Fixed and adjustable louvers and wall vents as required.
34. 10265 - Impact Resistant Wall Protection: Protection for walls, corners, and door edges.
35. 10505 - Metal Lockers: 12 in. wide x 18 in. deep metal lockers. Provide benches in front of all rows of lockers.
36. 10520 - Fire Protection Specialties: Portable fire extinguishers and fire protection cabinets as required.
37. 10605 - Wire Mesh Partitions: - Manufacturer's standard shop-applied enamel finish with swing and sliding gates/man doors as indicated.
38. 10810 - Toilet Accessories: Provide toilet accessories as scheduled in the standard specifications. Coordinate location and quantity of toilet accessories with the required quantity and type of plumbing fixtures. Coordinate with the example drawings and with the Authority Representative.
39. 11160 - Loading Dock Equipment: Dock bumpers at all elevated docks and dock levelers as indicated.
40. 14200 - Passenger Elevators: Provide ADA compliant hydraulic passenger elevator as described in the preceding Program descriptions.
41. 14215 - Freight Elevators: Provide ADA compliant hydraulic freight elevator as described in the preceding Program descriptions.

END OF SECTION

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PROGRAM CRITERIA

CIVIL

1.01 GENERAL

This section establishes:

- A. The basic design criteria for trackwork and clearances for the Washington Metropolitan Area Transit Authority Metro Rail System.
- B. The basic design criteria for water, sewer, storm drainage, stormwater management, site roadways, and sediment control.

2.01 SURVEY CONTROL

A. HORIZONTAL CONTROL

- 1. It shall be the responsibility of WMATA ENGA to direct the appropriate base control for use in establishing all future WMATA control points to be used for design or construction purposes.
- 2. In general, all new horizontal control points established will be related to the new North American Datum of 1983, as defined by the National Geodetic Survey. Where applicable and or required, local jurisdiction coordinate systems shall prevail. Global Positioning System, GPS, based control may be implemented where applicable. All finalized control must be approved and sealed by a registered land surveyor registered in the appropriate jurisdiction.
- 3. Project survey control points were established from USC&GS. Triangulation Stations. In April, 1974, the National Geodetic Survey (formerly USC&GS.) announced that all triangulation stations in the United States, except Washington, D.C., were readjusted. Since there are significant changes in the final values, a note shall be affixed to the final design plans stating, "The Grid Coordinates and Horizontal Control Values are based on USC&GS. 1971 Field Geographic Positions and Coordinate Values." This provision applies to design plans not using GPS based coordinates.
- 4. The horizontal control for all alignments shall be based on survey control points established under the direction of the WMATA as follows:
- 5. District of Columbia and Maryland Coordinates for control points in the District of Columbia and Maryland that are generally based on the Maryland State Plane Coordinate System, adjusted for scale and elevation to project grid, herein referred to as Project Coordinates.
- 6. To convert project coordinates to Maryland state plane coordinates, multiply the project coordinates by 0.9999430.
- 7. For map showing designation of various coordinate systems by Metro Route see Figure III.1.

B. VERTICAL CONTROL

- 1. All bench marks established shall contain a minimum of one deep bench per half mile of vertical control to be used for construction. The relationship between USC&GS datum and the various datum planes common to the Washington Metropolitan area are as shown on Figure III.4.
- 2. District of Columbia - The vertical control for the District of Columbia is related to the U.S. Coast and Geodetic Survey Mean Sea Level Datum, 1929 General Adjustment. Refer to Figure III.4 for the relationship between District of Columbia and WMATA vertical datums. Coordination shall be made with the D.C. Surveyor's Office.
- 3. Maryland - Bench marks for the lines in Maryland will be based upon the U.S. Coast and Geodetic Survey Mean Sea Level Datum, 1929 General Adjustment.

C. HORIZONTAL AND VERTICAL CONTROL ADJUSTMENTS

1. All new control shall conform to the most current version of Standards and Specifications for Geodetic Control Networks published by the Federal Geodetic Control Committee.
2. Horizontal closures for control traverses shall have a relative accuracy ratio of not less than 1:100,000 (distance accuracy standard) if using GPS.
3. Secondary control traverses used to establish centerline geometry shall have a relative accuracy ratio of not less than 1:50,000.
4. When connecting new GPS based control to the existing control, some modifications may be made to the requirements with consent of WMATA and other governing authorities involved with the project.
5. Computations for all control (horizontal and vertical) shall be prepared under the direction of a professional land surveyor registered in the appropriate jurisdiction and sealed prior to submission to WMATA. Computations will show results in both the U.S. survey foot and in the metric system, for incorporation into the existing WMATA system, and to meet the new requirements of WMATA and other agencies.

3.01 CURVATURE

Circular curves shall be defined by the arc definition of curvature and specified by the radii. Refer to Figure III.5 for circular curve functions and abbreviations.

4.01 TRACKWORK

Metro track materials and special trackwork shall comply with the Design Drawings, Design Criteria and Standard Drawings of WMATA which are based on the current American Railway Engineering and Maintenance-of-Way Association (AREMA) "Manual for Railway Engineering" and "Portfolio of Trackwork Plans".

Railroad trackwork shall comply with current plans and specifications.

A. GAUGE

Metro track gauge shall comply with the criteria in Table 3.1:

TABLE 3.1

HORIZONTAL TRACK ALIGNMENT	Track Gauge
Tangent Track & Curve of Radius $\geq 350'$	4'-8 1/2"
Curve of Radius $<350'$ with restraining rail	4'-9 1/4"

These gauges apply only with standard AAR wheel Gages of 4'-7 11/16" and vehicle axle spacing of 7'-0" and 8'-6" inclusive.

For every 1/4" change in track gauge, the transition in gauge shall be made in a length of track not less than 31" nor more than 62".

B. CONSTRUCTIBILITY AND MAINTAINABILITY OF TRACKWORK

All trackwork design shall be performed with the objective of obtaining an optimum degree of constructibility and maintainability. Alternative analyses of major cost items of trackwork shall be made using life cycle and other analytic procedures which address the following principles

1. Selection of materials, configurations, and tolerances (manufacturing and construction) shall be based on lowest life cycle cost which meets the level of quality established by Metro standards, good engineering practice, and the level of service intended, with consideration of constructibility and maintainability. Key components

shall be standardized to provide interchangeability and reduce maintenance stockpiles.

2. Constructibility shall be considered from initial design development to final detailing. Packaging and scheduling of trackwork procurement and installation contracts shall seek to minimize brokering, periods of inactivity, excessive storage time, re-handling of materials, and interference with other disciplines. Installation contracts shall be staged to maximize trackbed availability, access, and continuity of work. Special consideration should be given to handling of continuous welded rail. Other disciplines should be provided with convenient, adequate staging and storage sites. Selection of materials and configuration of materials should give consideration to the site conditions, and other discipline's skill levels and plant capacity for their affect on the ease of handling and installing materials and the tolerances to be met.
3. Maintainability encompasses the selection of materials and configurations that result in highly durable, easily accessible and easily repaired or replaced components and systems. Durability is achieved by materials which resist wear, fatigue and deterioration due to environmental conditions. Accessibility is achieved by configuring materials, particularly fasteners, and clearances to permit inspection, adjustment, repair and replacement with minimum disturbance to other components. Maximum accessibility should be provided to these components requiring most frequent maintenance. Repairability is achieved by providing materials and configurations which require minimum quality control effort in the field to inspect, adjust, repair or replace, by avoiding complex sequences of steps to mix, place, cure, tighten, finish, or adjust and which require minimum tolerance to be acceptable.
4. Where a conflict between constructibility and maintainability occurs, preference shall be given to maintainability. Within maintainability, preference shall be given to durability over accessibility and repair ability.

C. TURNOUTS

Refer to Figures III-18 and III-19 for the clearance point and signal location beyond the heel of the frog.

D. CLEARANCES

Clearances between obstructions and the rail car are determined from the dynamic outline. See Figure III-29 for the design vehicle dynamic outline.

The clearance envelope is shown on Design Drawing DD-C-1 "WMATA Rapid Transit Car Clearance Envelope." The clearance envelope is developed from the rail car dynamic outline, and is a composite of the WMATA Design Vehicle, the Rohr Car and the Breda Car. Each of the extreme dimensions of each car have been taken into account in the development of the Clearance Envelope.

The Clearance Envelope is equal to the Dynamic Outline plus 2" (inches). The design of structures and surface sections must accommodate the dynamic outline of the rail car for safe operations.

1. Clearance Definitions:

DW Dynamic Width - Maximum horizontal width of dynamic outline, exclusive of M.O. and E.O. and equal to $DW_A + DW_T$

DW_A Dynamic Width Away - Maximum horizontal distance from the centerline of track to the dynamic outline, exclusive of M.O., on the side of the rail car away from the curve center.

DW_T Dynamic Width Toward - Maximum horizontal distance from the centerline

of track to the dynamic outline, exclusive of M.O., on the side of the rail car toward the curve center.

- M.O.** Mid Ordinate - Distance from the centerline of a curved track to the centerline of the rail car at a point midway between the trucks.
- E.O.** End Overhang - Distance from the centerline of a curved track to centerline of car at each end of the car measured normal to the centerline of the track.
- A_C** Allowance Corded Construction - Measured horizontally.
- C.T.** Construction Tolerance Allowance.
- SW** Safety Walk
- X_A** Structure Centerline Offset - Away from Curve Center
- X_T** Structure Centerline Offset - Toward the Curve Center

Offset is measured from centerline of track.

P.G. Profile Grade Elevation at top of low rail.

Structure Size Factors used in sizing the structure, but not included in the clearance envelope are allowances for chorded construction, construction tolerances and clearances to walls specified by type of cross-section.

2. **Construction Tolerance**
All walls and roof slabs shall have a horizontal and vertical construction tolerance allowance of 1". Fences, piers, columns, light standards and miscellaneous structures shall have a horizontal construction tolerance of $\pm 1"$.
3. **Middle Ordinate Displacement**
Is the horizontal displacement of the center of the side of the design vehicle toward the center of the curve, as it transits a curve of a specific radius. The Middle Ordinate can be calculated for any radius from the formula $M.O. = R - (R^2 - 676)^n$ where R = radius in feet and $n = \frac{1}{2}$. For design purposes, the end overhang and middle ordinate of the vehicle are considered equal. The formula is based on a 75'-0" long vehicle with 52'-0" truck centers. Rounding at car corners has not been considered. The centerline radius of the curve should be reduced by half of the width of the car plus the dynamic outline.
4. **Clearance Envelope below Top of Rail**
Refer to Figure III-28 to determine the clearance envelope for structures below the top of rail in ballasted track.
5. **Minimum Clearances from the Dynamic Outline**
Fixed surfaces and installations shall be located so as to provide the following minimum clearances:

Table 3.4
Minimum Clearances from the Dynamic Outline

Description of Location	Clearance Distance
Between the face of wall and the dynamic outline	6"
Between the roof surface and the dynamic outline	4"
Between any fixed installation (e.g., pipes, pipe hangers, pipe supports, signals, lighting fixtures, air conditioning units, etc.) and the design vehicle dynamic outline.	2"

Minimum Clearances from the Dynamic Outline

Description of Location	Clearance Distance
Between light standards and the design vehicle dynamic outline.	4"
Between existing adjacent intermittent columns and existing point restrictions, and the dynamic outline	6"
Between new adjacent intermittent columns and new point restrictions, and the dynamic outline	2'-0"
Between top of low rail to the under-clearance point of overhead structure.	13'-0"
Between track centers.	14'-0"
Between top of rail and bottom of new bridges spanning the right-of-way	15'-0"

Note: Wherever possible, installations shall be dimensioned and located so that maximum distances are obtained between these and the dynamic outline along tangent and curved alignments.

6. Turnout Clearances

The horizontal offsets from centerline of track to the design vehicle dynamic outline as shown on Figures III.63 and III.64 have been determined graphically from a plan drawn at a scale of 1" = 1'-0". In developing these offsets it has been assumed that the design vehicle is on a tangent track as it approaches the turnout and as it leaves the turnout. It is also assumed that the vehicle is operating on track that is not superelevated. If the turnout is from a curved track, the values shown on Figures III.63 and III.64 must be adjusted to compensate for additional clearance required for curvature.

7. Clearances Diagrams

The clearance requirements for surface track sections are indicated in Figure III.54.

8. Design Tables

The tabulated values for the horizontal dimensions A, T, A_s, and T_s, measured from centerline of track to inside face of wall, are shown in Figures III-56 and III-61. Linear interpolation is to be used for values of radii and superelevation intermediate to those shown in the tables.

The increase of A, T, A_s, and T_s, from a tangent condition to a curved condition shall be applied and removed linearly over 100 feet, beginning at a point on the tangent 125 feet prior to the P.C. Full width required on the circular curve shall be reached at a point on the tangent 25 feet before the S.C. and maintained 25 feet after the C.S.

5.01 ADDITIONAL TRACKWORK - Ties, Derails, Bumping Posts

A. TIE SPACING

Wood ties will be used in ballasted track. Wood ties shall be spaced 30 inches center-to-center in yard track. Yard tracks with radii less than 350 feet shall use 24 inch tie spacing. Only wood ties shall be used in ballasted special trackwork units and they shall be spaced in accordance with the trackwork Standard Drawings. Except in special trackwork units, every fourth tie shall be a contact rail tie.

B. DIRECT FIXATION RAIL FASTENER SPACING

Concrete trackbed reinforcing steel shall be designed to provide the anchorage clearance envelopes shown on the Design Drawings and in such manner as to permit the following direct fixation rail fastener spacing of 33 inches in yard track

C. BUMPING POSTS

A bumping post shall be installed at the end of each stub end track. The minimum distance between the face of bumping post when uncompressed and the end of track shall be 14'-6".

D. APPROACH SLABS

An approach slab shall be provided at all transitions between direct fixation and ballasted track construction.

6.01 BASIC DESIGN CRITERIA

A. GREENBELT AND SHADY GROVE YARD

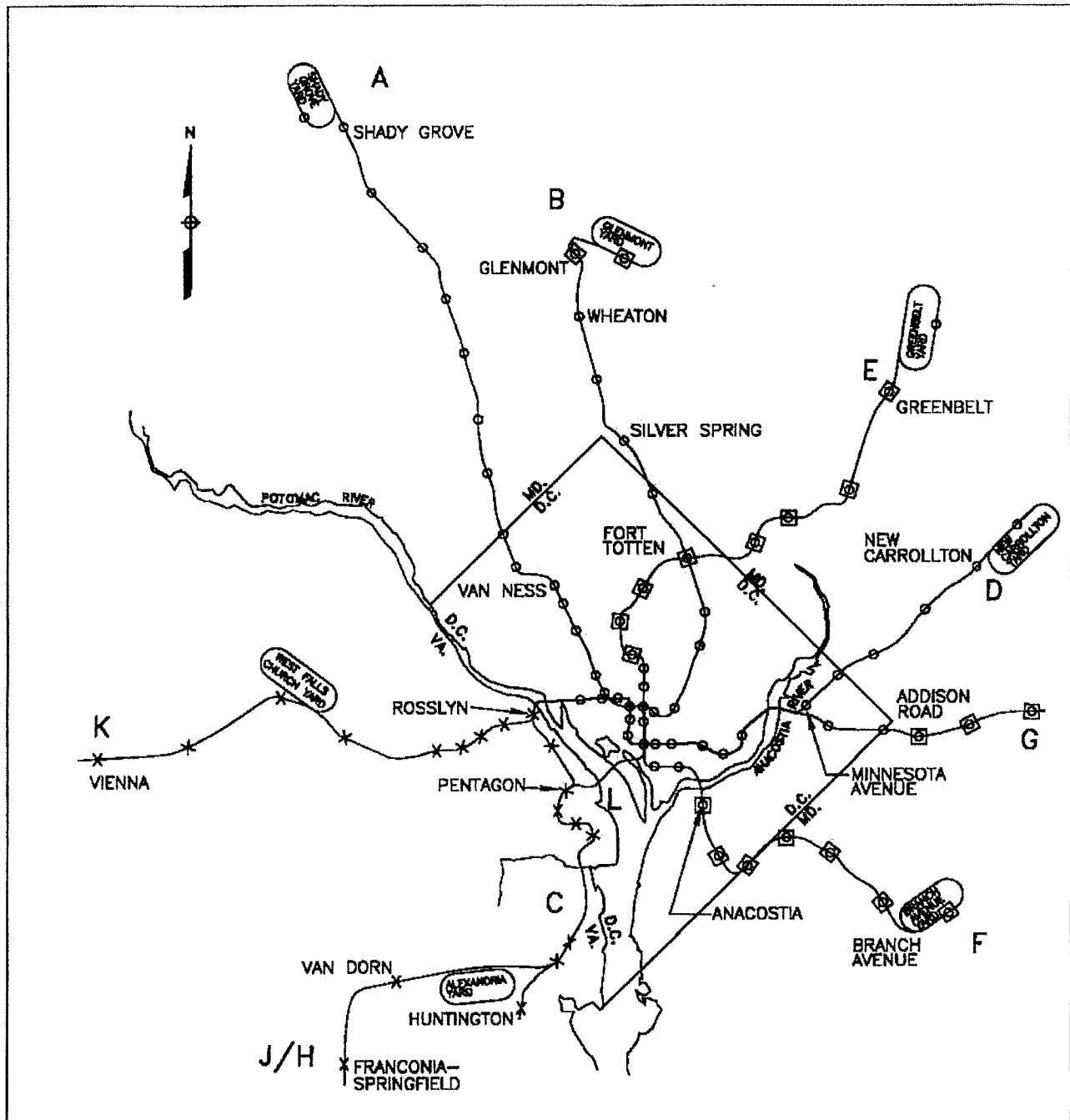
1. Water and Sanitary Sewer Systems - All water and sanitary sewer systems, including both WSSC and WMATA on-site systems, shall be designed, approved and constructed in accordance with all requirements of the Washington Suburban Sanitary Commission (WSSC).
2. Stormwater Management, Storm Drainage, and Sediment and Erosion Control - All stormwater management, storm drainage, and sediment and erosion control shall be designed, approved and constructed in accordance with the requirements of the Maryland Department of the Environment (MDE), using jurisdictional Low Impact Development requirements.

B. BRENTWOOD YARD

1. Water, Storm Drainage and Sanitary Sewer Systems - All water, storm drainage and sanitary sewer systems, including both DC WASA and WMATA on-site systems, shall be designed, approved and constructed in accordance with all requirements of the *District of Columbia Water And Sewer Authority (DC WASA)*.
2. Stormwater Management and Sediment and Erosion Control - All stormwater management and sediment and erosion control shall be designed, approved and constructed in accordance with the requirements of the *District of Columbia, Department of Health, Environmental Health Administration, Bureau of Environmental Quality, Watershed Protection Division*.

C. ON-SITE ROADS PARKING LOTS AND OTHER AREAS FOR ALL YARDS

1. All on-site roadways and parking lots and other related items shall be designed, approved and constructed to allow accesses to building facilities, designated loading docks and parking lots as shown on plans and in accordance with the requirements of the jurisdictional agencies, except bituminous paving and materials which shall be in accordance with the standards of the Maryland State Highway Administration.
2. Proposed parking lots at Shady Grove Yard and Greenbelt Yard shall be designed, approved and constructed with new curb and gutter, sidewalk and sidewalk ramps and landscaped island as shown on plans and as specified. Proposed parking spaces at Brentwood Yard shall be created by removing debris and cleaning the designated areas completely, and by striping parking spaces as shown on plans. Adequate accessible parking spaces shall be provided at all yard facilities as per the ADA requirements. All sidewalk ramps shall be designed, approved and constructed per ADA requirements.
3. Proposed Storage and Laydown Area and access road connection near the loop track at Shady Grove Yard shall be constructed with gravel on a well compacted subballast roadbed material.
4. All truck routes or designated areas near loading facilities shall be designed, approved, and constructed with concrete pavement.
5. Timber shall be used for all grade crossings.



- PORTION OF ROUTES UNDER PROJECT COORDINATE SYSTEM.
- *— PORTION OF ROUTES UNDER VIRGINIA STATE PLANE COORDINATE SYSTEM.
- GPS BASED CONTROL

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF
TRANSIT SYSTEM DEVELOPMENT
OFFICE OF
ENGINEERING & ARCHITECTURE

**DESIGNATION OF COORDINATE
SYSTEMS**

FIGURE III.1

DATUM PLANES – WASHINGTON METROPOLITAN AREA

ELEVATION RELATIVE TO
PROJECT DATUM (FEET)

DATUM

ABOVE PROJECT DATUM	0.94 WASHINGTON AQUEDUCT AND FILTRATION PLANTS (W.A.D.) 0.70 DISTRICT OF COLUMBIA ENGINEERING DEPARTMENT Potomac Electric Power Company Washington Gas Company C. & P. Telephone Company D. C. Engineering Departments 0.57 PENNSYLVANIA RAILROAD
— 0.00 —	PROJECT DATUM = SEA LEVEL DATUM (NGVD 1929 GENERAL ADJUSTMENT) U.S. Coast & Geodetic Survey U.S. Geological Survey Naval Research Laboratory (Bellevue) R. F. & P. Railroad B. & O. Railroad (Alexandria Branch) Arlington County
BELOW PROJECT DATUM	0.15 SEA LEVEL DATUM (1912 GENERAL ADJUSTMENT) * Washington Suburban Sanitary Commission * Montgomery County 1.41 LOW WATER DATUM – WASHINGTON HARBOR (L.W.D.) Baltimore District, Corps of Engineers (Except Washington Aqueduct) National Park Service Public Roads Administration Washington National Airport 1.63 BOLLING AIR FORCE BASE 4.50 NAVAL GUN FACTORY 4.70 ANACOSTIA NAVAL AIR STATION

* Note: The Washington Suburban Sanitary Commission and Montgomery County also use sea level datum (1929 general adjustment) in some areas.

EXAMPLE:

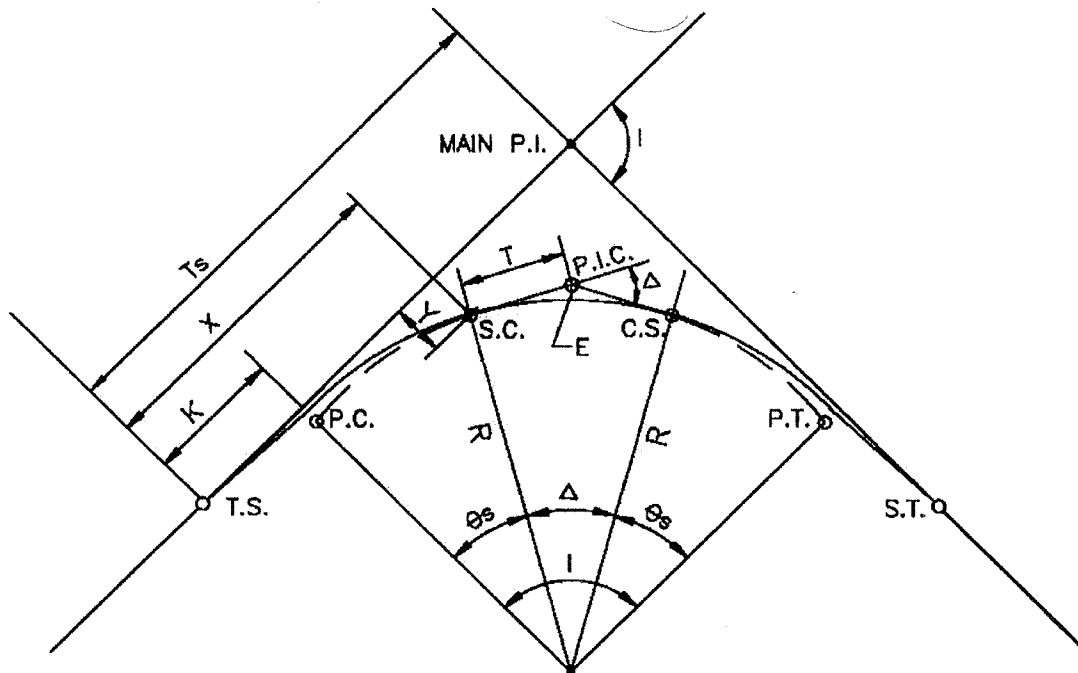
CAPITOL BENCH MARK – APEX OF BRONZE BOLT SET IN EAST WINDOW SILL OF THE SOUTH SIDE OF THE SENATE WING OF THE U.S. CAPITOL. IT WAS PLACED IN POSITION IN JUNE 1894 AND IS INSCRIBED "CAPITOL B.M."

DISTRICT OF COLUMBIA ENGINEERING DEPARTMENT	89.840
PENNSYLVANIA RAILROAD	89.970
PROJECT DATUM = SEA LEVEL DATUM (1929 GEN. ADJ.)	90.540

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

**DEPARTMENT OF
TRANSIT SYSTEM DEVELOPMENT
OFFICE OF
ENGINEERING & ARCHITECTURE**

**DATUM PLANES
WASHINGTON METROPOLITAN AREA
FIGURE III.4**



- I = TOTAL INTERSECTION ANGLE
- $\theta_s = \text{SPIRAL ANGLE} = \frac{LsDc}{200}$
- $\Delta = \text{CENTRAL ANGLE OF CIRCULAR CURVE} = I - 2 \theta_s$
- R = RADIUS OF CIRCULAR CURVE
- T = TANGENT LENGTH OF CIRCULAR CURVE = $R \tan \Delta/2$
- L = LENGTH OF CIRCULAR CURVE = $\frac{\Delta \pi R}{180}$
- E = EXTERNAL DISTANCE = $R \text{ EXSEC } \Delta/2$
- $T_s = \text{TANGENT LENGTH FROM T.S. TO MAIN P.I.} = (R+P) \tan I/2 + K$
- P.C. = POINT OF CURVATURE
- P.T. = POINT OF TANGENCY
- T.S. = TANGENT TO SPIRAL
- S.C. = SPIRAL TO CURVE
- C.S. = CURVE TO SPIRAL
- S.T. = SPIRAL TO TANGENT
- P.I. = POINT OF INTERSECTION

NOTE:

SEE FIG. III.6 FOR SPIRAL CURVE FUNCTIONS & ABBREVIATIONS.

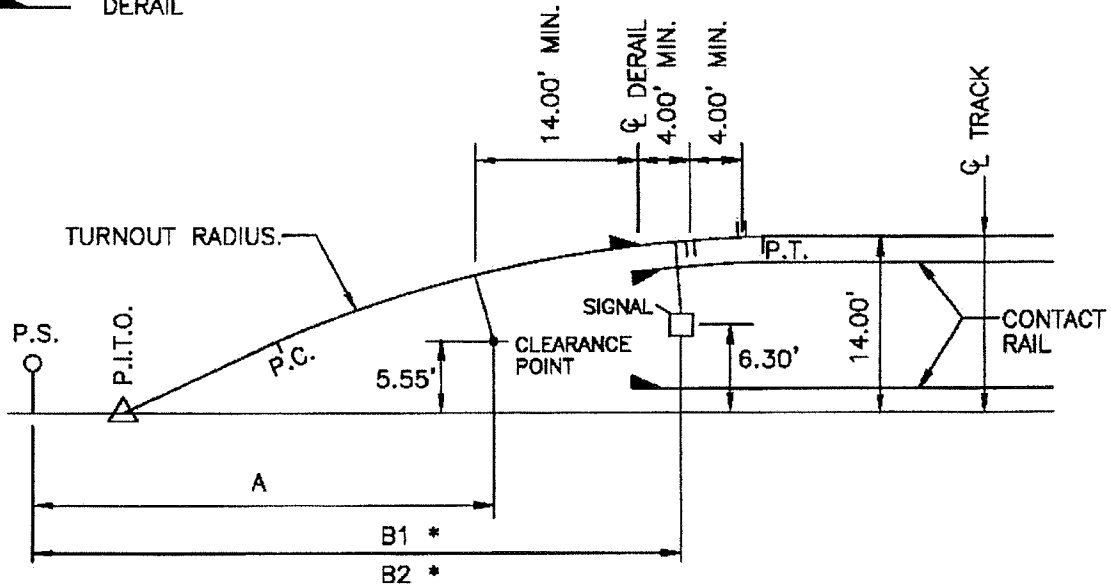
WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF
TRANSIT SYSTEM DEVELOPMENT
OFFICE OF
ENGINEERING & ARCHITECTURE

CIRCULAR CURVES
FUNCTIONS & ABBREVIATIONS
FIGURE III.5

LEGEND:

-  INSULATED JOINT
-  DERAIL



SIGNAL IS LOCATED WITH MINIMUM CLEARANCE AND A 1 FOOT WIDE SIGNAL HEAD.

T.O. NO.	A	B1 (Min.)	B2 (Min.)
6	102'	111'	111'
8	137'	150'	150'
10	158'	175'	175'
15	221'	247'	250'

* IF EITHER CONTACT RAIL IS TO THE INSIDE (AS SHOWN) THEN B2 APPLIES.

NOTE:

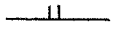

IF DERAIL IS NOT REQUIRED, THE INSULATED JOINT NEAREST THE P.S. SHALL BE LOCATED NOT LESS THAN 14.00' BEHIND THE CLEARANCE POINT. THE SECOND INSULATED JOINT, IF REQUIRED, SHALL BE LOCATED IN THE OPPOSITE RAIL 4.00' BEHIND THE FIRST INSULATED JOINT.

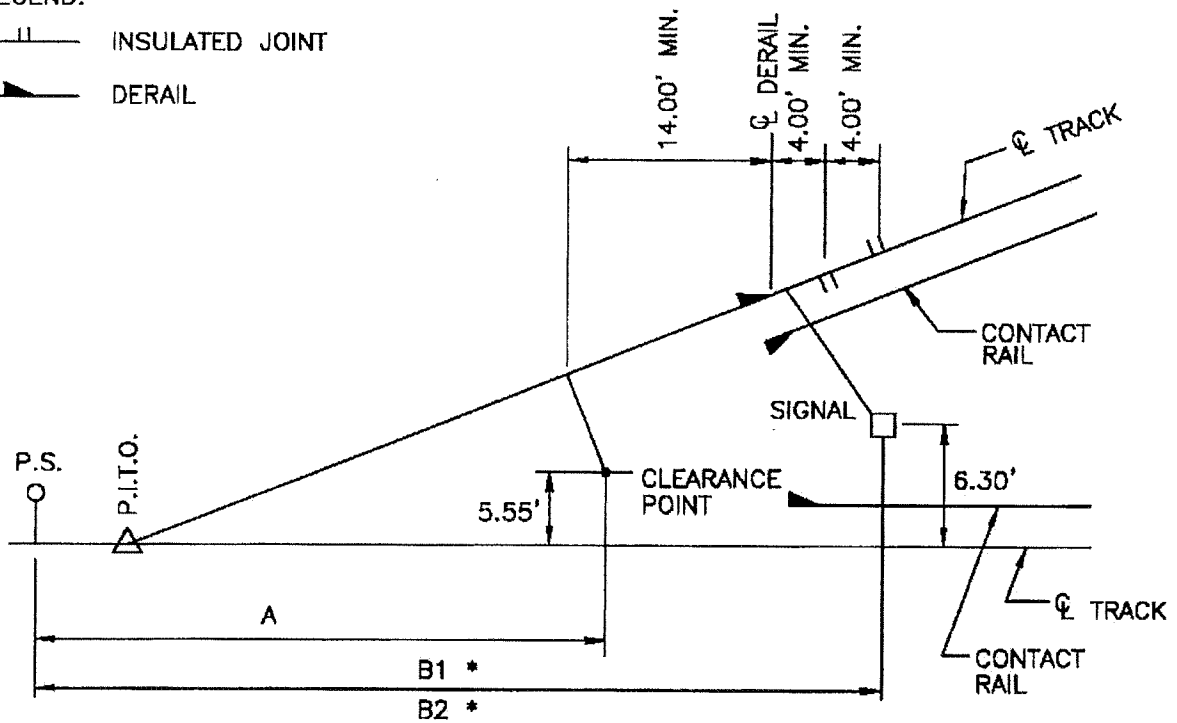
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CLEARANCE FOR TURNOUTS
TO PARALLEL SIDINGS ON
14 FOOT TRACK CENTERS
FIGURE III.18

LEGEND:

-  INSULATED JOINT
-  DERAIL



SIGNAL IS LOCATED WITH MINIMUM CLEARANCE AND A 1 FOOT WIDE SIGNAL HEAD.

T.O. NO.	A	B1 (Min.)	B2 (Min.)
6	85'	94'	110'
8	118'	130'	140' YARD 150' M/L
10	141'	155'	175'
15	204'	224'	250'

* IF EITHER CONTACT RAIL IS TO THE INSIDE (AS SHOWN) THEN B2 APPLIES.

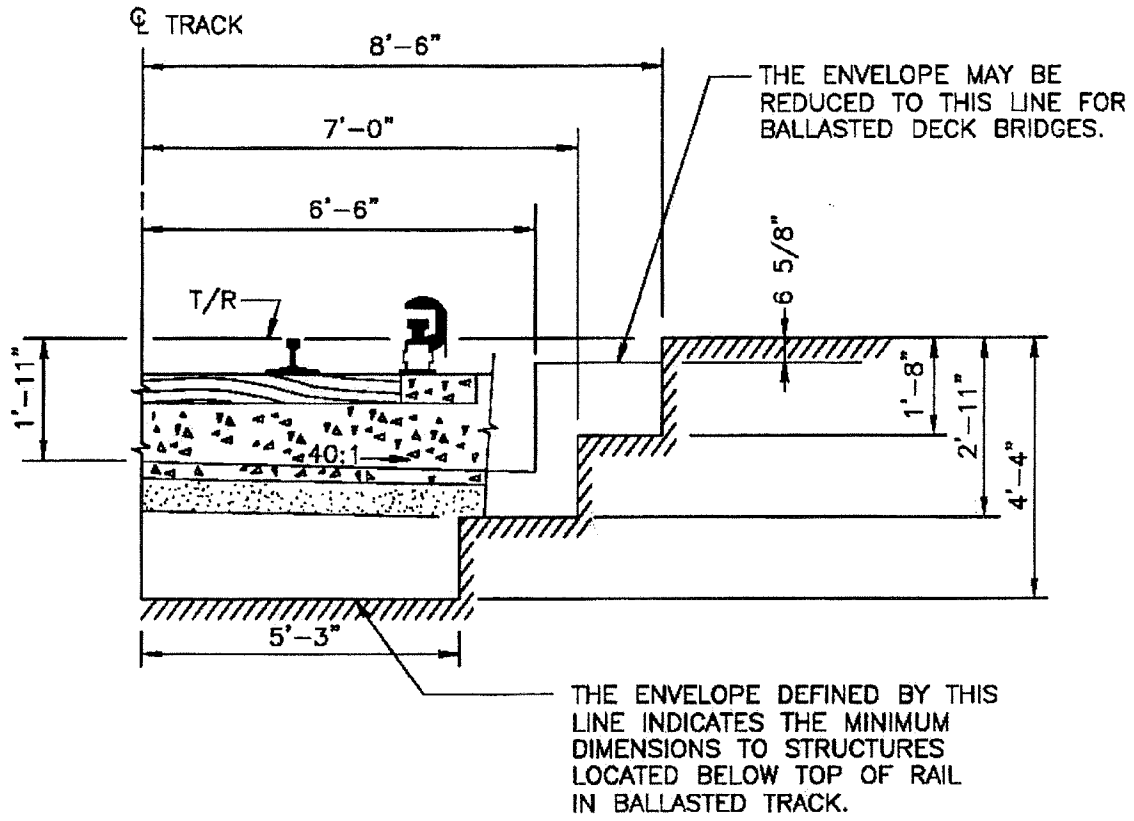
NOTE:

IF DERAIL IS NOT REQUIRED, THE INSULATED JOINT NEAREST THE P.S. SHALL BE LOCATED NOT LESS THAN 14.00' BEHIND THE CLEARANCE POINT. THE SECOND INSULATED JOINT, IF REQUIRED, SHALL BE LOCATED IN THE OPPOSITE RAIL 4.00' BEHIND THE FIRST INSULATED JOINT.

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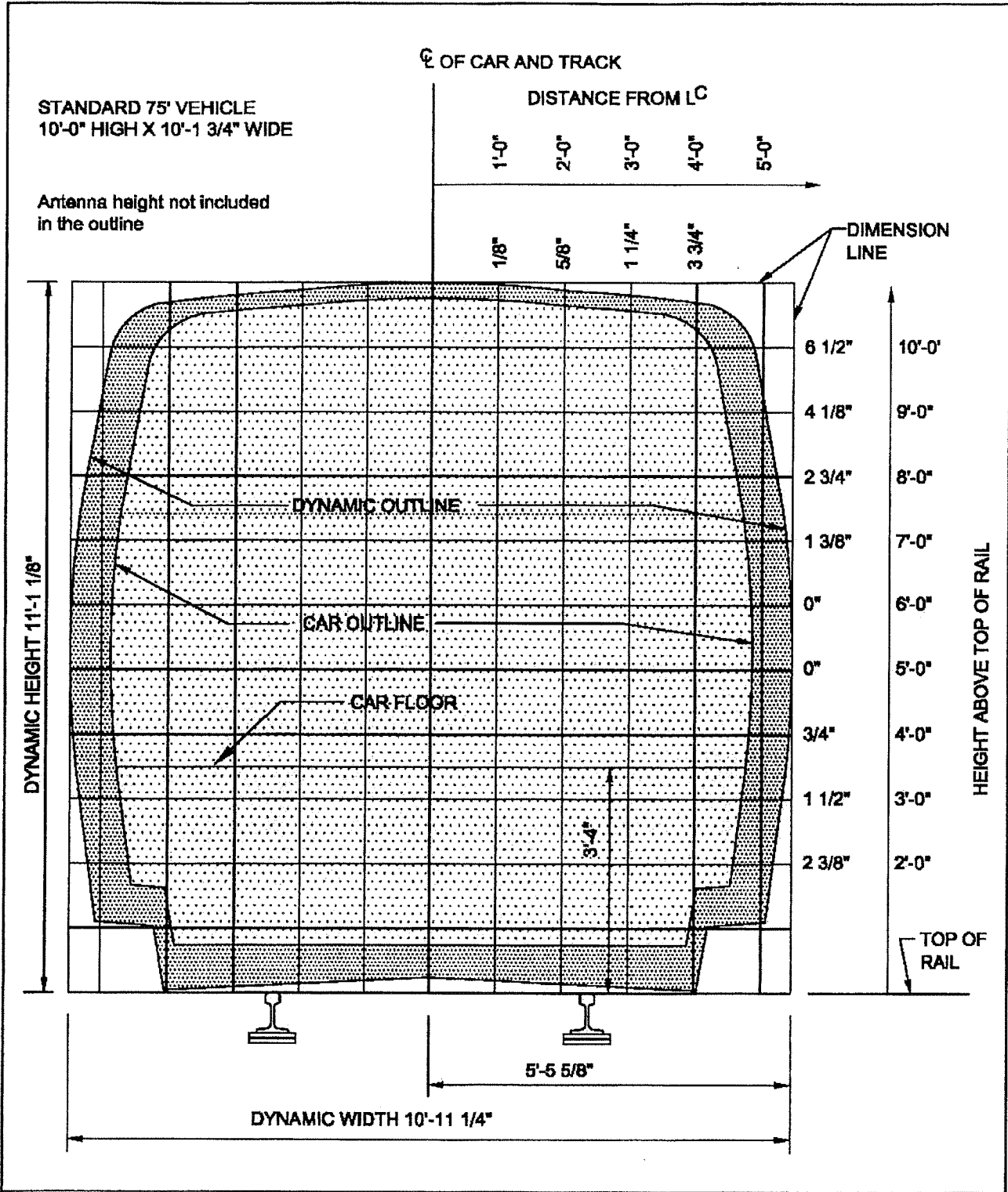
CLEARANCE FOR TURNOUTS
WITH TANGENT TRACKS
BEYOND THE FROG
FIGURE III.19



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CLEARANCE ENVELOPE FOR STRUCTURES
 BELOW T/R IN BALLASTED TRACK
 FIGURE III.28

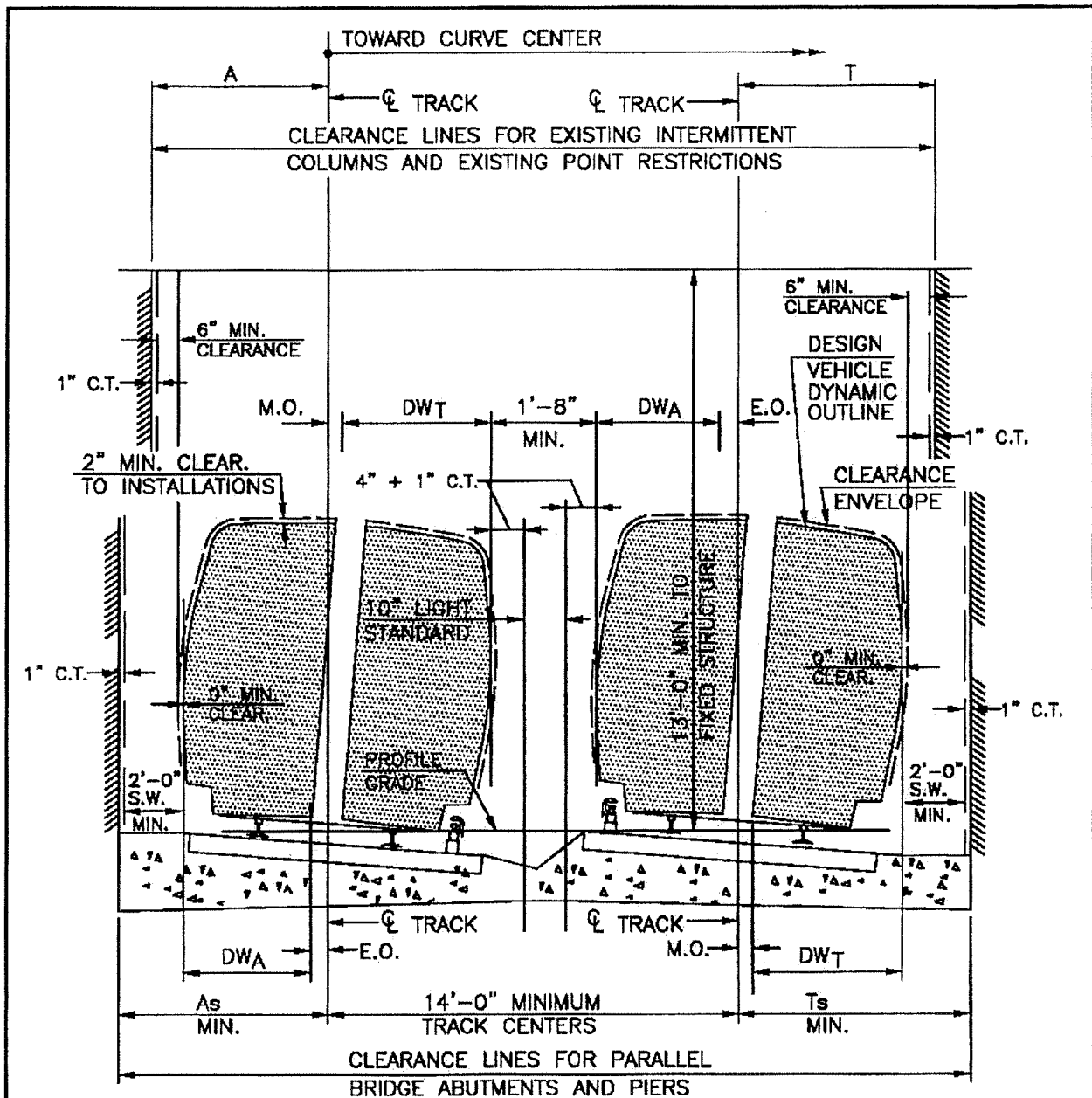


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DESIGN VEHICLE
DYNAMIC OUTLINE DIAGRAM
TANGENT TRACK

FIGURE III.29



NOTES:
 FOR A, A_s , T & T_s VALUES SEE FIGURES III.56 TO III.59.
 FOR DW_T & DW_A VALUES SEE FIGURES III.30 & III.31.
 FOR TRACK CENTERS SEE FIGURE III.55.

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SURFACE TRACK SECTION
 CLEARANCE DIAGRAM

FIGURE II.54

RADIUS	SUPERELEVATION=0"				SUPERELEVATION=1"			
	A	Ts (MIN.)	As (MIN.)	T	A	Ts (MIN.)	As (MIN.)	T
200'	7'-11"	9'-3"	9'-3"	7'-11"	7'-10"	9'-4 1/4"	9'-2"	8'-0 1/4"
300'	7'-4 1/8"	8'-8 1/8"	8'-8 1/8"	7'-4 1/8"	7'-3 1/8"	8'-9 3/8"	8'-7 1/8"	7'-5 3/8"
400'	7'-0 3/4"	8'-4 3/4"	8'-4 3/4"	7'-0 3/4"	6'-11 3/4"	8'-6"	8'-3 3/4"	7'-2"
500'	6'-10 3/4"	8'-2 3/4"	8'-2 3/4"	6'-10 3/4"	6'-9 3/4"	8'-4"	8'-1 3/4"	7'-0"
600'	6'-9 3/8"	8'-1 3/8"	8'-1 3/8"	6'-9 3/8"	6'-8 3/8"	8'-2 5/8"	8'-0 3/8"	6'-10 5/8"
700'	6'-8 3/8"	8'-0 3/8"	8'-0 3/8"	6'-8 3/8"	6'-7 3/8"	8'-1 5/8"	7'-11 3/8"	6'-9 5/8"
800'	6'-7 3/4"	7'-11 3/4"	7'-11 3/4"	6'-7 3/4"	6'-6 3/4"	8'-1"	7'-10 3/4"	6'-8"
1000'	6'-8 3/4"	7'-10 3/4"	7'-10 3/4"	6'-8 3/4"	6'-5 3/4"	8'-0"	7'-9 3/4"	6'-8"
1200'	6'-6"	7'-10"	7'-10"	6'-6"	6'-5"	7'-11 1/4"	7'-9"	6'-7 1/4"
1400'	6'-5 1/2"	7'-9 1/2"	7'-9 1/2"	6'-5 1/2"	6'-4 1/2"	7'-10 3/4"	7'-8 1/2"	6'-8 3/4"
1600'	6'-5 1/8"	7'-9 1/8"	7'-9 1/8"	6'-5 1/8"	6'-4 1/8"	7'-10 3/8"	7'-8 1/8"	6'-8 3/8"
1800'	6'-4 7/8"	7'-8 7/8"	7'-8 7/8"	6'-4 7/8"	6'-3 7/8"	7'-10 1/8"	7'-7 7/8"	6'-8 1/8"
2000'	6'-4 5/8"	7'-8 5/8"	7'-8 5/8"	6'-4 5/8"	6'-3 5/8"	7'-9 7/8"	7'-7 5/8"	6'-5 7/8"
2500'	6'-4 1/4"	7'-8 1/4"	7'-8 1/4"	6'-4 1/4"	6'-3 1/4"	7'-9 1/2"	7'-7 1/4"	6'-5 1/2"
3000'	6'-4"	7'-8"	7'-8"	6'-4"	6'-3"	7'-9 1/4"	7'-7"	6'-5 1/4"
4000'	6'-3 5/8"	7'-7 5/8"	7'-7 5/8"	6'-3 5/8"	6'-2 5/8"	7'-8 7/8"	7'-6 5/8"	6'-4 7/8"
5000'	6'-3 1/2"	7'-7 1/2"	7'-7 1/2"	6'-3 1/2"	6'-2 1/2"	7'-8 3/4"	7'-6 1/2"	6'-4 3/4"
6000'	6'-3 1/4"	7'-7 1/4"	7'-7 1/4"	6'-3 1/4"	6'-2 1/4"	7'-8 1/2"	7'-6 1/4"	6'-4 1/2"
7000'	6'-3 1/4"	7'-7 1/4"	7'-7 1/4"	6'-3 1/4"	6'-2 1/4"	7'-8 1/2"	7'-6 1/4"	6'-4 1/2"
8000'	6'-3 1/8"	7'-7 1/8"	7'-7 1/8"	6'-3 1/8"	6'-2 1/8"	7'-8 3/8"	7'-6 1/8"	6'-4 3/8"
9000'	6'-3 1/8"	7'-7 1/8"	7'-7 1/8"	6'-3 1/8"	6'-2 1/8"	7'-8 3/8"	7'-6 1/8"	6'-4 3/8"
10,000'	6'-3"	7'-7"	7'-7"	6'-3"	6'-2"	7'-8 1/4"	7'-6"	6'-4 1/4"
15,000'	6'-2 7/8"	7'-6 7/8"	7'-6 7/8"	6'-2 7/8"	6'-1 7/8"	7'-8 1/8"	7'-5 7/8"	6'-4 1/8"
25,000'	6'-2 3/4"	7'-6 3/4"	7'-6 3/4"	6'-2 3/4"	6'-1 3/4"	7'-8"	7'-5 3/4"	6'-4"
TANGENT	6'-2 5/8"	7'-6 5/8"	7'-6 5/8"	6'-2 5/8"				

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

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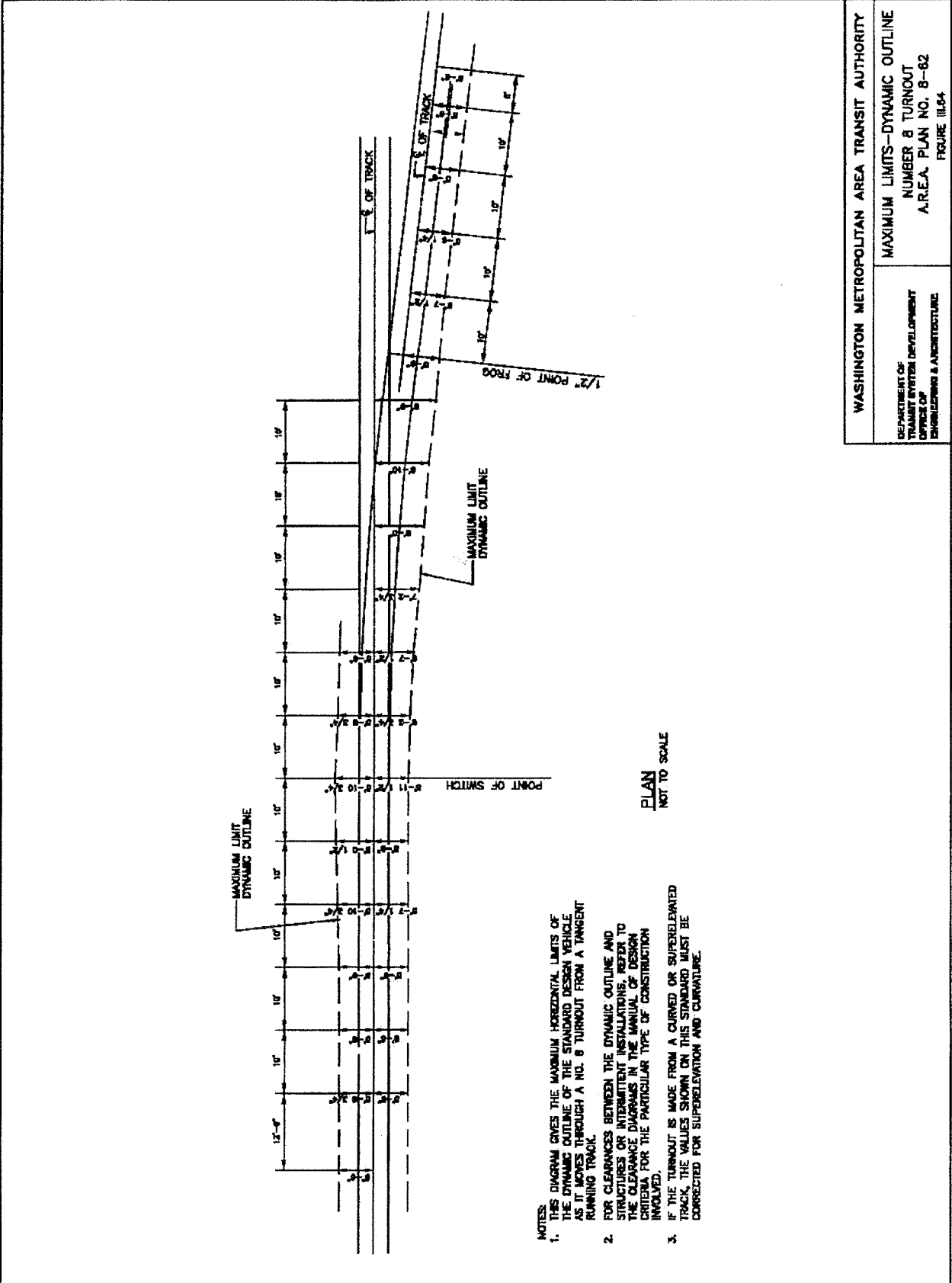
**SURFACE TRACK SECTION
DESIGN TABLES
FIGURE III.56**

RADIUS	S.E.=0"		S.E.=1"		S.E.=2"		S.E.=3"	
	As (MIN.)	Ts (MIN.)	As (MIN.)	Ts (MIN.)	As (MIN.)	Ts (MIN.)	As (MIN.)	Ts (MIN.)
200'	9'-8 1/4"	9'-3"	9'-7 1/4"	8'-4 1/4"	8'-6 1/8"	8'-5 3/8"	8'-5"	8'-6 5/8"
300'	8'-11 1/2"	8'-8 1/8"	8'-10 1/2"	8'-9 3/8"	8'-9 3/8"	8'-10 1/2"	8'-8 1/4"	8'-11 3/4"
400'	8'-7 1/4"	8'-4 3/4"	8'-6 1/4"	8'-6"	8'-5 1/8"	8'-7 1/8"	8'-4"	8'-8 3/8"
500'	8'-4 3/4"	8'-2 3/4"	8'-3 3/4"	8'-4"	8'-2 5/8"	8'-5 1/8"	8'-1 1/2"	8'-6 3/8"
600'	8'-3"	8'-1 3/8"	8'-2"	8'-2 5/8"	8'-0 7/8"	8'-3 3/4"	7'-11 3/4"	8'-5"
700'	8'-1 3/4"	8'-0 3/8"	8'-0 3/4"	8'-1 5/8"	7'-11 5/8"	8'-2 3/4"	7'-10 1/2"	8'-4"
800'	8'-1"	7'-11 3/4"	8'-0"	8'-1"	7'-10 7/8"	8'-2 1/8"	7'-9 3/4"	8'-3 3/8"
1000'	7'-11 3/4"	7'-10 3/4"	7'-10 3/4"	8'-0"	7'-9 5/8"	8'-1 1/8"	7'-8 1/2"	8'-2 3/8"
1200'	7'-10 7/8"	7'-10"	7'-9 7/8"	7'-11 1/4"	7'-8 3/4"	8'-0 3/8"	7'-7 5/8"	8'-1 5/8"
1400'	7'-10 1/4"	7'-9 1/2"	7'-9 1/4"	7'-10 3/4"	7'-8 1/8"	7'-11 7/8"	7'-7"	8'-1 1/8"
1600'	7'-9 3/4"	7'-9 1/8"	7'-8 3/4"	7'-10 3/8"	7'-7 5/8"	7'-11 1/2"	7'-6 1/2"	8'-0 3/4"
1800'	7'-9 3/8"	7'-8 7/8"	7'-8 3/8"	7'-10 1/8"	7'-7 1/4"	7'-11 1/4"	7'-6 1/8"	8'-0 1/2"
2000'	7'-9 1/8"	7'-8 5/8"	7'-8 1/8"	7'-9 7/8"	7'-7"	7'-11"	7'-5 7/8"	8'-0 1/4"
2500'	7'-9 3/4"	7'-8 1/4"	7'-8 3/4"	7'-9 1/2"	7'-7 5/8"	7'-10 5/8"	7'-8 1/2"	7'-11 7/8"
3000'	7'-9 1/4"	7'-8"	7'-8 1/4"	7'-9 1/4"	7'-7 1/8"	7'-10 3/8"	7'-6"	7'-11 5/8"
4000'	7'-8 5/8"	7'-7 5/8"	7'-7 5/8"	7'-8 7/8"	7'-6 1/2"	7'-10"	7'-5 3/8"	7'-11 1/4"
5000'	7'-8 1/4"	7'-7 1/2"	7'-7 1/4"	7'-8 3/4"	7'-6 1/8"	7'-9 7/8"	7'-5"	7'-11 1/8"
6000'	7'-7 7/8"	7'-7 1/4"	7'-8 7/8"	7'-7 1/2"	7'-5 3/4"	7'-9 5/8"	7'-4 5/8"	7'-10 7/8"
7000'	7'-7 3/4"	7'-7 1/4"	7'-6 3/4"	7'-7 1/2"	7'-5 5/8"	7'-9 5/8"	7'-4 1/2"	7'-10 7/8"
8000'	7'-7 5/8"	7'-7 1/8"	7'-8 5/8"	7'-8 3/8"	7'-5 1/2"	7'-9 1/2"	7'-4 3/8"	7'-10 3/4"
9000'	7'-7 1/2"	7'-7 1/8"	7'-6 1/2"	7'-8 3/8"	7'-5 3/8"	7'-9 1/2"		
10,000'	7'-7 3/8"	7'-7"	7'-6 3/8"	7'-8 1/4"	7'-5 1/4"	7'-9 3/8"		
15,000'	7'-7 1/8"	7'-6 7/8"	7'-6 1/8"	7'-8 1/8"	7'-5"	7'-9 1/4"		
25,000'	7'-6 7/8"	7'-6 3/4"	7'-5 7/8"	7'-8"				
TANGENT	7'-6 5/8"	7'-6 5/8"						

NOTE: THE MINIMUM CLEARANCE BETWEEN ϕ OF TRACK AND FACE OF WALL SHALL BE 8'-6" IF A CLOSED DRAINAGE SYSTEM IS INSTALLED BETWEEN THE TRACK AND THE WALL.

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	RETAINING WALL SECTION DESIGN TABLES FIGURE III.61
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- NOTES:
1. THIS DIAGRAM GIVES THE MAXIMUM HORIZONTAL LIMITS OF THE DYNAMIC OUTLINE OF THE STANDARD DESIGN VEHICLE AS IT MOVES THROUGH A NO. 6 TURNOUT FROM A TANGENT RUNNING TRACK.
 2. FOR CLEARANCES BETWEEN THE DYNAMIC OUTLINE AND STRUCTURES OR INTERMITTENT INSTALLATIONS, REFER TO THE CLEARANCE DIAGRAMS IN THE MANUAL OF DESIGN CRITERIA FOR THE PARTICULAR TYPE OF CONSTRUCTION INVOLVED.
 3. IF THE TURNOUT IS MADE FROM A CURVED OR SUPERELEVATED TRACK, THE VALUES SHOWN ON THIS STANDARD MUST BE CORRECTED FOR SUPERELEVATION AND CURVATURE.

PLAN
NOT TO SCALE

END OF SECTION

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY	MAXIMUM LIMITS—DYNAMIC OUTLINE
DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	NUMBER 8 TURNOUT A.R.E.A. PLAN NO. 8-62 FIGURE III.64

PROGRAM CRITERIA

STRUCTURAL

1.01 CODES AND HANDBOOKS

- A. The structural design shall satisfy the requirements of the following:
1. The "Manual of Design Criteria" by the Washington Metropolitan Area Transit Authority (WMATA).
 2. The current edition of the "Manual for Railway and Maintenance-of-Way Engineering", hereinafter referred to as the AREMA Manual.
 3. The current edition of the "Building Code Requirements for Structural Concrete (ACI-318) and Commentary (ACI 318R)" adopted by the American Concrete Institute, hereinafter referred to as the ACI 318 Code.
 4. The current edition of the "Manual of Steel Construction - Allowable Stress Design" by American Institute of Steel Construction, Inc., hereinafter referred to as the AISC Code.
 5. The current edition of the "American Society of Civil Engineers Minimum Design Loads for Building and Other Structures", hereinafter referred to as the ASCE 7. This shall apply where referenced in this 'Design Criteria'.
 6. The current edition of the International Building Code (IBC).
 7. In addition to the above, the latest Building Codes of the local jurisdiction, supplemented by any WMATA requirements, shall apply.
 8. Any special applicable requirements or codes, not listed and in WMATA Criteria or above, should be considered only with the approval of the Authority.
 9. American Society of Testing Materials (ASTM) Standards.
 10. American Welding Society (AWS) Welding Code D 1.1 and D 1.4.
 11. Precast and Prestressed Concrete Institute (PCI) Design Handbook.
- B. In case of conflict among the Codes, the most stringent shall govern.
- C. The Designer shall list the latest edition and/or year of the Standards, Codes and Criteria used in the design.

1.02 LOADS

- A. The following loads shall be the basis for structural design:
1. Dead Load:
 - a. Dead Loads shall comply with IBC.
 2. Capacity of Cranes and Hoists:
 - a. Overhead Traveling Crane 15 Tons
 - b. Body Hoists, Truck Hoists, Turntables, etc.
 - 1) Operating weight with a minimum safety factor of 2.0
 3. Uniform Live Load:
 - a. Roof (Minimum) 30 PSF
 - b. Ground Snow Load (Snow drift per IBC) 25 PSF
 - c. First Floor 250 PSF minimum, or as shown on Figures V.1 and V.2 for train and crane cars design loading, whichever produces worst effect
 - d. Ground Floor/Basement level 250 PSF
 - e. Mezzanine Level (Brentwood) 150 PSF
 - f. Platforms and Pits 250 PSF

- g. Yard & Train Control Rooms 275 PSF or actual weight of equipment whichever is larger.
- h. Mechanical & Electrical Rooms, Service Rooms, Storage Spaces, Machinery Rooms, Parts Storage and other elevation floor areas unless specifically stated otherwise 250 PSF or actual weight of equipment whichever is larger.
- i. Stairs & Landings, Assembly 150 PSF
- j. Railing 200 lbs (applied at any direction, at any point) or 50 PLF (applied vertically and horizontally), whichever produces the worst case.
- k. Floors Accessible to Vehicles, Grating Walkways over Repair Pits, Driveway over Grease Trap AASHTO HS20-44
- l. Highway Traffic Surcharge for Retained Fill AASHTO
- m. Guard Railing / Parapet Traffic Load AASHTO
- n. Wind:
 - 1) Basic Wind Speed² (3 second gusts) 110 MPH
 - 2) Wind Exposure "C"
 - 3) Seismic As per IBC
- 4. Concentrated Live Load (LL)
 - a. Live load shall consist of any non-permanent gravity load placed on the structure:
 - 1) Rapid Transit Loading
 - (a.) See Figure V.1 for car dimensions and weights. Any combination of train lengths and loadings which produces the critical design loading shall be used for structural design.
 - 2) Crane Car Loading
 - (a.) See Figure V.2 for car dimensions and weights.
 - 3) Force (RF)
 - (a) A force equal to 10% of the rapid transit loading per track shall be applied downwards on one rail and upwards on the other, on all tracks.
 - 4) Longitudinal Braking and Traction Force (LF)
 - (a) A force equal to 15% of the rapid transit loading per track shall be applied 5 feet above the top of rail on all tracks. Consideration is to be given to combinations acceleration and deceleration forces where more than one track occurs.
 - 5) Impact
 - (a) 30 percent of the total rapid transit vehicle or crane car loading
- 5. Lateral Earth Pressure: Refer to the Geotechnical Design Summary Report by GeoConcepts.

B. Loading combinations shall be in accordance with ACI-318, and IBC Code.

1.03 MATERIALS:

- A. Concrete:
1. Concrete to be made with normal weight aggregates. Admixtures containing chloride salts shall not be used.
 2. Concrete shall conform to type of class designated below:
 - a. Class 4000 for cast-in-place concrete
 - 1) with a water cement ratio of 0.45 or less
 - b. Class 6000 min. for precast concrete
 - 1) Precast concrete with a maximum water-cement ratio of 0.38
- B. Reinforcing Steel:
1. Reinforcing steel:
 - a. ASTM A615, Grade 60 ($F_y = 60000$ psi). Use ASTM A 706 where required for welding.
 2. Welded Wire Fabric:
 - a. ASTM A185 ($F_y = 65000$ psi). Lap edges of wire fabric at least 6" in each direction.
 - b. All concrete slabs on grade shall have a minimum of one layer of 6x6 - W2.9xW2.9 WWF at 2 inches from top of slab.
 3. Mechanical splices of reinforcing bars made by the use of Cadweld or NMB splices are acceptable. No other type of mechanical splice is acceptable.
 4. Reinforcing details shall be in accordance with the current "ACI Manual of Standard Practices for Detailing Reinforced Concrete Structures". Reinforcing bar lap splices shall be Class B tension lap splices.
- C. Structural Steel:
1. All structural steel shall conform to one of the following; ASTM A36 ($F_y = 36$ ksi), ASTM A572, ($F_y = 50$ ksi), ASTM A992. Structural tubing shall be cold formed welded structural tubing conforming to ASTM 500, grade ($F_y = 46$ ksi).
 2. Welding Electrode: E70XX.
 3. Bolts: 3/4" Dia., minimum, ASTM A325, Connection Type X (thread excluded from shear plane).
 4. Anchor Bolts: ASTM A307.
 5. Shear Studs: ASTM A108 3/4" Dia.
 6. All beam connections shall be shop welded or shop bolted, and field bolted. All shop welded connections shall be prequalified welded connections. Field connections shall be AISC standard bolted connections using 3/4" Dia. high strength bolts conforming to ASTM A325.
 7. All exposed structural steel shall be hot-dip galvanized after fabrication.
- D. Open Web Steel Joist:
1. Open web steel joist shall be K -Series or LH-Series and shall conform to the latest specifications of the Steel Joist Institute (SJI).
 2. The ends of the bridging lines shall be anchored in accordance with SJI requirements.
 3. All bridging shall be placed and anchored before installation of deck.
 4. The bottom chord of the steel joist shall be welded/anchored to steel column/beam/wall.
- E. Roof Deck
1. Steel Deck: Steel deck shall have a minimum yield strength of 33 ksi and shall be galvanized.
 2. Roof decking shall be minimum 20 gage x 1½" deep with a min. section modulus of 0.20 in³/ft. Floor deck shall be minimum of 24 gage x 1½" deep metal slab form with a minimum section modulus of 0.120 in³/ft.
 3. Galvanizing shall conform to ASTM A525, coating class G60.

- F. Limits of Stresses:
1. Prestressed Concrete:
 - a. Extreme fiber stress in tension in concrete immediately after prestress transfer (before time-dependent prestress losses) shall be as noted in section F.1.c.1) below. Increase in the depth of the members, and/or the use of draped tendons or a judicious use of additional tendons can be used to maintain stresses within the recommended limits. Bonded auxiliary reinforcement, if used, shall consist of many small bars distributed uniformly over the face rather than a few small large bars (like 3-#10, 2-#11, etc).
 - b. Extreme fiber stress in tension, in precompressed tensile zone at service loads (after prestress losses) shall be as given in section F.1.c.2) below.
 - c. Concrete Stresses in Structural Members
 - 1) Extreme fiber stress in tension immediately after prestress transfer (before time-dependent prestress losses) shall not exceed 6 times the square root of f'_c even if bonded reinforcement is provided.
 - 2) Extreme fiber stress in tension, in pre-compressed tensile zone at service loads (after prestress losses) shall not exceed 6 times the square root of f'_c .
 2. Additional Requirements for Non-prestressed Concrete Members for One-way Construction:
 - a. For non-prestressed reinforced concrete members for one-way construction which are exposed to weather or earth, for the serviceability, the minimum thickness of the member (beams, slabs etc.) shall be as specified in the 'Table 9.5(a)' of the ACI 318 Code. The reduction in the thicknesses based on the computation of deflections as given in ACI 318 Section 9.5.2.1, shall not be used to reduce the thicknesses specified in the 'Table 9.5(a)' of the ACI 318 Code, for this project.
 - b. In addition to the criteria given in 'a' above, it is intended that the section should not be cracked under dead load with a load factor of one. Therefore, the maximum flexural tensile stress in the concrete section under dead load should not exceed 7.5 times the square root of f'_c , for both precast and cast in place members. This can be achieved by selection of appropriate thickness, width and the concrete strength. In case it is not possible to limit the stress to 7.5 times the square root of f'_c , for cast in place concrete only, the crack widths based on cracked section at the extreme fiber in tension under dead load should be limited to 0.003 inches.
- G. Connections: The precast manufacturer shall design and provide all embedded items necessary to adequately anchor the precast member to the foundation including anchor bolts. Any additional foundation details required for proper transfer of forces between the precast members and the foundation not already shown in the design shall be submitted with the shop drawings by the precast manufacturer. All exposed connection hardware and assemblies shall be hot-dipped galvanized after fabrication. Galvanized connections which are subsequently field-welded shall be touched up with zinc-rich paint after welding as per Standard Specifications.
- H. The fabricator (precast contractor) shall participate in the Precast/Prestressed Concrete Institute (PCI) Certification Program and be designated as a PCI certified plant for product categories A1 and C3. The fabricator shall have continuous experience and is to be regularly engaged in the fabrication of precast/prestressed concrete products as per the requirements of the RFP and as stated in the Technical Proposal as finally accepted.

1.04 SOILS AND GEOLOGIC CRITERIA

- A. The Authority has provided and approved a final geotechnical report with recommendations pertaining to the Brentwood, Greenbelt and Shady Grove Shop and Yard Expansion. This information is contained in the GeoConcepts, Inc. Soils and Foundation Report dated September 2004.

- B. The Design-Builder shall use the information provided in the GeoConcepts, Inc. report. The Design-Builder may perform additional geotechnical investigations, after Contract Award, at no additional cost to the Authority. Any field work performed on WMATA property shall require a written request that includes a field investigation plan and proposed schedule for review and acceptance by the owner. The Design-Builder shall submit any additional geotechnical data and/or recommendations to the Authority for review and comment prior to final design.
- C. The Design-Builder will be responsible for design and sealing of design drawings.

1.05 GEOTECHNICAL DESIGN:

- A. The design criteria for the geotechnical portion of the work shall be in accordance with the GeoConcepts, Inc. geotechnical reports dated September 2004 contained in this contract document, and with any additional geotechnical recommendations submitted and accepted by the Authority.
- B. Temporary Retaining Walls - Temporary Retaining Walls shall be designed on the basis of specific soils information and in accordance with the procedures outlined on Figures V.15a, V.15b and V.16.

1.06 FOUNDATIONS:

- A. Foundation design shall be based on the subsoil exploration and the recommendations of the Authority-approved geotechnical report(s) and recommendations submitted by an engineer registered as a professional engineer in the jurisdiction, where the structure is proposed.
- B. Spread footings, piles or caissons may be used as foundations for this structure, such that the maximum settlement of any column shall not be greater than 1/2 inch nor the differential settlement between any two adjacent columns greater than 1/4 inch.
- C. If piles foundations are used, pile driving records and results of pile driving load tests shall be developed and submitted as required in standard specification.
- D. Caissons must be designed by and fully justified by an Authority-approved Geotechnical Engineer registered as a professional engineer in the Jurisdiction where the structure is proposed, and retained by the Designer/Builder.
- E. Any variations shall be reported to the Authority Representative in writing before the construction of the foundations.

1.07 COMPACTED STRUCTURAL BACKFILL:

- A. Compacted structural backfill against interior ramp walls and retaining walls shall be in accordance with the requirements of 1.07B
- B. Compact each layer of embankment, fill or backfill to 95 percent of maximum dry density as determined in accordance with ASTM D698, at moisture content within tolerance specified, except the following:
 - 1. From upper surface of fill or backfill to a plane 12 inches below subbase level of vehicular pavement, sidewalks, trackbeds and structural foundations to 100 percent of maximum dry density, as determined in accordance with ASTM D698, at moisture content within tolerance specified.
 - 2. In areas of 95-percent compaction where utility facilities are located in fill and are not

supported on concrete cradles, compact material for a depth of one foot directly below bottom of facility to 100 percent of maximum, as determined in accordance with ASTM D698, dry density at moisture content within tolerance specified.

- C. Light hand-operated compaction equipment (2,000 pounds) shall be used within ten feet of any structure.
- D. All subgrade shall be proof-rolled with at least two passes of a fully loaded 10 wheel dump truck prior to placing the stone layer or placing fill in the building area and at least five feet beyond the outer edge of the footings.

1.08 PERMANENT RETAINING WALLS

- A. Reinforced Concrete Retaining Walls - Retaining walls shall be designed on the basis of specific soils information relating to the backfill material and in accordance with the procedures outlined in the AREMA Manual, Chapter 8, Part 5.
- B. External Stability of Wall System
 - 1. Stability of the retention system as a whole must satisfy three conditions: The factors of safety against sliding and overturning must be adequate; the soil pressure beneath the toe of the foundation must not exceed the allowable soil pressure; and differential settlements of the foundation must not be excessive.
 - 2. Safety Against Sliding
 - a. Sliding of a retaining wall is resisted by the friction between the soil and base and by the passive earth pressure of the soil in contact with the outer face of the foundation.
 - b. The factor of safety against sliding is equal to horizontal resisting forces divided by the horizontal component of the backfill pressures, which should be at least 1.5. The friction between the base and clean sand or silty sand is equal to the effective normal pressure on the base times the tangent of the friction angle, ϕ , between soil and base. The value of f may be taken as 30° for a coarse-grained soil containing no slit or clay, and as 24° for a coarse-grained soil containing silt. The value of ϕ between sand and the underlying clay can be assumed as 20° . The passive resistance in front of the wall shall be disregarded unless approved otherwise by the authority.
 - 3. Safety Against Overturning - The factor of safety against overturning is determined by dividing the sum of moments of forces tending to resist rotation of the wall about its toe by the sum of moments of forces tending to produce the overturning. A factor of safety of at least 1.5 is conventional.
 - 4. Allowable Soil Pressure and Settlement - The maximum base pressure at the toe of the wall will be limited by the allowable bearing capacity of the soil. If the wall rests on a very compressible soil, the foundation should be designed in such a way that the point of application of the resultant pressure is located close to the midpoint of the base. A minimum factor of safety of 2 shall be provided.
 - 5. Overall Stability - In addition, where retaining walls are underlain by weak soils ($\phi < 25^\circ$), the overall stability of the mass containing the retaining wall should be checked with respect to the most critical surface of sliding. A minimum factor of safety of 2 is required.

C. Reinforced Earth/Mechanically Stabilized Earth:

1. This system may be used with the following criteria:
 - a. Reinforced Earth (RE) and Mechanically Stabilized Earth (MSE) walls shall be designed in accordance with the current requirements of the AASHTO Standard Specifications for Highway Bridges, Section 5, as supplemented by the below criteria and requirements.
 - b. Service Life of walls shall be minimum 100 years; with minimum 5-year warranty period on wall system, during which annual inspections shall be performed by the engineer of record or authorized agent.
 - c. RE/MSE wall supplier shall be the engineer of record for the RE/MSE wall design, and shall be responsible for internal, external and global stability design including allowable bearing capacity. Supplier shall certify that wall installation conforms to approved design.
 - d. RE/MSE wall supplier shall provide the following for WMATA approval: With Proposal package:
 - 1) Complete specifications identifying
 - (a) Design parameters (including minimum required soil bearing capacity)
 - (b) Materials and design properties
 - (c) Installation methods
 - (d) Catalog cuts
 - (e) Equipment list
 - (f) Sample calculations for tallest wall section (including internal, external and global stability calculations, and settlement calculations for which design/builder will be fully responsible)
 - (g) QC Plan and QC Staff
 - (h) Cost Loaded Bar Chart Schedule showing planned start and finish dates of activities and associated dollars
 - (i) Identification of limit of work and access through site.
 - (j) Method of controlling differential settlement along the wall based on the available soil boring information. (To include at least the minimum requirements in Requirement of "Subgrade Preparation" below.)
 - (k) Monitoring program to monitor potential settlements and other wall movements.
 - (l) Schematic design of drainage system to control, collect and discharge water from behind the wall.
 - (m) Design for corrosion protection of steel elements.
 2. Prior to NTP:
 - (a) Final calculations with P.E. stamp (including internal, external and global stability calculations, and settlement calculations).
 - (b) Shop Drawings
 - (c) Details of drainage system to control, collect and discharge water from behind the wall.
 3. RE/MSE wall design/construction must demonstrate that highly acidic soils ($\text{pH} < 3$) if found on-site do not affect the performance and service life of the wall.
 4. Backfill:
 - (a) Backfill for undercut shall be similar to Virginia DOT Stone No. 57 requirements as specified in the latest edition of Virginia Department of Transportation Specifications, Road and Bridge Specifications.

- (b) Backfill for reinforced earth volume: VDOT Stone No. 57 or Select Granular Backfill Material as specified below shall be used.
- (c) Select Granular Backfill Material shall be free from organic and other deleterious material and conform to the following gradation limits:

U.S. Sieve Size	% by Weight of Material Passing Sieve
1½ in	100
½ in	25-60
No. 40	15 - 30
No. 200	0 - 5

- 5. Plasticity Index (PI) for Select Granular Backfill Material shall not exceed 6.
- 6. Random backfill beyond the limits of the reinforced earth volume shall meet the requirements for backfill in Standard Specification Section 204, Article 2.1.A. The pH for Random Backfill shall be between 5.0 and 8.0 measured in a peroxide medium.
- e. Subgrade Preparation: To control differential settlement along the length of wall, undercut within limits described below, place Tensar Geogrid BX1100 or equal on excavated surface, overlay geogrid with layer of geotextile fabric and fill with VDOT Stone No. 57.

f. Limits of undercut:

- 1) Length: The entire length of the wall.
- 2) Width: Equal to or greater than the length of the reinforcing elements behind the wall, and in front of the wall to a distance from the edge of the leveling pad equal to or greater than the depth of undercut.
- 3) Depth: Minimum 3 feet, but depth shall be increased as required, so that differential settlement is eliminated or reduced to a negligible amount. If unexpected unstable or bad ground conditions are encountered during excavation, engineer of record to provide proposed solution; resulting additional undercut, rip rap, fabric, fill will be paid as a unit price item.

g. RE/MSE wall supplier shall provide the following minimum factors of safety (FOS):

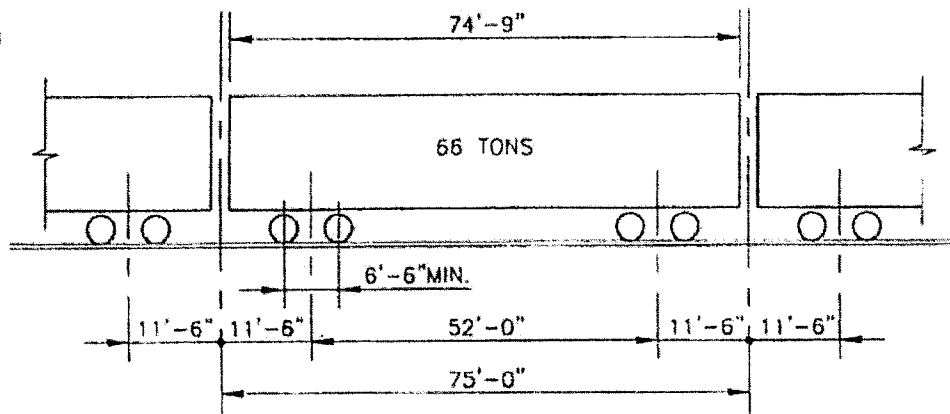
External Stability	Minimum FOS
Sliding	2.0
Overturning	2.5
Global Stability	1.7
(Overall depth/Deep seated slope stability)	
Bearing Capacity	2.5
Internal Stability	
Pullout Resistance	2.0

h. Wall face:

- 1) Reinforced Concrete Panels are preferred.
- 2) Minimum concrete strength at installation shall be 4000 psi.
- 3) Alignment of panels and construction of wall face shall provide a true vertical plane with uniform surface after deflection. Precast tolerances and erection tolerances shall be coordinated.
- 4) A minimum of 2 layers of steel reinforcing per panel with maximum vertical spacing of 30" on centers shall be provided. Panels shall be adequately reinforced for flexure.
- 5) All panels shall be keyed to each other (shear connection).

- i. Concrete Block Wall may be used as an alternate.
- 1) Minimum strength of concrete block at installation shall be 4000 psi.
 - 2) Alignment of blocks and construction of wall face shall provide a true vertical plane with uniform surface after deflection. Precast tolerances and erection tolerances shall be coordinated.
 - 3) Place steel reinforcement on 16" centers vertically (every other course) for 8" block. Place steel reinforcing in the course of every other block in the horizontal direction. On the course of blocks in between, place an intermediate reinforcing layer of continuous geotextile or geogrid extending a minimum 8 feet length into backfill behind wall. All blocks shall be doweled to each other.
 - 4) The steel reinforcing shall be designed to provide the full structural support, neglecting any contribution from the geotextile or geogrid, which shall be assumed to provide the facial stability only.
 - 5) Inextensible Reinforcements:
 - a) Steel, hot-dipped Galvanized after fabrication.
 - b) Minimum layers and spacing in accordance with requirement number h above.
 - c) Minimum length $> 1.0 \times H$ (wall height)
 - 6) Settlement:
 - a) No settlement 3 months after completion of the yard. Surcharge wall as needed.
 - b) Allowable during construction, as long as an approved monitoring and remediation program can be implemented without compromising the project schedule.
 - c) Design/Construction shall include provisions such as subgrade preparation to limit settlement. See "Subgrade Preparation" above.
 - 7) RE/MSE wall shall be designed to support the traffic barrier and moment slab withstanding AASHTO loading and deflection due to fire truck (WB-50). Traffic barrier shall be capable of accommodating future site lighting pole.
 - 8) Provide effective permanent drainage including necessary drainage blankets in back of and behind the reinforced zone, and other internal drainage elements, to eliminate seepage from behind the wall. Drainage from behind the wall shall be controlled, collected and discharged from common point(s).
 - 9) Detailed design for corrosion protection (100 year minimum) of any steel elements in the system including consideration of stray current, aggressive elements infiltrating from surface flows and groundwater flows. All steel elements in the system must be hot-dipped galvanized.
 - 10) Design/Construction shall accommodate subsurface utilities, such as ballast drains, cable trenches, ductbanks, light pole foundations and storm drain pipes; without decreasing wall performance/service
 - 11) RE/MSE wall supplier shall provide full time inspector during wall construction. Inspector shall provide daily reports thru Contractor. Reports shall include, but not be limited to, pre-placement, placement, and post-placement inspection records of precast panels.

The requirements set forth herein shall be treated as a minimum. The responsibility of production and erection of structurally adequate, stable structures, free from structural flaws, cracks or damage lies with the Designer/Builder.



1. DESIGN Loads _____ VEHICLE _____ 82,000 LB.
 _____ PASSENGERS _____ 50,000 LB.
 TOTAL RAPID TRANSIT
 LOADING (LL) _____ 132,000 LB.
2. AXLE LOAD _____ 33,000 LB.
3. IMPACT _____ AS SPECIFIED
4. CENTRIFUGAL FORCE _____ [0.0012 x SPEED² (MPH) x DEGREE
 OF CURVE (DEG)] % LL
5. ROLLING FORCE _____ 10% LL
6. LONGITUDINAL BRAKING AND TRACTIVE FORCE _____ 15% LL
7. LOADING COMBINATIONS _____ FOR COMBINATIONS OF ABOVE
 LOADS REFER TO SECTION E

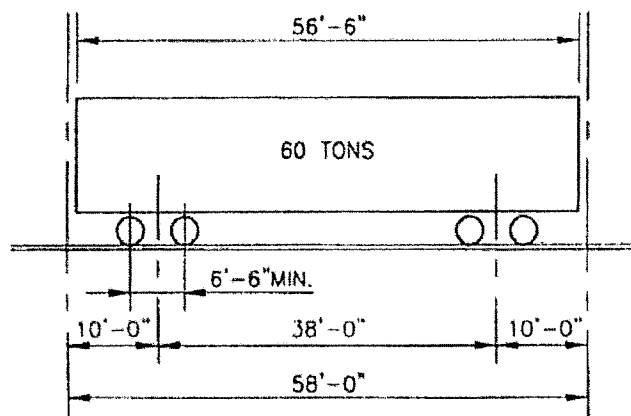
WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT
 OFFICE OF ENGINEERING AND ARCHITECTURE

SCALE: NONE DATE: 04/24/2001

**RAPID TRANSIT VEHICLE
 DESIGN LOADING**

FIGURE V.1



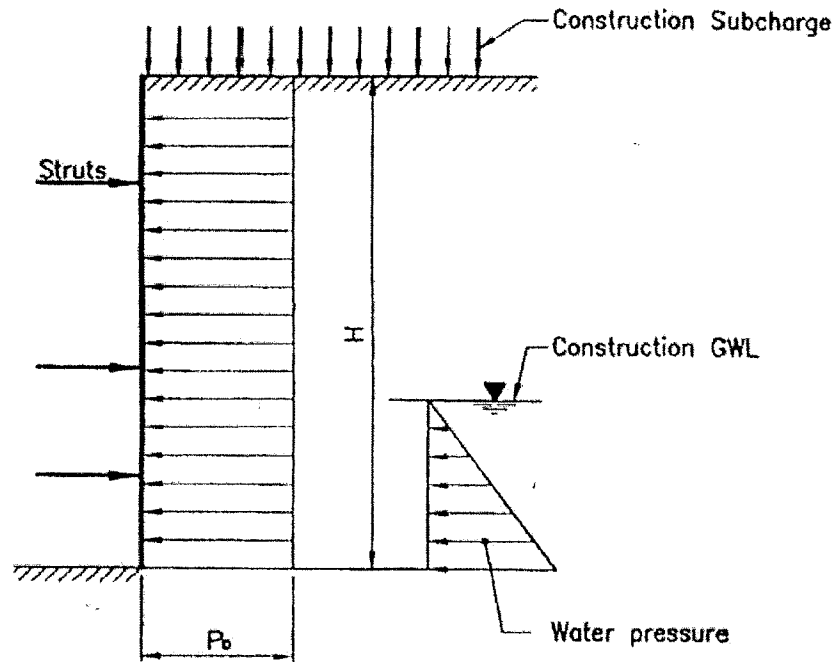
1. DESIGN Loads _____ CAR _____ 80,000 LB.
 PAYLOAD _____ 40,000 LB.
 TOTAL CRANE CAR
 LOADING (LL) _____ 120,000 LB.
2. AXLE LOAD _____ 30,000 LB.
3. IMPACT _____ AS SPECIFIED
4. CENTRIFUGAL FORCE _____ $[0.0012 \times \text{SPEED}^2 (\text{MPH}) \times \text{DEGREE}$
 OF CURVE (DEG)] % LL
5. ROLLING FORCE _____ $\pm 10\%$ LL
6. LONGITUDINAL BRAKING AND TRACTIVE FORCE _____ 15% LL
7. LOADING COMBINATIONS _____ FOR COMBINATIONS OF ABOVE
 LOADS REFER TO SECTION E

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 OFFICE OF ENGINEERING AND ARCHITECTURE

SCALE: NONE DATE: 04/24/2001

CRANE CAR
 DESIGN LOADING
 FIGURE V.2



APPARENT PRESSURE DIAGRAM FOR STRATIFIED SANDS WITH STIFF TO HARD CLAY AND SILT LAYERS
WATERTIGHT RIGID WALLS

NOTES:

1. Effective earth pressure is equal to the average of active and at-rest pressures distributed as a rectangle with P_0 ordinate.
2. Total thickness of clay and silt layers as much as 50% of the depth of the cut.
3. Use effective soil friction shown on Table V.2 in estimating the active and at-rest earth pressures.

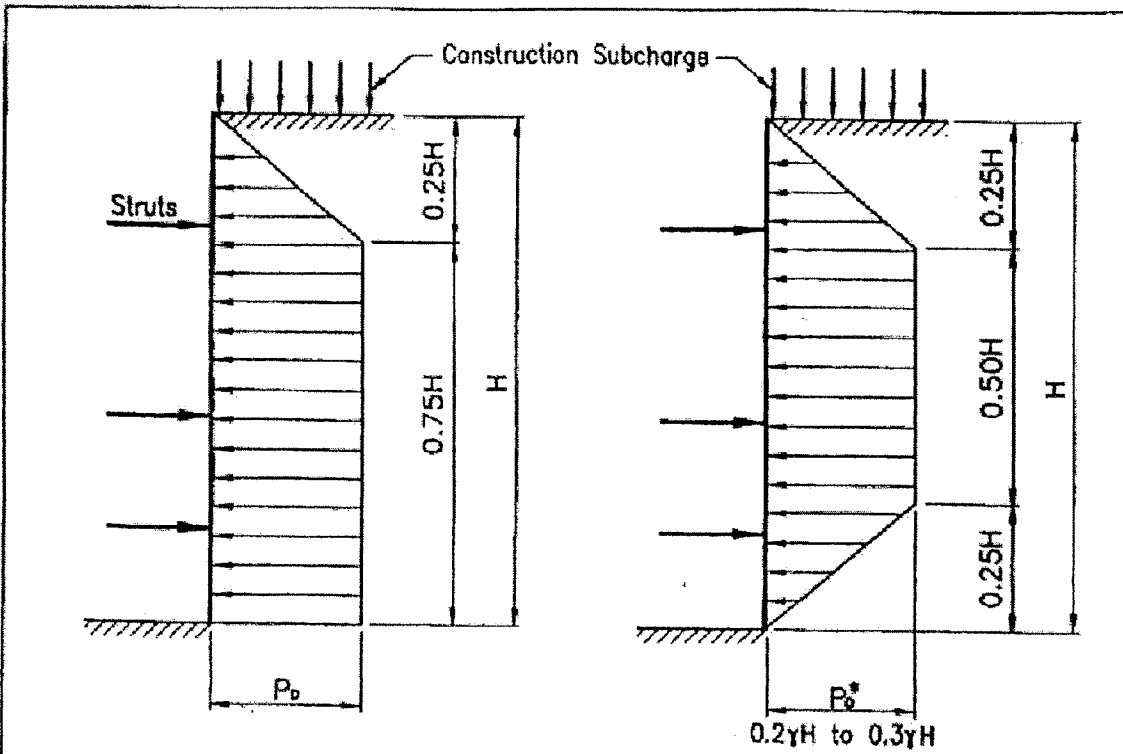
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OFFICE OF ENGINEERING AND ARCHITECTURE

SCALE: NONE DATE: 04/24/2001

**DESIGN LOADING—TEMPORARY COFFERDAM
STRATIFIED SANDY SOILS**

FIGURE V.15a



(a) SOFT TO MEDIUM CLAYS $N_b > 5$
WATERTIGHT RIGID WALLS

(b) STIFF TO HARD CLAYS $N_b > 5$
WATERTIGHT RIGID WALLS

APPARENT PRESSURE DIAGRAMS FOR STRATIFIED CLAYS WITH SAND LAYERS AND LENSES

NOTES:

1. Diagrams (a) and (b) can be used in stratified clays, where the total thickness of sand layers or lenses does not exceed 25% of the depth of the cut.
2. Soil Pressure for soft to medium clays is equal to the average of active and at-rest pressures distributed as a trapezoid with P_D ordinate. P_D shall be not less than $0.3yH$.
3. Use effective soil friction shown on Table V.2 in estimating the active and at-rest earth pressures.
4. Presence of groundwater level does not have any effect on magnitude of lateral pressure.

LEGEND

- $N = \frac{yH}{S_u} =$ Base stability factor
- Sub = Average undrained shear strength below base of cut.
- $\gamma =$ Total soil unit weight.
- $P_D^* = 0.2 yH$ for very stiff intact nonfissured clays.
- $P_D^* = 0.3 yH$ for fissured or slickensided clays.

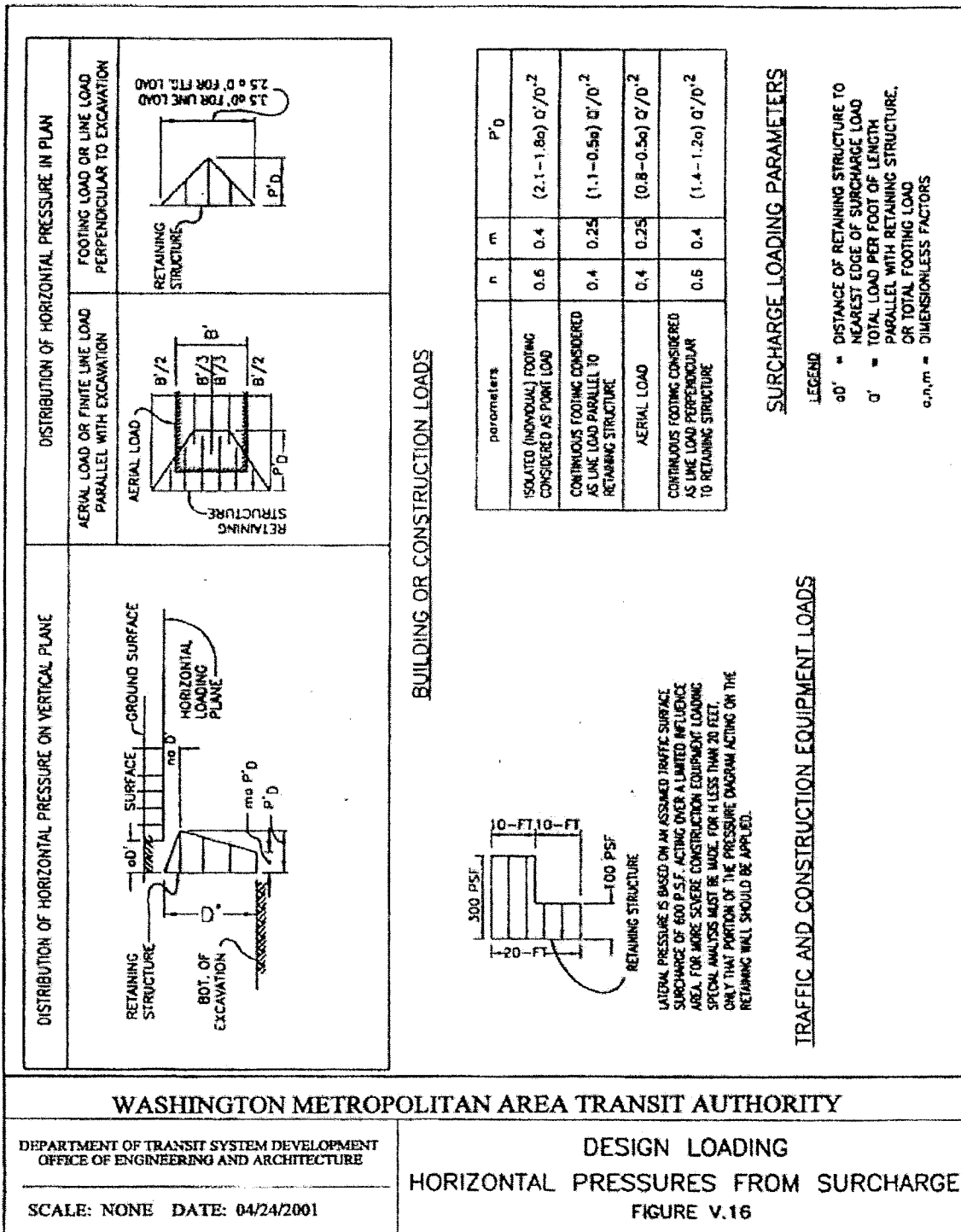
WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT
OFFICE OF ENGINEERING AND ARCHITECTURE

**DESIGN LOADING—TEMPORARY COFFERDAM
STRATIFIED CLAY SOILS**

SCALE: NONE DATE: 04/24/2001

FIGURE V.15b



END OF SECTION

PROGRAM CRITERIA

MECHANICAL

1.01 GENERAL

- A. These criteria cover the work required to retrofit, design, furnish, install and test mechanical systems for the Washington Metropolitan Area Transit Authority (WMATA) modified maintenance facilities at Brentwood, Greenbelt, and Shady Grove including:
1. Ventilation
 2. Heating
 3. Air Conditioning
 4. Air Filtration
 5. Vibration Isolation
 6. Fire Protection
 7. Plumbing
 8. Process Piping
 9. Automated Energy Management System
 10. Elevator Machine Room
 11. Clearance to Installations
 12. Maintainability and Constructability
 13. Submittals
- B. The design shall be complete with automatic temperature controls and automatic energy management controls. The design shall be based on applicable codes, regulations and the following standards.

1.02 CODES AND STANDARDS

- A. Unless otherwise required herein, mechanical designs and installations shall be governed by all applicable local codes in addition to the codes, guidelines and standards listed below. In cases where national codes, local codes, and WMATA standards conflict, the most stringent code or standard shall take precedence. The following publications, in their entirety and of the latest approved edition, form a part of this System Description:
1. WMATA Design Criteria
 2. WMATA Standard Mechanical Specifications
 3. WMATA Standard Drawings

4. WMATA Reference Drawings
 5. WMATA Design Drawings
 6. National Fire Protection Association (NFPA) - 13, 25, 30, 54, 70, 90A, 130, and 2001
 7. ASME- A.17.1
 8. International Mechanical Code (IMC)
 9. International Plumbing Code (IPC)
- B. Heating, Ventilating and Air Conditioning
1. All heating, ventilating and air conditioning system designs shall be based on the version of International Mechanical Code (IMC), as amended by the local jurisdiction, in effect at the time of design.
 2. Air conditioning and refrigerating equipment shall bear the ARI stamp.
- C. Sheet Metal Ductwork
1. All sheet metal ductwork shall be constructed in accordance with Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA) standards.
- D. Fans
1. All fans shall be rated in accordance with the "Standard Test Code for Air Moving Devices" and the "Test Code for Sound Rating Air moving Devices" of the Air Movement and Control Association, Inc.(AMCA).
- E. Acoustical Materials
1. Acoustical materials shall be rated in accordance with the standards of the Acoustical Society of America, UL, ASTM and NFPA.
- F. Noise Criteria
1. Noise criteria shall be as described herein and in the current handbook series published by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).
- G. Fire Protection
1. Fire protection system designs shall be based on NFPA.
- H. Plumbing
1. Plumbing shall meet the standards of the appropriate local authority. The District of Columbia is covered by the International Plumbing Code (IPC), as amended by the District of Columbia. Montgomery and Prince George Counties in Maryland are covered by the Plumbing and Gas Fitting Code for the Washington Suburban Sanitary Commission (WSSC).
 2. All plumbing installations and fixtures shall comply with the applicable requirements of the Americans with Disabilities Act Guidelines (ADA).

I. Piping

1. Friction losses in piping shall be as described in the current edition of the Cameron Hydraulic Handbook.

1.03 CODE COMPLIANCE

A. The following issues shall be addressed to meet current codes:

1. Air intakes and contaminated air sources separated to comply with IMC.
2. Overflow roof drains or scuppers necessary to comply with the IPC.
3. Guardrails for equipment located within 10 feet of the roof edge to comply with the IMC.
4. Fire protection systems shall be modified to comply with NFPA and/or the International Fire Code.

1.04 SCOPE

A. Site Specific Scope

1. Greenbelt

a. Existing Shop Building

(1) Ventilation

- (a) Summer ventilation in the existing building is provided with roof mounted supply fans with air relieved through dampers and louvers.
- (b) The main AC/DC Switchgear Room is ventilated with a filtered and ducted outside air system using two (2) high velocity inline fans. Air is relieved through wall louvers and dampers, which are interlocked with the supply fans. Contractor shall modify system as required to maintain the Program Criteria with the addition of new electrical equipment serving the new addition and the remodeled areas of the existing shop areas.
- (c) Contractor shall verify all supply fans and motor-operated dampers operate properly and as noted in existing sequence of controls.
- (d) The new Oil Storage Room and Welding Room added to the existing building shall be ventilated per IMC.
- (e) The ventilation system (HVU-6) serving the remodeled Steam and Degreasing Room shall be modified and rebalanced as required to coordinate with revised layout. Existing piping and ductwork shall be modified and supported to coordinate with new walls.

- (f) The new Gear Box Rebuild room created within the shop area and the newly enclosed Machine Shop # 1 shall be ventilated per Program Criteria for.
 - (g) The Lathe Room (located where the HVAC Room was previously) shall be ventilated per IMC.
- (2) Heating and Air Conditioning
- (a) The first floor shops, offices, elevated walkway, and locker rooms are conditioned by a central single-zone, constant volume air handling unit (AHU-1) with direct expansion cooling and gas-fired duct furnace heating located in the east mechanical room and a remote air-cooled condensing unit on the roof. Return air is ducted to the unit with an inline return fan. Electric duct heaters provide heat for the locker rooms and two entries.
 - (b) The main AC/DC Switchgear Room temperature and humidity control is maintained with a DX-cooling rooftop unit.
 - (c) AHU-1 system shall be modified and rebalanced as required to serve remodeled Storage Cage, Machine Shop #2, Grit Blast & Parts Washroom, and Lathe Room on the first floor. Contractor shall verify capacity of AHU-1 and provide additional HVAC units as required to meet the additional requirements.
 - (d) The new Gear Box Rebuild room and Machine Shop # 1 shall be heated per Program Criteria for shop areas, and cooled to 84 degrees F.
 - (e) New and remodeled offices within the shop area shall be heated and cooled per Program Criteria with outside air provided to comply with the International Mechanical Code.
 - (f) The new Oil Storage Room and Welding Room shall be heated per Program Criteria for shop areas.
- (3) Fire Protection
- (a) The existing sprinkler systems shall be modified as necessary to accommodate remodeled areas.
- (4) Plumbing
- (a) Domestic water, storm, sanitary, waste, venting and utilities (above and below ground) in conflict with the new structure and modifications in the basement, at the first floor and second floor (mezzanine) shall be modified to accommodate new equipment and space arrangement.
- (5) Process Piping

- (a) Process piping systems and equipment including but not limited to piping, gauges, natural gas, connections, compressed air, filters, grease, lube fluids, and waste oil in conflict with the new structure and modifications in the basement, at the first floor and second floor (mezzanine) shall be modified to accommodate new equipment and space arrangement.

b. New Shop Building

(1) Ventilation, Heating and Air Conditioning

- (a) The new addition shall be heated, ventilated and cooled for office areas unless noted otherwise, with the exception of the Component Parts Storage Rooms and the Mechanical Room.
- (b) The Component Parts Storage Rooms shall be heated and ventilated per Program Criteria for Shop areas.
- (c) The Motor Repair Shops, Mechanical Component Repair Shop, Open Corridor, Pneudraulics Repair Shop, Steam and Degreasing, Parts Washing Rooms, Grit Blast Rooms, and Component Paint Rooms shall be cooled to 84F.

(2) Fire Protection

- (a) The fire protection sprinkler systems shall be modified as necessary to the new addition.

(3) Plumbing

- (a) Domestic water, storm, sanitary, waste, venting, and utilities (above and below ground) shall be expanded with new plumbing fixtures, domestic water, sanitary, waste, venting, and utility services to accommodate new equipment and space arrangement.

(4) Process Piping

- (a) Process piping systems and equipment including but not limited to piping, gauges, connections, compressed air, filters, natural gas, grease, lube fluids, and waste oil shall be increased and modified as required to accommodate new construction.

(5) Elevator

- (a) One (1) new freight elevator and one (1) new passenger elevator shall be provided.

2. Brentwood

a. Existing Shop Building

(1) Ventilation

- (a) Outside air intake hoods are located on the roof and serve the heating and ventilating units throughout the shop area. An outside air intake hood also serves the dual duct air handling unit. These shall be modified and balanced as required for the new arrangement and occupancy.
- (b) The office area additions are ventilated with outdoor air hoods on the rooftop units. These shall be balanced as required for the new arrangement and occupancy.
- (c) The basement General Storage, Wheel and Truck Storage and Dock areas are served by a hot water heating and ventilating unit (HVVU-09). The ductwork, grilles, and system balancing shall be modified for the new arrangements and space occupancies.
- (d) The Ground Floor Shop area is served by hot water heating and ventilating units (HVVU-01 thru HVVU-06 and HVVU-08) located near the roof. Outside air requirements for these units shall be evaluated and adjusted to meet the International Mechanical Code.
- (e) The pit area is served by a heating only unit (HVVU-07) located in the basement. No outside air is provided to the unit (HVVU-07). Outside air requirements for this unit shall be provided per IMC.
- (f) The Shop areas, Toilet and Locker Rooms, Dock, Flammable Liquids Room, and Degreasing Room are served by roof mounted exhaust fans. The Battery Room is ventilated with an inline exhaust fan. The Substations are ventilated with cabinet fans. Each system may be modified or relocated as required for the new building arrangement.

2. Heating

- (a) A central hot water system consisting of two natural gas-fired boilers is located in the basement boiler room. Hot water pumps circulate water to the hot water unit heaters, heating and ventilating units and the office area dual deck air handling unit. The hot water piping and system shall be modified to meet the new building needs.
- (b) Refer to the Brentwood Air Conditioning section for additional existing heating systems.

3. Air Conditioning

- (a) The air handling unit (AHU-01) currently serving the south end of Brentwood is a dual duct unit with a chilled water cold deck and a hot water hot deck. The hot deck is served by a central, gas fired boiler hot water system. The cold deck is served by an air-cooled chiller located on the roof of

the office area. The air handling unit serves the locker/shower and lunch room on the basement level as well as the office areas on the first floor and mezzanine level using dual-duct mixing box air terminals. Modify the mixing boxes, ductwork, diffusers, controls and system balancing as necessary to accommodate the new office space arrangement.

- (b) The interior mezzanine office area addition between columns 4 and 6 is currently served by rooftop unit (RTU-01) with direct expansion (DX) cooling and electric heat. Modify the ductwork, diffusers and system balancing as necessary for the new office space arrangement.
- (c) The first floor electronics shop is currently served by rooftop unit (RTU-02) with DX cooling and electric heat. Modify the ductwork, diffusers and system balancing as necessary for the new office space arrangement.
- (d) The calibration lab is currently served by a split computer room unit (CRU-01) with the condensing unit located on the roof. This unit has electric reheat and a humidifier for control of both temperature and relative humidity. If this system is still in good working order, it may be used in a new lab that requires both temperature and humidity control.
- (e) The basement server and telephone rooms are served by an air handling unit (AHU-02) with DX cooling with the condensing unit located on the roof and the air handling unit located in the server room. The unit has electric heat. Modify the ductwork, diffusers and system balancing as necessary for the new office space arrangement.
- (f) The basement Pneudraulics and Electronics Components Rooms are served by air handling units (AHU-03 and AHU-04) with DX cooling with the condensing units located on the Dock roof. The units have electric heat. Modify the ductwork, diffusers and system balancing as necessary for the new office space arrangement.
- (g) The Automatic Train Control (ATC) room is served by rooftop unit (RTU-03) with DX cooling and electric heat. This is a retrofit system. Provide new system with reconfigured ductwork to condition the new ATC room.
- (h) Various local office spaces within the basement and ground floor shops are served by small thru-wall packaged terminal air conditioners. Modify or replace units as necessary for reconfiguration of spaces.

4. Fire Protection

- (a) The existing fire protection sprinkler systems shall be modified as necessary to accommodate the modifications to the structure and building systems. This modification includes the basement, first floor, and mezzanine areas being modified to incorporate three new tracks in two existing bays. New sprinkler systems and the required water supply modifications shall be provided in the new addition for the at-grade dock. The existing system shall be

temporarily supplied to maintain sprinkler protection throughout construction.

5. Plumbing
 - (a) Domestic water, storm, waste, and vent piping shall be expanded with new plumbing fixtures, domestic water, sanitary, waste, venting, and utility services to accommodate new equipment and space arrangement.
 - (b) Roof drain piping shall be relocated to accommodate new location of skylights.
 6. Process Piping
 - (a) Process piping systems and equipment including but not limited to piping, gauges, connections compressed air, filters, natural gas, grease, lube fluids, and waste oil in conflict with the new structure and modifications in the basement, first floor, and mezzanine shall be modified to accommodate new equipment and space arrangement.
 - (b) Vacuum pump at the mezzanine level in conflict with modifications shall be adapted to accommodate equipment and space arrangements.
 7. Elevator
 - (a) Provide new freight elevator and modify existing passenger elevators to be ADA compliant.
3. Shady Grove
- a. Existing Blow Pit
 - (1) Ventilation
 - (a) Replace the existing Blow Pit dust collector and ventilation system and the new system shall cover the modified Blow Pit and expansion.
 - (b) Blow Pits shall be ventilated to effectively remove the dust produced by the blow cleaning.
 - i. The air from the Blow Pit cleaning area shall be ducted through a dust collector system before being recirculated in the blow pit area, or before being discharged to the atmosphere.
 - (2) Heating
 - (a) Hot water heating piping shall be expanded to include addition to blow pit area.
 - (b) Replace heating systems in the Blow Pit area.
 - (3) Fire Protection

- (a) The existing sprinkler systems shall be modified as necessary to accommodate the new addition for the Shop Building to house Service & Inspection operations, the new Support Area, and Blow-down Pit Addition areas. The existing sprinkler riser on the southwest side of the building shall be moved for the new addition. The systems shall be temporarily supplied to maintain sprinkler protection throughout construction.
- (4) Plumbing
 - (a) Domestic water, sanitary, waste, venting, and utilities (above and below ground) in conflict with the new structure and modifications in the basement, at the ground floor and mezzanine shall be modified to accommodate new equipment and space arrangement.
 - (b) Trench drain sludge collection shall be modified to eliminate standing water in the blow pit area.
- (5) Process Piping
 - (a) Process piping systems (compressed air, filters, natural gas, fuel oils, grease, lube fluids, and waste oil) in conflict with the new structure and modifications in the basement, at the ground floor and mezzanine shall be modified to accommodate new equipment and space arrangement.
 - (b) Modify existing instantaneous pressure washer system to accommodate modified Blow Pit.
- b. New Shop Expansion
 - (1) Ventilation
 - (a) The relief louver for the AC Switchgear Room and the intake louver for the DC Breaker Room are located in the existing exterior wall. The new addition requires the relief louver and the intake louver to be relocated.
 - (b) The existing basement Battery Room relief louver, ductwork and associated accessories shall be relocated to accommodate new addition.
 - (c) The elevator equipment room shall be ventilated per Program Criteria.
 - (d) Ventilate new addition per Program Criteria for shop areas.
 - (2) Heating
 - (a) New hot water heating coils and hot water unit heaters shall be used for heating. Existing fuel oil-fired boilers located in the basement mechanical

equipment room shall supply hot water through a closed loop system.

- (b) The existing fuel oil storage tank is located below the existing parking lot. Due to the new addition, the fuel oil storage tank, piping and associated appurtenances shall be relocated.
- (c) Heat new addition per Program Criteria for shop areas.

(3) Air Conditioning

- (a) The AC Switchgear Room and DC Breaker Room shall be air conditioned to maintain 84 degree F summer and 50 degree F winter using the glycol heat recovery loop system. For conditions where the glycol heat recovery loop system is not accessible or economical, a DX-cooling system shall be used. Modify cooling system as required to condition new equipment.
- (b) Office, meeting and toilet rooms within the shop expansion shall be heated and cooled per Program Criteria with outside air provided to comply with the International Mechanical Code.
- (c) Modify air conditioning for control room per Program Criteria as necessary to accommodate new equipment.

(4) Fire Protection

- (a) The fire protection sprinkler systems shall be modified as necessary to accommodate the new addition and new functions. The new addition shall require new sprinklers, and the areas being modified shall accommodate the new functions.

(5) Plumbing

- (a) Domestic water, storm, sanitary, waste, venting and utilities (above and below ground) shall be expanded with new plumbing fixtures, domestic water, sanitary, waste, venting, and utility services to accommodate new equipment and space arrangement
- (b) Trench drains sludge collection shall be designed to eliminate standing water in the blow pit area.
- (c) Roof drain piping shall be expanded to accommodate the new addition.
- (d) Domestic water, fuel oil, and fire supply lines shall be modified.

(6) Process Piping

- (a) Process piping systems and equipment including but not limited to piping, gauges, connections, fuel oil, compressed air, filters, grease, fuel oils, lube fluids, and waste oil capacity shall be increased as required to accommodate new construction.
 - (b) Provide new Blow Pit wash equipment to match existing.
- (7) Elevator
- (a) Provide (1) new passenger elevator.

1.05 VENTILATION

A. General

1. All existing, retrofitted, and new office and shop areas shall be evaluated for use and shall be modified or designed to meet all current codes, standards, and/or this Program Criteria for ventilation rates.
2. Spaces not described in this Program Criteria shall be ventilated as per the IMC.
3. All outside air shall be filtered before building distribution.

B. Characteristics

1. The characteristics of the individual ventilation systems for all areas and rooms in the shop renovations and additions are described below. The following are minimum requirements:
 - a. AC Switchboard Rooms
 - (1) Provide two fans of equal capacity. A room thermostat shall cycle the lead fan when the room temperature reaches 90°F. The two fans shall not operate simultaneously except when under manual control. During each cycle, one fan shall serve as a stand-by which will operate only upon failure of the lead fan. Lead fan and stand-by fan shall alternate automatically after each operating cycle. Provide a H-O-A switch for each fan. Provide controls such that the air intake dampers remain open when neither fan is operating. During operation of any one fan, the intake damper with other fan shall be closed. The fans shall be located on the supply side of the system. The ductwork, air distribution system, intake and relief louvers and dampers shall be sized for one fan operation. Relief air shall be discharged to a point outside of the building unless otherwise approved by the Authority. Supply air shall be from a point outside of building filtered through a bag filter sized for one fan operation and discharged into the AC Switchboard Room to maintain a positive pressure of 0.1 inch of water gauge within the room with respect to adjacent space. Air quantities for each fan shall be based on the following:
 - (2) Single AC Switchboard Rooms - 8 cfm per kVA for the total output rating of the main and auxiliary transformers and 51

cfm per kVA for the total output rating of the uninterrupted power system.

- (3) Combined AC Switchboard Rooms - 8 cfm per kVA for 65% of the combined total output rating of the two main transformers, 8 cfm per kVA of the total output rating of the auxiliary transformers, and 51 cfm per kVA of the total output rating of the uninterrupted power system. When it is determined that a combined switchboard room has only essential loads, reference Electrical Program Criteria, provide 8 cfm per kVA for only 50% of the combined total output rating of the two main transformers. If the switchgear and transformers are located in separate rooms, the air shall be distributed in proportion to the load in each room. Transfer of air from one room to the other is not allowed. Provide tight fitting, weather-stripped doors with no undercuts on underground AC Switchboard Rooms.
- (4) A special consideration shall be given for control of humidity in the room.

b. DC Breaker Rooms

- (1) Below Grade:
 - (a) Supply: Provide eight air changes per hour. Provide a H-O-A switch. Air shall be drawn from and discharged to a point outside of the building unless otherwise approved by the Authority, filtered, and discharged into the breaker room so as to maintain a positive pressure not exceeding 0.1" WG within the room. Provide tight fitting, weather-stripped doors with no undercuts. Fan will be operated by thermostat to maintain room temperature of 90°F.
- (2) Surface:
 - (a) Supply: Provide eight air changes per hour. Maintain positive pressure not exceeding 0.1" WG within the room. Filtering of air not required unless special conditions exist.

c. Battery Rooms

- (1) Exhaust: 18 Air Changes per Hour. Exhaust system shall be operated continuously. Air shall be drawn from adjacent AC Switchboard Rooms and discharged to a point outside of the building unless otherwise approved by the Authority. Additional filtering is not required. Provide tight fitting, weather-stripped doors with no undercuts on underground Battery Rooms.
- (2) Suspended ceilings are not allowed. Battery Rooms shall be under negative pressure not to exceed 0.1" WG.

d. Train Control, Dispatch, and Communications Rooms

- (1) Provide air conditioning with 0.3 CFM of filtered, outside air per square foot of floor area.

- (2) Train control room has 8,000 watts of internal electrical heat load, plus a lighting load of 4 watts per square foot. Communication Room has 6,000 watts of internal electrical heat load plus a lighting load of 4 watts per square foot. Train Control and Communications Rooms doors shall be tight fitting with no undercutting for relief air. Relief venting of these rooms shall be accomplished by means of adjustable, motorized dampers. Dampers shall be sized at 1100 feet per minute to maintain slight positive pressure in the rooms.
- e. Maintenance Rooms
 - (1) Exhaust: 10 Air Changes Per Hour
- f. Restrooms, Locker Rooms, Cleaners' Rooms, and Sewage Ejector Rooms
 - (1) Exhaust: 2-1/2 CFM per square foot of floor area, exhausted to outside where possible.
- g. Shop areas, basements, and inspection pits shall be ventilated during the summer to remove heat gain from all sources with temperature rise of 10°F. The winter ventilation rate shall be based on the IMC.
- h. Elevator Machine Rooms - See Elevator Machine Room Section.
- i. Electric and telephone equipment rooms - no mechanical ventilation unless heat producing equipment, i.e. transformers, are to be installed in the room(s).

1.06 HEATING

A. General

- 1. All-heating equipment shall be natural gas heating or hot water heating. Where natural gas heating or hot water heating are not accessible or not economical, electric resistance heat shall be used. Wall heaters, unit heaters, duct heaters or combination heating/cooling units may be employed as required by the application. Convective type wall heaters are preferred to force-flow types provided units are available in the required capacity.
- 2. Design Temperature
 - a. Design dry-bulb temperatures for each room are as follows:
 - (1) AC Switchboard Rooms (Below Ground): No heat required.
 - (2) AC Switchboard Rooms (Above Ground): Provide heat to maintain 50°F. Calculations of heating load shall include a deduction of 10,000 BTU per hour for each 100 KVA of transformer capacity.
 - (3) DC Breaker Rooms - Below and above ground, provide heat to maintain 77°F.

- (4) Battery Rooms - Provide heating for underground battery rooms to maintain 77°F. Assume heat gain from the adjoining AC switchgear room equal to one percent of the rated capacity of the transformers in the switchboard room. Above ground, provide heat to maintain 77°F.
- (5) Train Control and Communications Rooms-60°F.
- (6) Dispatch, Operations, and Trainmen's Rooms-70°F. Deductions shall not be made for internal loads in the computation of heating load.
- (7) Above Ground Maintenance Rooms-60°F, no heating is required in below ground maintenance rooms.
- (8) Washrooms, 70°F.
- (9) Cleaner's Rooms and water service rooms, 50°F.
- (10) Elevator Machine Rooms, 50°F.
- (11) Above Ground Electric rooms and mechanical rooms-60°F, except no heating is required in below-ground rooms.
- (12) Shop area, inspection and cleaning pits, blow pits, stair wells, basement, offices, lunch room, rest rooms and locker rooms shall be heated to maintain a temperature of 70°F.

3. Heat Loss Parameters

a. Underground:

- (1) One BTU per square foot per hour loss to ground.
- (2) Ambient temperature assumptions: 14°F outdoor.

4. Heating Equipment - Electrical Characteristics

- a. See Electrical Program Criteria for electrical characteristics. Verify that scheduled equipment is commercially available. All heating equipment shall be thermostatically controlled. Control transformers shall be provided where required.

5. Special Systems

- a. Air curtains: Air curtain supply to be tempered to a minimum of 50°F DB.

1.07 AIR CONDITIONING

A. General

- 1. In general, air conditioning shall be provided in rooms where personnel are stationed for extended periods of time or where equipment operation requires lower temperatures than can be provided by mechanical ventilation. Variation from these criteria must be approved by the Authority.

2. All offices, lunch rooms, locker rooms, office areas, control rooms and restrooms shall be air conditioned to maintain a temperature of 72°F.
 3. Operations Rooms and Dispatcher's Rooms
 - a. Provide air conditioning designed for two occupants and a lighting load of 4 watts per square foot. Provide manual on/off control. In the case of underground rooms, use split system air conditioning units. Locate condensers in areas where exposure to dust is minimized. Small capacity self contained air conditioning units are acceptable for use in isolated rooms above ground.
- B. Design Conditions
1. The following conditions shall be used in the selection of equipment and design of air conditioning systems.
 - a. Ambient summer design conditions: 91°F Dry Bulb and 77°F Wet Bulb
 - b. Design room conditions at peak load: 72°F Dry Bulb
- C. Air Conditioning Equipment
1. Air conditioning equipment may be self-contained or split system type. Thermostatic control shall be provided. Control voltage shall not exceed 120 volts.

1.08 AIR FILTRATION

- A. Air filters shall be of the following types:
1. Under 5,000 cfm: Replaceable media
 2. 5,000 cfm and over: Primary - bag type, 80-85% efficiency; Prefilter - replaceable media

1.09 VIBRATION ISOLATION

- A. Vibration Isolation
1. Equipment producing vibrations shall be isolated from the structure by spring or rubber-in-shear vibration isolators. All pipe and ducts connected to equipment mounted on vibration isolators shall contain flexible connections or provisions made for vibration isolating type supports. Identify on drawings where vibration isolators are to be provided.
- B. Equipment Mountings
1. Equipment to be mounted on the floor shall be placed on reinforced concrete housekeeping pads. Minimum pad height shall be six inches; all equipment to be suspended from ceiling shall be provided with suspension type hangers consisting of combination of spring and neoprene in series.

1.10 FIRE PROTECTION

A. Fire Suppression Systems

1. Fire Suppression Systems shall be designed to comply with requirements of NFPA 13 for a completely sprinklered building.

B. Fire Alarm System

1. Fire Alarm Systems shall be designed per this section and the communications section.

C. Smoke and Fire Detection System

1. Detectors will be of the ionization type, combined rate of rise/fixed temperature type or fixed temperature type. Detectors will be designed to detect abnormal smoke densities, products of combustion or heat in electrical rooms, ducts of air conditioning systems, and elevator machine rooms. The detection system will be equipped with contacts which can perform the following functions:
 - a. Stop all air conditioning fan units and ventilation fans having a capacity in excess of 2000 cfm and battery room fans that serve or are located in the zone protected by activated detector.
 - b. Terminal boxes shall be located in mechanical equipment rooms and control wiring shall be run to nearest terminal box. Equipment schedules shall identify the units served by each terminal box.

D. Fire Extinguishers

1. Portable fire extinguishers, where required by fire code standards, shall be of the dry powder, stored pressure type, Type 4A: 40B: C, suitable for use on Class A, B, and C fires; or alternate type consistent with the degree of hazard, except as follows:
2. Train Control, Communications Rooms, Electrical Rooms -- Carbon dioxide or Clean Agent (CF₃CH₂CF₃), 10B: C.
3. Fire extinguishers in traction power substations and A.C. switchboard rooms are to be located such that the maximum travel distance to any extinguisher will not exceed 50 feet. Extinguisher locations are to be identified on the plans with extinguishers furnished and installed by the Authority.

F. Fire Hydrants

1. Assure or provide fire hydrant within 100 feet of fire department Siamese connection, within public right-of-way if possible, and in a location that will not necessitate running fire hoses across a major or heavily-trafficked thoroughfare. Advise the Authority if no hydrant exists within the 500 feet limit or if a hydrant is required to comply with access criteria. Coordinate specific location with local jurisdiction. Fire hydrants located in public right-of-way will be provided by the local jurisdiction. Water line of adequate size will be extended to the WMATA property line by the responsible jurisdiction.

G. Fire Walls

1. The integrity of all fire walls shall be maintained at all penetrations of whatever sort, as for piping, conduits, ductwork, air intake, air exhaust or air relief

openings, etc. Walls or floors shall be protected when designated fire rated in order to comply with applicable codes.

2. Fire dampers complying with the SMACNA Fire Damper Guide and all other applicable codes and standards shall be installed at all duct penetrations and at all other openings provided for the passage of air in fire rated floors or walls. The location of fire dampers shall be indicated on the contract drawings. Where fire dampers are installed in ducts, access panels will be provided to permit inspection and resetting of the fire dampers.
3. Where pipes or conduits penetrate a fire wall, the space between the sleeve and pipe or conduit shall be tightly packed with an approved noncombustible material of a rating equivalent to the wall or better. In all cases, there shall be full closure of the penetration in a manner as to preserve the fire rating of the fire wall.

H. Fire Protection for all Areas

1. All rooms shall be provided with a sprinkler system for NFPA ordinary hazard, Group 1 minimum water density and spacing, except where NFPA 13 requires higher hazard use.
2. Sprinkler heads shall be uniformly located within the space, midway of the width of the room in cases where a single sprinkler head is required, and equally spaced where two or more sprinkler heads are required.
3. Sprinkler heads are to be of the fusible link type with temperature rating of 165 degrees F in conditioned spaces and in accordance with NFPA 13 for ambient temperatures above 100 degrees F. An unmonitored OS&Y shut-off valve, a swing check valve and a flow detector switch are to be provided in the branch line to the sprinkler heads. OS&Y valve shall be easily accessible, be readily viewed from the room door, and sealed in the open position. A flow detector shall be located between the OS&Y valve and check valve. A 1/2" bronze angle hose valve is to be installed at the end of the sprinkler pipe. The flow switch is to be connected into the fire alarm circuit for the fire zone in which the sprinklers protect.

I. Clean Agent Suppression Systems

1. Where fire suppression systems in electrical rooms are required by the local jurisdiction, Clean Agent (CF3CHFCF3) systems shall be provided in accordance with NFPA 2001 Standards and as follows:
 - a. Each protected room shall be served by an independent system.
 - b. Systems shall be sized on a 7% total flooding basis.
 - c. Reserve supplies shall not be provided unless required by local jurisdiction.
 - d. Clean Agent (CF3CHFCF3) storage shall be located near the protected room (storage may be in protected room if conditions make it necessary).
 - e. Each system shall have a dual zone panel.
 - f. Ionization detectors will be provided and transmit a zone 1/zone 2 signal to panel.

- g. Clean Agent System panel shall activate audible alarm, close dampers and shut off fan if either zone signal is received.
- h. When the second zone signal is received, Clean Agent System panel shall:
 - (1) Activate second (different) audible alarm.
 - (2) Start timer (0 to 60 sec.).
 - (3) Discharge Clean Agent when timer times out.
 - (4) Activate "Clean Agent" visual alarm outside of each entrance to the room when Clean Agent is discharged.
- i. Clean Agent shall discharge in 10 sec. maximum.
- j. A manual by-pass fan switch shall be provided outside the protected room (for Fire Department use).
- k. A manual Clean Agent release shall be provided to function as if a zone 1/zone 2 signal had been received.
- l. Battery power shall be provided for Clean Agent panel. Batteries shall be equipped with a trickle charger.
- m. A remote reset switch shall be provided at a station supervising the system.
- n. Protected room doors shall swing out.
- o. Panic hardware shall be provided for protected room door latches.

1.11 PLUMBING

- A. Pipe and Fittings
 - 1. Soil pipe within the structure shall be pitched at 1/4" per foot, except soil pipe in invert running the length of the station shall be pitched at 1/8" per foot with one pipe size larger pipe.
 - 2. Domestic hot and cold water piping in the structure shall be copper tubing.
 - 3. Drainage pipe (for track drains and seepage drains) shall be perforated or unperforated as required.
 - 4. Force mains shall be mechanical joint, ductile iron pipe.
 - 5. Pipe for water service entrance shall be ductile iron, mechanical joint.
 - 6. Floor drains in Mechanical Equipment rooms may be connected to the track drains without venting.
 - 7. Minimum waste pipe size underground or in structural slab shall be 2".
 - 8. Electrolytic separation shall be provided for dissimilar metals.
 - 9. Cathodic protection for buried pipe shall be provided as required.

10. Unless otherwise approved by the Authority, water, sewer and drainage pipes shall not be run through electrical equipment spaces.

B. Roughing-in

1. Sleeves shall be provided in the structure to accommodate plumbing installations. Sleeves shall be provided in structural walls for the extension of the force main from the sewage ejector. Piping shall be run as directly as possible. All piping shall be run parallel to and at right angles to walls and partitions. Multiple pipes shall be grouped in parallel lines.

C. Water Service

1. At least four (4) inch diameter water service connection shall be provided to each facility. Each domestic service shall have a main shut-off valve immediately inside the structure wall.
2. Required load, in GPM, shall be estimated from fixture unit values as follows:

Flush valve water closet	10
Flush valve urinal	5
Lavatory	2
Mop Service Basin	3
3. Fixture demand in GPM can be estimated from data in The Model Plumbing Code, Washington Suburban Sanitary Commission Plumbing Code, or International Plumbing Code, whichever is applicable.
4. The demand for outlets, (hose connections, cooling tower, make-up, etc.) which are likely to impose continuous demand, shall be estimated separately and added to the fixture demand GPM to determine the total demand.

D. Hot Water Service

1. Hot water shall be supplied to all toilet and cleaner's rooms. Hot water shall be supplied by electric heaters. Heaters shall be installed at least six inches above floor. Heater capacity shall be based on 100°F recovery and shall be sized in conformance with the fixtures installed which are to be served by the heater.
2. Provide relief valves in accordance with code requirements. Relief valve shall be piped to indirect waste.
3. Provide a recirculation system if supply piping is more than 100 feet long.

E. Insulation and Freeze Protection

1. The following shall be insulated:
 - a. Water piping.
 - b. Traps at roof drains.
 - c. Exposed floor drain traps.

- d. Portions of all water piping subject to freezing. Condenser water piping exposed to freezing temperatures shall be drained after the cooling season. Any remaining exposed sections which are not drained shall be heat traced to prevent freezing.
 - e. Portions of drainage and cold water piping subject to sweating.
 - f. Hot water heater, if not factory insulated.
2. Where freeze protection is required, use electric heating cable.

F. Plumbing Fixtures

1. Provide number and types of fixtures as required by the applicable local plumbing code. One set of fixtures and accessories in each men's and women's washrooms shall be suitable for use by the physically handicapped and in compliance with local codes and ADA.
2. Mop service basins shall be of the floor-mounted type.
3. Provide one electric water cooler per local building code. Electric water coolers shall be wall-mounted and hand-operated and ADA compliant.
4. Water supplied to lavatories and flush valve fixtures shall have water shock absorbing provisions.
5. Vacuum breakers shall be installed on all outlets with hose bibb connections and submerged inlets.
6. In addition to the features listed above, plumbing fixtures shall also meet the following requirements:
 - a. Lavatories: Self closing outlet devices 0.5 GPM
 - b. Outlet temperature, 110°F maximum
 - c. Maximum hot water, 0.25 gallon/actuation
 - d. Showers: 3 GPM per shower head
7. All water supplies to fixtures shall have key operated service valves. Each connection shall carry the pressure recommended by the fixture manufacturer but not less than 15 psi for flush valves and 8 psi for other fixtures.

Plumbing Fixture Schedule

<u>Symbol</u>	<u>Fixture</u>	<u>Waste</u>	<u>Trap</u>	<u>Vent</u>	<u>HW</u>	<u>CW</u>	<u>Remarks</u>
WC	Water Closet	4"	Integral	2"	No	Yes	Wall Hung
UR	Urinal	2"	Integral	1-1/2"	No	Yes	Wall Hung
LAV	Lavatory	1-1/2"	1-1/4" x 1-1/2"	1-1/2"	Yes	Yes	Wall Hung
MSB	Mop Service Basin	3"	3"	1-1/2"	Yes	Yes	Set on Floor Slab
EW/BS	Eye Wash Fountain and Body Spray	1-1/2"	*	*	No	Yes	Wall Hung
EWC	Electric Water Cooler	1-1/2"	1-1/2"	1-1/2"	No	Yes	Wall Hung
SH	Shower	3"	3"	1-1/2"	Yes	Yes	Set in Wall

* Required only where connected to sanitary sewer.

Minimum Fixture Supply Pipe Sizes

Flush Valve Water Closet	1"
Flush Valve Urinal	3/4"
Lavatory	3/8"
Mop Service Basin	1/2"
Hose Bibb	3/4"
Eye Wash Fountain and Body Spray	1/2"
Electric Water Cooler	1/2"
Shower	1/2"

8. Where city water pressure is above 60 psi at water service room, provide reducing valve assemblies consisting of reducing valve, three-valve bypass, and strainer.
9. Emergency eye wash and body spray facilities shall be provided in chilled water plants, battery rooms, traction power substations, tie breaker stations, car wash buildings, and in any other areas where corrosive materials are handled or stored. Portable eye wash and body spray facilities will be furnished and installed by the Authority; however, their locations are to be designated and a clear wall space of not less than 30" wide and 6'-0" high provided. Shields will be provided at both permanent and portable facility locations as required to

protect electrical equipment from water spray. A minimum of 20 psi water flow pressure is to be provided to the permanent eye wash fountain and body wash facilities.

G. Sewage Ejector Station

1. Sewage ejector stations shall be of the triplex type and utilize vertical dry pit sewage pumps. Dry pits shall be provided with ladder access and covered with grating. A sump pit and pump shall be provided in the dry pit and shall discharge to the wet well. Wet wells shall be sealed and vented per local codes. Wet well access shall be through a gas tight manhole. Each pump shall have a capacity of 100 percent of design load and as follows:

Pump Rating	Based on fixture unit as previously stated for water service, minimum capacity of 50 gpm.
Pump Head installation.	To suit static and friction heads of each installation.
Electrical Characteristics	See Electrical Program Criteria.
Ejector Discharge	Ejector discharge to the nearest sanitary or combined sewer shall be minimum four-(4) inch cast iron pressure pipe - mechanical joint. Discharge velocity shall be 2.5 feet per second minimum, 7 feet per second maximum.

2. Sewage ejector station controls shall utilize float switches such that the lead pump is energized after the lead pump float switch rises to the pump start position and de-energized after the pump off float switch falls to the off position. If the sewage level continues to rise after the lead pump is energized, additional float switches shall energize the first lag pump and a high level alarm. If sewage level still continues to rise, additional float switches shall energize the second lag pump and a second high level alarm. An alternator shall be provided to alternate lead and lag pumps after every cycle.

H. Elevator Sump Pump

1. Elevator sump pump that does not pump oil into storm or sanitary system and complies with local codes and regulations.

1.12 PROCESS PIPING

A. Compressed Air Systems:

1. Compressed air shall be provided for equipment scheduled in shop equipment listing. In addition, provide miscellaneous cool air drops with valving, filters and connections to match existing shop air drops. Space air drop stations to match existing shop distribution.
2. New compressors shall be rotary screw type UL approved air compressors, dual receiver/compressor with each speed for 60% of required capacity.

1.13 AUTOMATED ENERGY MANAGEMENT SYSTEM

A. General

1. The Automated Energy Management System (AEMS) shall be modified to incorporate the building system modifications to the HVAC, plumbing and fire protections systems.
2. New buildings shall implement an AEMS system to control and monitor the HVAC, plumbing, and fire protection systems.

1.14 ELEVATOR MACHINE ROOM

A. Machine Room

1. The purpose of temperature control in the Machine Room is to prevent equipment shutdown due to over-cooling or over-heating. Machine Room temperature shall be maintained between 50 °F minimum and 100 °F maximum, unless elevator manufacturer's recommendations differ. Temperature controls shall be automatic.
2. Maximum temperature control shall be maintained with one of the following systems:
 - a. Exhaust the airflow required to maintain Machine Room temperature at or below maximum design requirement. Make-up air shall be transferred from inside the building. Calculate airflow as follows, using motor heat output to space as provided by equipment manufacturer:

$$\text{CFM} = \frac{\text{Motor heat output to Machine Room in BTUHs}}{1.08 \times (100 \text{ }^\circ\text{F} - \text{make-up air temperature})}$$
 - b. Where adequate make-up air is unavailable, utilize an air terminal unit, fan coil unit, or split system to provide temperature control for Machine Room. All air shall be recirculated within Machine Room.
3. For planning purposes, design for 15 horsepower motors for electric elevators, 30 horsepower for hydraulic elevators up to 20 feet of rise, and 35 horsepower for hydraulic elevators of more than 20 feet of rise.
4. Machine room walls shall be constructed with 2-hour fire rating. Ducts penetrating rated walls shall have 2-hr fire dampers protecting penetrations.
5. Minimum head room clearance of 7'-0" shall be provided under HVAC equipment and ductwork.
6. No water piping shall be designed or installed to cross through any elevator machine room.

1.15 CLEARANCE TO INSTALLATIONS

- A. A minimum of two inches is required between any fixed installations (e.g. pipes, pipe hangers, pipe supports, signals, lighting fixtures, etc.) and the design vehicle dynamic outline. Installations shall be so dimensioned and located that maximal distances are obtained between these and clearance envelope along tangent and curved alignments.

1.16 MAINTAINABILITY AND CONSTRUCTABILITY

- A. The design of mechanical systems and equipment installations shall be coordinated with structural, electrical, architectural and other disciplines for the purpose of insuring adequate space, clearances, structural support, and non-interference with other trades during construction. Designs shall take ease of mechanical equipment maintenance into account. Maintenance operations will include inspection, adjustments, cleaning,

trouble shooting, servicing, repairs and replacement of mechanical equipment. The selected equipment shall be subject to minimal system component failure.

1. Space and Accessibility
 - a. Sufficient working space and adequate access shall be provided for the maintenance and replacement of all mechanical equipment. This requirement shall include adequate space for movement of equipment during initial installation, and during subsequent unscheduled maintenance involving removal and replacement of failed equipment.
2. Specific Requirements
 - a. Mechanical system designs shall be in accordance with the following requirements:
 - (1) Mechanical equipment mounted 8 feet or more above the finish floor shall be provided with work platforms. The mechanical equipment in this category shall include any items which require frequent servicing or contain large components or require large replacement parts.
 - (2) Access to work platforms less than 10 feet shall be by portable ladder. Fixed ladders shall be provided to work platforms 10 feet or more in height.
 - (3) Chain operators shall be provided for chilled and condenser water valves mounted 8 feet or more above the finish floor.
 - (4) Chiller and boiler tube pull spaces shall be indicated on the contract drawings.
 - (5) Filter pull spaces shall be indicated on the contract drawings.
 - (6) Coil pull spaces shall be indicated on the contract drawings.
 - (7) Special requirements (e.g. cooling tower drive shaft pull space) shall be considered and called out on the contract drawings as required.
 - B. Equipment shall not be suspended over floor mounted equipment or pits in a manner which prevents access to the suspended unit.

1.17 SUBMITTALS

A. GENERAL:

1. The contractor shall submit to the Authority for approval.
2. Products to be used prior to the design phase.
3. 60 and 90 percent complete design drawings for review.
4. O& M manuals and training manuals
5. As built mechanical drawings.

END OF SECTION

PROGRAM CRITERIA

ELECTRICAL

1.01 GENERAL

- A. These program criteria include functional and design requirements for the supply and supervision of electrical power to the Washington Metropolitan Area Rapid Rail Transit System shop renovations at three sites: Brentwood, Greenbelt, and Shady Grove.
- B. The Electrical Systems will supply power to all building systems to provide safe, efficient and continuous operation. Design the Electrical Systems in coordination with the requirements of the individual power companies in D.C. and Maryland providing primary power to the system.

1.02 GLOSSARY

- A. Standard Terminology
 - 1. In general, definitions applied to AC power conform to definitions listed in ANSI/IEEE C37.100 of the American National Standards Institute and the Institute of Electrical and Electronics Engineers.
 - 2. Basic electrical terminologies used in these criteria, which are not defined in the ANSI/IEEE reference are to be interpreted in their normal usage.

1.03 STANDARDS AND CODES

- A. Where applicable, conform to the current adopted version of the following standards and codes:
 - 1. National Electrical Code (NEC)
 - 2. National Electrical Safety Code (NESC)
 - 3. Electrical Codes of the District of Columbia and Counties of Maryland and Virginia through which the Transit System may operate.
 - 4. American National Standards Institute (ANSI)
 - 5. National Electrical Manufacturers Associations (NEMA)
 - 6. Institute of Electrical and Electronic Engineers (IEEE)
 - 7. Illuminating Engineering Society of North America (IESNA)
 - 8. Insulated Cable Engineers Association (ICEA)
 - 9. Underwriters Laboratories, Inc. (UL)
 - 10. Intertek Testing Services (ITS)
 - 11. ASHRAE 90.1
 - 12. International Energy Conservation Code (IECC)
 - 13. Building As-Built Drawings
 - 14. WMATA Design Criteria

1.04 SCOPE

- A. General Scope
 - 1. The scope includes all work required to design, furnish, install, connect, test, and energize the power, lighting, and grounding required for the redeveloped and new

- buildings and buildings' systems equipment. Systems include, but are not limited to, DC power, HVAC, special purpose receptacles, elevators, turntables, car hoist/crane systems, service shop equipment, communications, control systems, and equipment required by other disciplines.
2. Coordinate with WMATA to determine locations, loads, voltages, connection requirements and other electrical characteristics of WMATA's new and relocated equipment.
 3. The work may modify existing exits and means of egress. Re-evaluate exit signs and emergency lighting and modify where necessary.
 4. Provide temporary power to keep work disruptions to a minimum. Coordinate and stage all electrical work to maintain maximum operational ability of the facility during construction.
 5. Carefully phase work at all three sites to keep maintenance services as functional as possible during construction. Provide a complete schedule of the phased construction plan to owner for approval.
 6. Work in existing facilities includes removing and/or relocating power, lighting, and grounding systems and coordinating work to minimize downtime and interference with building functionality.
 - a. Remove abandoned conduit above accessible ceilings. Cut conduit behind walls and below floors. Patch surfaces and finishes to match existing fire ratings and finishes.
 - b. Without additional cost to owner, replace equipment, facilities, and materials damaged as a result of demolition work.
 7. Work in the new facilities includes primary and secondary power distribution.
 8. Work includes site visit and field verification of existing conditions.
 9. Where existing overcurrent protective devices are intended for re-use, test and certify for re-use.

B. Site Specific Scope

1. Greenbelt
 - a. Existing Shop Building
 - (1) Relocate or remove electrical equipment, panels, area lighting, and associated wire and conduit in designated areas to facilitate the project upgrades to the building.
 - (2) New and relocated equipment may be installed in the existing building shop areas. Provide working clearance and track clearance around new electrical equipment.
 - (3) Provide all new and replacement electrical equipment needed to facilitate new shop layouts. Equipment may include, but not be limited to, feeders, Motor Control Centers, distribution panels, combination motor starters, fused and non-fused disconnect switches, welding receptacles and circuit breakers. Coordinate individual space requirements with owner.
 - (4) In spaces where existing lighting may remain, measure and record existing lighting levels. If lighting levels are deficient for the new use of space, modify lighting to meet the illumination levels referenced in the lighting systems section of this document.
 - (5) Provide new light fixtures for new rooms.
 - (6) Work includes bringing area of work up to current code.
 - b. New Shop Building

- (1) New and relocated equipment may be installed in the new building shop areas. Provide working clearance and track clearance around new electrical equipment.
- (2) Provide a new electrical distribution system to provide power for the new and relocated shop equipment, receptacles, HVAC equipment, elevator equipment, special systems and lighting. Equipment may include, but not be limited to, feeders, Motor Control Centers, main and secondary distribution panels, transformers, combination motor starters, fused and non-fused disconnect switches, welding receptacles and circuit breakers. Coordinate individual space requirements with owner.
- (3) The new shop building shall be provided with a complete grounding system.

2. Brentwood

- a. Analyze existing electrical distribution system to determine equipment that must be removed or relocated due to new construction, including, but not limited to panelboards, transformers, disconnect switches, conduit, and wire.
- b. Provide new electrical distribution system including, but not limited to, panelboards, transformers, disconnect switches, conduit, and wire to connect remaining, relocated, and new equipment, including HVAC and shop equipment.
- c. Provide new motor control centers for new train hoist system.
- d. Install new equipment to match the existing track area layout. Provide working clearances and track clearances around new electrical equipment.
- e. Coordinate with architect to determine required clearances and locations of new motor control centers.
- f. New track work area conflicts with numerous conduit banks. Verify which conduits may be relocated and provide rerouting solutions and scheduling to owner before construction begins.
- g. Modify lighting to meet the illumination levels referenced in the lighting systems section of this document.
- h. Provide new light fixtures in office areas and new rooms.
- i. Work includes bringing area of work up to current code.
 - (1) Provide convenience outlets on roof as required by code.
 - (2) Remove lights and equipment supported by conduit and re-support from building structure.

3. Shady Grove

- a. Blow Pit
 - (1) Remove power and lighting systems from the existing blow pit as necessary to accommodate demolition and new work.
 - (2) Provide power and lighting systems for the new blow pit. Provide 120V convenience receptacles on Blow Pit platforms. Provide only materials and equipment suitable for the dirty and wet environment present in the pit.
 - (3) Investigate current load on motor control center MCC-1A and replace if necessary to accommodate additional loads; allow for 100% future growth.
- b. New Shop Expansion

- (1) The primary electrical service ductbank and manhole may need to be relocated to accommodate the new shop.
- (2) Remove or relocate existing electrical equipment where new construction interfaces with the existing building.
- (3) Provide power and lighting systems for the new shop expansion.
- (4) Investigate the accumulation of water in the facility entering from nearby manholes into the basement AC switchgear room. Devise and implement an acceptable solution to (1) provide proper drainage for storm and ground water, and (2) effectively waterproof the AC switchgear room.

1.05 AUXILIARY ELECTRICAL SYSTEMS

A. General

1. This section identifies the requirements for installation of lighting circuits and auxiliary electrical equipment.
 - a. Demolition work includes removal of feeders and/or branch circuits to all equipment determined to be demolished in final project documents. Feeders to equipment determined to be relocated or feeders and circuits run in areas that are otherwise considered for demolition may be evaluated on a case by case basis whether to extend, re-route or demolish and re-feed.
 - b. New work includes routing and coordination of new or relocated feeders to new and relocated equipment from power service points to final served loads.
 - c. Match existing 480Y/277V and 208Y/120V, 3-phase, 60Hz systems for distribution and service.
 - d. Provide load calculations based on equipment data, power density data, PEPCO historical data, WMATA design standards, and expected future loads to determine new equipment sizes and modifications to the existing distribution systems.
 - e. Provide available short circuit current calculations and perform a coordination study to determine equipment withstand and interrupting ratings. Replacement of ANSI C37 power breakers with molded case breakers is not permitted without clear justification by analysis.
 - f. Provide new electrical service and/or upgrade existing electrical service as required to accommodate new work. Perform a continuous two-week survey to monitor power factor or reactive power (kVARs) demand. Use either the 15-minute peak kVAR demand or the 15-minute minimum power factor and combine with the most recent 12-month peak power (kW) demand as reported by PEPCO as a basis for facility current load calculation.

B. AC Power Descriptions

1. Greenbelt Shop
 - a. New Shop Building
 - (1) The existing AC substation that serves the existing Greenbelt Shop is located in the first floor substation room. The substation has capacity to serve the expected load of the new shop building.

- (2) The AC power distribution system for the new building may be served from new sections and breakers added to the existing AC substation or new service from PEPCO.
- (3) The new electrical distribution system will include a 480Y/277V, 3-phase, 4-wire service entrance switchboard sized to provide all expected power needed for the new building plus 20% reserve for future growth. Provide new Switchboard equipment with transient voltage surge suppression.
- (4) The main Switchboard will radially feed local and remote distribution panels, lighting panels and motor control centers located in the main electrical room or shop areas. Locate primary and secondary distribution panels to minimize the branch circuit voltage drop, provide maintenance and operational convenience to the users, and to serve each concentration of loads.
- (5) Step down, dry-type, 480V-208Y/120V transformers will be utilized to feed the buildings receptacle panels.
- (6) Emergency loads are currently served by a 50kVA uninterruptible power supply (UPS), located in the main Switchgear room. New emergency loads may be connected to the existing system or a new UPS, subject to load analysis. Provide load analysis, and additional UPS capacity as needed. Provide 2 hours of emergency power for life safety equipment and as required by code.
- (7) Shop electrical requirements are to be coordinated with end users on an individual shop by shop basis when laying out receptacle concentrations and welding receptacles.

b. Existing Shop Building

- (1) The existing AC substation has capacity to serve the addition of distribution panels or motor control centers needed for the building upgrades.

2. Brentwood Shop

- a. The existing AC substations are located on the basement level. The substations have sufficient capacity to serve the expected load of the new shop expansion.
- b. Reconfigure substations' feeds as needed to avoid tapping the bus.
- c. Emergency loads are currently served by a 50kVA uninterruptible power supply (UPS), located in the main switch room. New emergency loads may be connected to the existing system or a new UPS, subject to load analysis. Provide load analysis, and additional UPS capacity as needed. Provide 2 hours of emergency power for life safety equipment and as required by code.

3. Shady Grove Shop

- a. The existing AC substation that serves the Shady Grove Shop is located on the basement level. The substation has capacity and breaker space to serve the expected load of the new shop expansion.
- b. The AC power distribution system for the new expansion may be served from new breakers or spares in the existing AC substation.
- c. The new electrical distribution system will include MCCs and panelboards

to provide power to the new process equipment, receptacles, HVAC equipment and lighting. Do not connect or re-connect to panelboards no longer available from their manufacturers, but replace with new equipment. Install panelboards and MCCs on the shop floor of common manufacturer and similar to the existing facility. Provide working clearance and track clearance around the new electrical equipment.

- d. Emergency loads are currently served by a 75kVA uninterruptible power supply (UPS). New emergency loads may be connected to the existing system or a new UPS, subject to load analysis. Provide load analysis, and additional UPS capacity as needed. Provide 2 hours of emergency power for life safety equipment and as required by code.

C. General Electrical Characteristics

1. Clearance to Installations

- a. A minimum of 2" is required between any fixed installation (e.g., pipes, pipe hangers, pipe supports, signals, lighting fixtures, etc.) and the design vehicle dynamic outline. This is defined by the clearance envelope. However, installations will be so dimensioned and located that maximal distances are obtained between these and the clearance envelope along tangent and curved alignments.

2. Utilization Voltages

- a. Utilization voltages for devices and equipment requiring AC power will conform to the following characteristics:
 - (1) Fluorescent Lights: 277 volts (preferred) or 120 volts single phase
 - (2) Tungsten-Halogen
 - (a) 120 volts single phase or 277 volts single phase.
 - (3) General Incandescent Lights
 - (a) Maintenance lights: 120 volts, single phase controlled manually
 - (4) High Intensity Discharge Lights
 - (a) General: 277 volts, single phase
 - (b) Lights equipped with medium base lampholder: 120 volts, single phase or 277 volts, single phase.
 - (5) Convenience Outlets: 120 volts, single phase, 20 ampere.
 - (6) Motors
 - (a) 3/4 to 200 HP: 460 Volts, three phase
 - (b) 1/2 HP and below: 115 volts, single phase
 - (c) Motor Control Power: 120 volts, single phase
 - (7) Duct heaters and unit heaters
 - (a) Below 4 KW: 277 volt, single phase
 - (b) 4 KW and above: 480 volts, three phase
 - (8) Wall convectors
 - (a) Below 4 KW: 277 volts, single phase
 - (b) 4 KW and above: 480 volts, three phase
 - (9) Water heaters
 - (a) 6 GPH recovery: 120 volts, single phase and below
 - (b) Above 6 GPH: 480 volts, three phase recovery
 - (10) Chillers: 460 volts, three phase
 - (11) Air conditioning
 - (a) 10,000 BTUH and below: 115 volts, single phase
 - (b) Over 10,000 BTUH up to 36000 BTUH: 208 volts, single phase

- (c) Over 36000 BTUH: 460 volts, three phase
3. Large Motor Starters
 - a. For 460 volt motors, starter will include a control transformer. Across-the-line motor starters will be used for motors up to and including 50 HP at 460 volts, three phase.
 - b. All motors over 50 hp will be equipped with reduced voltage starters of the auto-transformer, 2-step, closed transition type, unless otherwise approved by the Authority. Remotely located motor control centers (such as fan shafts, pumping stations or chiller plants) will be provided with main incoming breakers.
 4. Load Classification
 - a. Load requirements are classified into two categories: essential loads and emergency loads (from the Uninterruptible Power Supply (UPS) System).
 - b. Emergency power loads are listed in the Emergency Power System paragraph. In maintenance facilities treat all loads as essential loads except those requiring connection to emergency power.
- D. 480 Volt Switchgear and Switchboard
1. Secondary main and tie breakers will be 480 volts, 3 phase, 60 hertz, drawout type, low voltage power circuit breakers with stored energy closing mechanisms. These circuit breakers will be manually actuated close with manual and electrically operated trip; except that the tie breakers will include electrically actuated close.
 2. Each secondary main and tie breaker will be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based controlled phase overcurrent trip device and flux-transfer shunt trip, ground-fault protection, position indicating lights, spare auxiliary contacts for DTS, accessories and interlocks. The trip device will have long-time and short-time elements, communication interface, power metering and non-volatile memory for protective settings. The trip unit will be equipped with an energy monitoring function processor to provide at a minimum; phase current (amps), peak demand (kilowatts), present demand (kilowatts) and energy completion (kilowatts-hours).
 3. For each secondary main and tie breaker, provide digital power metering to measure the real-time rms values of phase currents, ampere demand, and phase and line voltages plus power measurements including kW, kW demand, kW-hours, kVA, kVAR-hours, power factor and frequency. Resettable minimum and maximum values for each measured value will be recorded in a nonvolatile memory. The digital power meter will derive power from a separate 125V AC or DC source, and include the following:
 - a. Internal illuminated display for reading all real-time and min/max measured values as well as programming initial configuration and any relay setpoints.
 - b. Three programmable relay outputs to activate and release based on threshold and time-delay values associated with any of the measured parameters.
 - c. Communications module to remotely read real-time and min/max measured values, interrogate the event log, reset min/max and kW/kVAR-hours, program configuration and any relay setpoints.
 - d. Extended memory
 - e. Portable Interface Device
 - f. Software
 4. All breakers will have short circuit interruption and withstand ratings as determined by short circuit and coordination calculations and approved by the Authority. Feeder breakers in switchboard will be ambient compensated and may be molded

case bolt-on type. C37 Power circuit breakers may be used where necessary to obtain suitable protection of down-stream equipment and wiring.

5. Provide time coordinated and interlocked ground fault protection on secondary main, tie breakers and feeder breakers. Provide single point grounding.
6. Size 480 volt switchgear buses and secondary main circuit breaker frames based on transformer forced air-cooled capacity. Set breaker trip ratings based on calculated initial connected loads plus allowance for future 20% growth.
7. Breaker Operation
 - a. Provide control power at 125 volts DC and feed with a minimum of two No. 6 AWG wires. Unit substations for 34.5 kV or 13.8 kV service through metal-clad switchgear will have the following control operation:
 - (1) Primary breaker is tripped by primary undervoltage condition (detected by 27/59 relay for 13.8 kV service and 27 relay for 34.5 kV service), residual ground, or phase overcurrent relays. Primary breaker is closed via manually operated switch.
 - (2) Secondary main breaker is tripped automatically by tripping of primary breaker. Secondary main breaker is closed via manually operated switch.
 - (3) When the secondary main breaker is tripped by the primary breaker due to an undervoltage at the primary service, and if the other secondary main breaker is closed, the tie breaker(s) will automatically close. Closing of the tie breaker(s) is blocked if the primary breaker or secondary main breaker has tripped because of overcurrent or ground fault condition; closing of the breaker(s) is also blocked if both secondary main breakers are closed.
 - (4) Second stage transformer overtemperature device will trip the primary breaker.
 - (5) Where two tie breakers are required due to unit substation being located in separate switchboard rooms, both tie breakers will close simultaneously, and the tripping of either tie breaker will instantaneously trip the other tie breaker.
8. Provision for System Growth
 - a. Design the AC power service facilities with a 20% allowance for future growth. This includes all switchboards, distribution transformers, feeders, panelboards, and motor control centers. Provide space at each unit substation for the installation of at least one additional switchboard cubicle.

E. Panelboards

1. Designations
 - a. The designation of each panelboard will indicate the following information about the panelboard:
 - (1) Service voltage -- 480Y/277 volt AC or 208Y/120 volt AC.
 - (2) Identify circuits with the panel identity and the branch circuit number. Example: circuit fed by breaker #3 in panelboard NE is identified NE-3.
 - b. Install panelboards with top 6'-6" maximum above finished floor.
 - c. Do not locate panelboards in cleaner's rooms, sewage ejector rooms, wash rooms, or locker rooms.
2. Panelboard Sizes
 - a. The following will serve as a guide in selecting panelboard sizes:

Minimum Breaker Poles <u>Connected</u>	No. of Spare 20A <u>Breakers</u>
Up to 8	2
9 to 12	4
13 to 22	4
22 to 28	4
29 to 36	4

- b. Unused spaces will be equipped with buswork and terminations for ready connection of ready connection of breakers.

3. Demand Factors Service

Service	Demand Factor
Lighting and Signs	100% of Connected Load
Emergency Lighting	100% of Connected Load
Elevators	50% of Connected Load
Ventilation Equipment	70% of Connected Load
Air Conditioning Equipment	70% of Connected Load
Heating	100% of Connected Load
Drainage Pumps & Ejectors	70% of Connected Load
Communications Equipment	100% of Connected Load
Convenience Outlets	1.5 amperes per receptacle

- a. Indicate the calculated demand load total at each panelboard schedule for summer and winter.

F. Emergency Power System

1. The UPS system will provide emergency power for loads listed below. The UPS output will be backed up by an alternate essential feeder and automatic transfer switch. The rectifier/charger, inverter, and transfer switch will be located in the AC Switchboard room adjacent to the battery room. The battery disconnect device (enclosed circuit breaker) will be wall mounted inside and next to battery room entry door, if possible. The UPS will be capable of operation from the power source of a mobile generator.
 - a. Rectifier/Charger
 - (1) A silicon rectifier/charger will be of adequate capacity to provide DC input to inverter to give rated output while simultaneously providing charge to battery at rate to give full charge in 12 hours after battery has been fully discharged, and to provide control power for high voltage and 480 volt switchgear.
 - b. Battery
 - (1) Storage batteries will be UPS cycle duty, industrial flooded lead acid cell.
 - (a) The discharge capacity capable of providing DC inverter input to give rated inverter output at 0.8 lagging power factor for three hours at 77°F while simultaneously

providing DC continuous and final minute load for switchgear. Minimum battery terminal voltage of 105 volts under full load at end of three hour discharge period.

- (b) The two tier battery rack will be 1'-3" wide by 2'-6" long by 6'-4" high. Each rack has two cells per tier.
- (2) Each battery room will be ventilated as stated in the Mechanical Design Criteria and the ventilation fan shall run continuously from an essential power source. Where required by local jurisdiction, interlock to charger shall be provided to prevent operation if fan is not operating.
- c. Inverter
 - (1) Inverter will be of solid state design with 480/277V, 3 Phase, 4 wire, 60 Hertz output and capable of delivering rated KVA into load which has power factor of 0.8 lagging, minimum.
- d. Automatic Transfer Switch
 - (1) The switch will be static type and capable of transferring automatically the emergency power load to AC by-pass line under the following conditions:
 - (a) Inverter failure
 - (b) Inverter output voltage dropping to 80% of rated voltage.
 - (2) The switch will automatically retransfer emergency load from by-pass line to inverter when inverter output voltage returns to 90% of rated voltage.
- e. Load Requirements
 - (1) Connect the following loads to the UPS:
 - (a) Communications.
 - (b) Exit signs, egress lighting, and 20% of indoor lighting.
 - (c) Elevator car light, fan, and controls.
 - (d) Fire suppression systems.
 - (e) Public Service Radio System.
 - (f) Chemical detector.
- f. Wiring
 - (1) Do not install emergency system wiring in raceway common to other system wiring.

G. Conduit

- 1. Conduit applications include but are not limited to the following:
 - a. Where access to wire or cable may not be available or required.
 - b. Where concealed wiring is required, such as in public areas.
 - c. Where mechanical protection is required beyond that provided by armored cable.
 - d. Buried conduit where clearances are limited.
- 2. Types and Materials
 - a. Liquid-tight Flexible Metal Conduit
 - (1) Use flexible conduit where vibration isolation is required (e.g., motors, transformers) and for short connections between items of equipment whose alignment precludes the use of rigid conduit.
 - b. Rigid Galvanized Steel Conduit
 - (1) Generally, galvanized rigid steel conduit may not be embedded. Use only for surface runs in normally dry underground areas including fan and vent shafts, on interior ceilings and walls, or concealed where conditions are normally dry, such as above drop

ceilings, and in CMU walls.

- c. Fiberglass Reinforced Epoxy (FRE) Conduit
 - (1) Embedded conduit for incoming service, communications, and auxiliary AC power requirements will be FRE. Conduit embedded in concrete structure is encased, while conduit embedded in earth shall have concrete encasement added.

3. General Requirements

- a. Conduit size for train control and communications will be as shown on electrical and train control Design or Standard Drawings.
- b. Minimum size conduit will be 3/4". Size conduits in accordance with NEC Annex 'C'.
- c. Where non-metallic conduits are used for AC power cables, provide proper equipment grounding conductors. Do not install conduits in floating slabs unless absolutely necessary and then only at right angles to the slab. Provide suitable isolation of conduit stub-ups; coordinate with structural design. Provide twenty percent spare conduits in embedded runs, ductbanks and sleeves in floors and walls for future needs.

4. Terminate empty conduits as follows:

- a. For conduits under 1.5 inch diameter, install heavy wall shrink tube as a seal.

H. Electrical Boxes

- 1. Provide boxes where surface mounted multi-conductor cables interface with single conductor cable in embedded conduits for proper termination of cable and cable fittings. Boxes located in underground locations (except electrical equipment rooms) will be fiberglass or stainless steel, watertight construction with threaded conduit hubs.
- 2. Boxes located in outdoor above ground locations will be of fiberglass, watertight construction with threaded conduit hubs. All other boxes will be provided with knockouts.

I. Conductors

1. Material and Insulation

- a. AC power, lighting and grounding conductors will be copper with flame retardant insulation and jacket. Minimum conductor size shall be No. 12 AWG, except for control and signal wiring.
- b. Power and lighting cables:
 - (1) Specific low-smoke and zero halogen generation characteristics.
 - (2) Fixture wire: stranded copper conductor of No. 16 AWG minimum size with Type SF-2 silicone rubber insulated or as necessary to suit temperature ratings of lighting fixture, minimum of 90° C.

2. Voltage Drop

- a. Calculate voltage drop for all long and heavily loaded circuits and feeders.
- b. Maximum total voltage drop for feeders plus branch circuits not to exceed five percent.

3. Feeders

- a. When the nearest WMATA-dedicated power source is at an excessive distance from the facility to be served, consideration may be given to use a separate utility service. Perform an economic evaluation to develop a recommended service scheme for these facilities. Final determination as to preferred service scheme will be made by the Authority, based on reliability and economics.

- b. Install neutral conductor with three phase feeders only when required. Provide each feeder and cable assembly with an equipment ground conductor, sized in accordance with NEC.
 - 4. Cable
 - a. All cables will be readily accessible for future maintenance and protected from mechanical damage.
 - b. Size feeder cables to accommodate 20% future growth in loads. Conceal cables and conduit in public areas.
 - c. Only one length of cable will be used in any feeder as far as it is practicable. Splice cables in junction boxes. Use splice boxes at any transition between MC cables and single conductor cable in conduit.
 - 5. Wiring methods
 - a. Wiring of emergency and essential AC systems and DC systems will each be independent of each other and will not occupy common raceways or enclosures.
- J. Wiring Devices
- 1. Switches
 - a. Provide snap switches to control lighting in all service rooms. Locate inside the individual rooms, on the knob side of the door.
 - b. Switches: specification grade, 20A, 120 277V rated.
 - 2. Receptacle (Convenience Outlets)
 - a. Receptacles: duplex, heavy-duty, 20A, 125V. Provide weather-proof-while-in-use enclosures and ground-fault circuit-interrupters for protection of personnel for receptacles in outdoor areas and in damp or wet locations. Provide ground-fault circuit-interrupter (GFCI) receptacles in wash rooms. Receptacles may be supplied from multi-wire branch circuits. No more than 6 receptacles on each circuit. In ancillary areas and maintenance facilities space receptacles on 20-foot centers unless indicated below.
 - (1) Ancillary and Service Rooms
 - (a) Offices, open office areas, lunch room: 10-foot centers on each wall. Provide (1) dedicated receptacle per microwave, coffee maker, and refrigerator.
 - (b) Office workstations: minimum of (3) per workstation.
 - (c) Shop workstations: 2-foot centers minimum.
 - (d) Vending: (1) dedicated receptacle per vending machine.
 - (e) Storage and custodial rooms: (1) minimum.
 - (f) Corridors: 25-foot centers.
 - (g) Train control rooms: 5-foot centers.
 - (h) Communication room: 12-foot centers with minimum of (1) per wall.
 - (i) Dispatcher's room: (6) total. Locate (3) of these above the desk level on the wall with the window facing the track.
 - (j) AC switchboard room, electrical rooms, mechanical rooms, chiller plants: 12-foot centers with a minimum of one per wall.
 - (k) Elevator machine rooms and hoistways: minimum of (2) GFCI receptacles in each elevator machine and hoistway.
 - (l) Battery room, maintenance room, trainmen's room, operation's room and bus driver's room: (2) Minimum with

- one on each opposite wall.
- (m) Wash rooms, cleaner's room, water service room and locker room: (2) minimum GFCI receptacles.
- (n) Bell system room, cart storage room: (1). Receptacles in these areas need not be GFCI.

K. Service Requirements for Ancillary Space

1. Train Control Room
 - a. Provide two 208Y/120V, 3-phase, 4-wire circuits, rated KVA as below, and terminated in disconnect switch.
 - b. Train Control Room in the S&I Shop or Yard (15 kVA):
 - (1) Train Control Room in Yard Operation Building:
 - (a) Transformers supplying the branch circuits will be located in the Yard Operation Building, AC switchboard room.
 - (2) Shop
 - (a) Normal supply will be from the emergency power panel. The reserve will be from the essential switchboard not used to feed the rectifier/charger in the UPS. Transformers supplying the branch circuits will be located in the Shop AC Switchboard Room.
2. Communications Rooms
 - a. Provide emergency 208Y/120V, 3-phase, 4-wire circuit, rated KVA as below, and terminated in a disconnect switch.
 - (1) For communications room in S&I shop or yard: 15 KVA. Transformer supplying the circuit will be located in the AC Switchboard room nearest to the Communication Room. Provide one point grounding.

L. Electrical Service Requirements for Elevators

1. Three feeders are required for the elevator machine room as follows: 1) 480V, 3-phase, 3-wire essential power feeder; 2) 208/120V, 3-phase, 4-wire auxiliary essential feeder; 3) 120V, 1-phase emergency feeder. Size the 480V feeder for the total load of all elevator motor drive systems in accordance with the Mechanical design criteria and terminate near the doorway inside the machine room. Provide a separate disconnecting means, in accordance with local codes, for each elevator drive unit.
2. The 208/120 volt auxiliary feeder will be provided to the elevator machine room and terminated in a multi-circuit panelboard or other disconnecting means where required by local codes. The number of circuits in the panelboard will be based on the following 120 volt circuits, as required for each elevator: a) lighted signal system (100 watts); b) hoistway lights; c) hoistway receptacles; d) canopy light cathodic protection rectifier (30 amp circuit). Install conduit and cables for hoistway lighting and receptacles and canopy light elevator machine room to and in the hoistway. Install the 120VAC emergency feeder to the elevator machine room and terminated in a separate disconnecting means for each elevator in accordance with local codes. For each elevator the load will include 500W for elevator car lighting and exhaust fan, 125W for intercom, and 300W future provision for elevator relay controls. Install conduit and cables for elevator car lighting and exhaust fan from the machine room to the hoistway pit and terminated in a junction box.
3. For hydraulic elevator with a steel casing, install conduits and cables for cathodic protection. Install conduits for all other functions from the elevator machine room

to the hoistway and to other areas.

M. Service Requirement for Fire Suppression Systems

1. Provide (1) 120V, 250W emergency power circuit and terminate in a junction box adjacent to each Fire Suppression system control panel.

N. AC System and Equipment Grounding

1. Provide a complete AC power grounding system for the protection of property and human life. Comply with the National Electrical Code and with requirements in these criteria, specifications and standard drawings. Ground all enclosures and raceways of the AC power and distribution system. Provide a low impedance path to ground for all exposed metallic structures, railings, stairways, etc., in the vicinity of the AC power systems.
2. Physically isolate the grounding system from structural rebars, stray current systems, and cathodic protection systems. Intentional metallic contact or electrical bonding between the two systems is not permitted. Where soldier piles are used for AC power system grounding purposes, any number of soldier piles may be bonded together provided they are in the same row and are adjacent to each other. Isolate soldier piles used for grounding from other soldier piles which are bonded and connected to drainage circuits and from reinforcing bars in the structure.
3. Provide a ground grid for each new or modified AC service at shop buildings. Ground grid/bus resistance will not exceed two ohms for AC switchboard rooms, traction power substations and chiller plants, and five ohms for tie breaker stations, electrical rooms, fan shafts, and pumping stations. Grid will consist of bare or insulated copper conductors and ground rods buried in earth and in a pattern to suit the structure; a rectangular pattern is preferred. In at-grade locations grid will be 24 inches minimum below grade. Where grid is below the bottom of the slab or near metallic objects, maintain minimum 24" separation. In underground locations, grids may be installed under the structure. A minimum of 24 inches separation must be provided between grid and soldier piles used for stray current control between grid and cathodic protection systems. In soils of high resistivity and in rock construction where normal grounding grid design does not provide required low resistance, alternate methods of ground grid design, or location, or soil treatment, etc., are to be submitted to the Authority for approval. Provide grounding of outdoor service transformers by means of a grounding electrode conductor from the transformer pad to the nearest ground grid, as well as to the substation ground bus.
4. After locations for ground grid(s) are determined and staked by survey personnel, provide engineering consultant to conduct a soil resistivity survey and report the data for use in design.
5. Main ground bus on walls of substation rooms will be used to ground the neutral of the secondary AC power distribution systems and to connect grounding sub-buses in train control and communication rooms, dispatcher and Bell system rooms, elevator machine rooms and other grounding as required. Ground bus will be copper, approximately 24 inches above floor and mounted on insulators 1-1/2 inches from wall. Where there is insufficient clearance behind the electrical AC or DC switchgear, install ground bus bar above the switchgear.
6. Requirements for installing grounding connections in train control and communication rooms:
 - a. The only connection on the bus bar provided for train control/communication equipment grounding is the cable leading to the

- AC switchboard room.
- b. No equipment or metallic structure shall be bonded to the ground bus provided for train control and communications equipment.
 - c. For items requiring bonding, the grounding conductors must go to the nearest ground bus beyond the ground bus provided for the train control and communications equipment.
 - d. Grounding transformers to the dedicated train control and communication room ground bus bars is not permitted.
 - e. Install ground bus as follows:
 - (1) AC switchboard room: 1/4" x 2" main bus installed around the inside periphery of the room.
 - (2) Train control room: 1/4" x 2" x 24" sub-bus near power supply switch and connected to AC switchboard room bus with No. 2/0 AWG insulated grounding conductor. Connect the sub-bus insulated grounding conductor to the AC switchboard room ground bus within 2" of the grounding conductor connection for the transformers supplying power to the train control room.
 - (3) Communications room: 1/4" x 2" x 24" sub-bus near power supply switch and connected to AC switchboard room bus with No. 2/0 AWG insulated grounding conductor. Connect the sub-bus insulated grounding conductor to the AC switchboard room ground bus within 2" of the grounding conductor connection for the transformer supplying power to the train control room.
 - (4) Others: Sub-bus in electrical and mechanical rooms, dispatcher and bell system rooms, as required for convenient grounding of separately derived AC power systems.
 - (5) Drainage pumping stations: 1/4" x 2" x 24" main bus installed on the wall adjacent to the AC power equipment.
 - (6) Battery Rooms: 1/4" x 2" x 24" grounding sub-bus bar located below battery disconnected device.
 - f. The complete AC power grounding system will include ground bus in each distribution equipment enclosure such as switchgear, panelboards, motor control centers, and load centers, and will be interconnected by insulated equipment grounding conductors that run with the feeders from the source panelboard or switchboard. Such conductors will be identified by a continuous green color and be sized in accordance with the NEC and will run in a common conduit with the associated phase and neutral conductors. Multiple-conductor cables with metallic sheaths will be provided with insulated or bare equipment grounding conductors; use of the metallic covering for grounding is not considered adequate.
 - g. Provide insulated copper equipment grounding conductors for the following services:
 - (1) All feeders.
 - (2) All branch circuits.
 - h. Provide grounding for personnel to minimize shock hazards as follows:
 - (1) In substations and electrical and mechanical rooms bond all exposed metallic structures, motor frames, AC equipment enclosures, ductwork and metallic piping to the local main ground bus with an exterior No. 6 AWG minimum insulated grounding conductor.
 - (2) Bond the elevator's metallic structure to equipment grounding conductor in the AC feeder and to local ground bus bar. Provide a

- minimum of two ground paths for electrical equipment (including but not limited to motor frames, AC equipment and lighting fixture enclosure) as follows:
- (a) Bonding to green insulated equipment grounding conductor in the AC feeder/branch circuit.
 - (b) Connection to grounded metallic structure using metallic fasteners, metallic conduit and/or bonding jumper.
 - (c) For elevators provide a second ground path connecting trusses and guide rails using a No. 1/0 AWG insulated ground conductor connected to ground bus bar in AC switchboard room. Leave 20-foot length of conductor coiled up in pits or wellways.
 - (d) Metallic structure grounding may be supplemented by a connection to the ground grid where conveniently available.
- (3) Where a dielectric water fitting is installed for cathodic protection of underground piping, only the exposed piping may be grounded. Do not install jumper around the fitting. The use of municipal water system as a grounding electrode is not permitted. Exposed structural metalwork such as stairways, handrails and safety walk gratings within reach of AC power equipment (5'-0"+) will be bonded to the nearest AC equipment ground bus or sub-bus.
 - (4) Exposed metallic structures in open areas such as light standards, handrails, cable trough and fence on at-grade construction, will be bonded and grounded to separate ground rods.
 - (5) Fencing will be grounded at approximately 50-foot intervals to ground rods, and jumpers provided where required for grounding continuity. Fencing around transformer pads shall be suitably grounded. Flexible jumpers shall be provided at gates to ensure continuity.
 - (6) Manholes, handholes, junction and pull boxes metallic body, cover frame and cover will be grounded as follows:
 - (a) Metallic cover will be bonded to metallic frame using a minimum No. 6 AWG insulated grounding conductor and a bronze or brass chain inside rubber hose.
 - (b) Metallic body and frame will be grounded to 5/8inch diameter by 10-foot long ground rod using a minimum No. 6 AWG insulated grounding conductor.
 - (c) When a cable is spliced or tapped in a handhole, manhole, junction or pull box the metallic body and frame will be bonded to equipment grounding conductor.
 - (7) Connections to metallic structure, safety walk grating, cable trough, stairway, hand railing, telephone and map case enclosures, fence, frame columns of shelters, pylon frame, diorama metallic cover and metallic body and metallic cover frame of handhole, manhole and junction box will be made by exothermic welding or gas torch brazing.
 - (8) When necessary, only handholes with nonmetallic cover and non-metallic junction and pull boxes will be installed in landscape and grassy areas.
 - (9) Cable splices and taps in outdoor handhole, manhole, junction

and pull boxes will be covered by watertight heat-shrinkable tubing or wraparound sleeve.

1.06 LIGHTING SYSTEMS

A. General

1. This criterion establishes desirable standards for illumination and design requirements for light fixtures and control.

B. Scope

1. Provide new light fixtures in areas where ceiling, grid, or light support surface is being modified.
2. Do not use or re-use T-12 fluorescent fixtures.
3. Provide illumination levels in new facilities per tables VII.3 and VII.4.
4. Upgrade illumination levels in existing facilities in the area of work per tables VII.3 and VII.4.
5. Provide temporary lighting as necessary during construction.
6. Clean and relamp fixtures which are relocated or removed and re-installed during construction. Verify proper operation of each fixture and replace non-functioning units.
7. The criteria covers lighting requirements for the following:
 - a. Ancillary Spaces
 - b. Car Storage Yards and Maintenance Facilities

C. Illumination Levels

1. Minimum maintained lighting levels for various areas shall be indicated in Tables VII.3 and VII.4.
2. The method for calculating these levels is per the Illuminating Engineering Society (IES) Lighting Handbook. For indoor lighting use the zonal cavity method. Lamp mean lumens or lamp depreciation as listed in the IES Lighting Handbook and the luminaire dirt depreciation factor classified as "Dirty" will be assumed.
3. Provide light levels with a uniformity ratio of 3:1 average to minimum at the workplane.

D. Lighting Fixtures and Control

1. Lighting Fixtures
 - a. Select luminaires as follows:
 - (1) Service and Inspection Areas
 - (a) Industrial Type fixtures as appropriate to give levels of illumination indicated in Tables VII.3 and VII.4.
 - (b) Fluorescent fixture Types 1, 2, 3, 4 and 5 equipped with energy saving ballasts and T8 lamps. Type 6 fixtures equipped with compact fluorescent lamps.
 - (c) Exit light Type X with backlit light emitting diode (LED) as its lighting source.
 - (2) Coordinate locations of luminaires with other equipment.

TABLE VII.3 - NORMAL ILLUMINATION LEVELS

AREA	FOOTCANDLES
1. Stairs	30.0
2. Storage Rooms	30.0
3. Electrical Rooms	30.0
4. Mechanical Rooms	30.0
5. Corridors	30.0
6. Elevator Equipment Room	30.0
7. Misc. Rooms	30.0
8. Offices and Open Office Areas	30.0
9. Shop and Work Areas	50.0
10. Track Floor	50.0
11. Open Areas on Shop Floor	50.0
12. Lunch Rooms	50.0
13. Conference Rooms	50.0
14. Small Parts Storage	50.0
15. Locker Rooms and Bathrooms	50.0
16. Train Control and Comm Rooms	50.0
17. Blow Pit	100.0

2. Control of Lighting

a. Indoor General Lighting

- (1) Lighting in service areas, including maintenance and service & inspection shops, will be manually controlled by switches.
- (2) Lighting in offices, restrooms, breakrooms, conference rooms, and storage rooms will be controlled automatically to comply with energy code. Conference room sensors will have manual override.

b. Lighting Circuits

- (1) Where multiphase branch circuits are used for feeding power to light fixtures, connect adjacent fixtures to alternating phases. Protective devices will be single-pole type to maintain a more uniform illumination with de-energization of one or two phases.

E. Emergency Lighting

1. Emergency lighting will be provided by a percentage of the normal continuous burning lighting fixtures to obtain the desired illumination levels. Submit lighting calculations verifying the level of illumination for each area listed below. Provide minimum maintained illumination for emergency purposes as follows:

TABLE VII.4 - EMERGENCY ILLUMINATION LEVELS

AREA	FOOTCANDLES
1. Washrooms	2.0
2. Communications Rooms	2.0
3. Train Control Rooms	2.0
4. AC Switchboard Rooms	5.0
5. Stairs, Mezzanines	3.0
6. Egress Corridor	5.0
7. Elevator Car	5.0

2. Approximately 50 percent of the lighting fixtures in emergency exit stairways, and 20 percent of the indoor lighting fixtures, will be connected on emergency circuits. Outdoor lighting fixtures will not be connected on emergency circuits unless approved by the Authority.
3. In all cases the emergency lighting will conform to the codes and regulations of all jurisdictional Authorities. Exit lights and signs will be fed from the emergency power system.
4. Emergency lighting for the stairs will be designed to emphasize illumination on the top and bottom steps or landings.

1.07 MAINTAINABILITY AND CONSTRUCTIBILITY

- A. Design the electrical system comprising equipment, raceways, fixtures, devices, wires and cables in coordination with structural, mechanical, architectural and other disciplines providing adequate space, clearances, and structural support, and to ensure non-interference with other trades during construction. Take into account the ease of maintainability of the electrical equipment installed. Maintenance operations include inspection, adjustments, cleaning, trouble shooting, servicing, repairs, and replacement of electrical equipment. The equipment selected should be subject to minimal system component failure.
- B. Space
 1. Provide sufficient working space and adequate access for the maintenance and replacement of electrical equipment. Provide adequate space around electrical

equipment to allow for heat dissipation and cooling. This requirement includes adequate space for movement of equipment during initial installation, and during subsequent unscheduled maintenance involving removal and replacement of failed equipment.

C. Accessibility

1. All electrical system switching and overcurrent protection devices will be accessible to authorized persons only. Access to cables or conduits installed in return air plenums will be provided at appropriate locations.
2. Provide adequate means, such as lifting eyes and/or I-beams with a running hoist for raising, lowering, shifting, removing or replacing heavy electrical equipment. Provide pulling eyes for the pulling of cables at the following locations:
 - a. AC Switchboard Rooms
 - b. Train Control Rooms
 - c. Communications Rooms
 - d. Electrical Rooms
 - e. Cable shafts
 - f. Manholes
 - g. Other locations where considered necessary.
 - h. Equipment Protection Against Water and Moisture:
3. Design each substation building and electrical room to preclude any entry of water. Provide seals on raceway and cable penetrating a building wall, floor or ceiling. Do not install water or sewage piping inside substation and electrical equipment rooms. Pipes or mechanical ducts that could cause moisture or condensation will not be located above any major electrical equipment.
4. Embedded Conduits, Conduit Sleeves and Channel Inserts:
 - a. Embedded conduits may be installed in the space available between rebars. Where a slab has to carry a large number of conduits, ensure that conduits are installed without compromising the structural integrity of the concrete structure. Show adequate cross sections on the drawings to indicate where raceways and other embedded items cross each other. With the exception of traction power conduit, where embedded FRE conduit emerges from a concrete slab or a wall provide an FRE to galvanized rigid steel conduit adapter.
 - b. Where conduits are not provided as raceways, install channel inserts for supporting multiple conductor cables located under platforms, and in manholes. Provide spare conduit and sleeves in concrete walls, floors, and ceiling slabs of the AC switchboard rooms, electrical rooms, mechanical rooms, ductbanks, and other areas as required for possible future requirements.

D. Electrical Plans, Details and Schedules:

1. Provide plans and details on the drawings showing physical arrangements and elevations with dimensions for all major electrical and mechanical equipment, raceways, junction boxes, fixtures and other items so that the design and construction can be coordinated with mechanical, structural, and other disciplines.
2. Provide schedules on the drawings of all major electrical equipment including switchgear, switchboards, panelboards, transformers, disconnect switches, conduits, and cables. Schedules will be complete and consistent with plans on associated electrical and mechanical drawings.

E. Lighting System

1. Avoid the use of incandescent lamps, whenever practical. Where incandescent lamps are used, provide the long life type.
 2. Select locations of lighting fixtures to permit easy cleaning, replacement and maintenance. Provide adequate illumination on all working areas around the electrical equipment.
- F. Operation and Maintenance Manual:
1. Provide Operation and Maintenance Manuals for major electrical equipment. Manuals to include manufacturer's operation and maintenance instructions, wiring diagram, control and power elementary diagrams, list of spare parts and recommended stock quantities for one year routine maintenance and repair. Include a copy of approved shop drawing of equipment and other items where considered necessary.
 2. Engage factory-authorized service representatives to train Authority maintenance personnel to adjust, operate, and maintain all components and devices. Video record all training sessions and provide DVD copies to the Authority.

END OF SECTION

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PROGRAM CRITERIA

TRACTION POWER AND YARD LIGHTING

PART 1. GENERAL

1.01 SUMMARY

- A. The scope includes all work required to design, furnish, install, connect, test and energize yards and shop traction power equipment and appurtenances, and yard lighting, to ensure safe, complete, workable, secure, and operational traction power systems and yard lighting at the referenced yards and shops of the WMATA Metro Rail System, including furnishing and installation of ancillary material as required.
- B. As referenced within this program criteria, "traction power" is intended to include all work associated with vehicle stinger systems (to facilitate energization of vehicles at the vehicle pickup shoes at 750 VDC, enabling movement of vehicles within the shops), car receptacle power (to provide 750 VDC power to vehicle auxiliary power systems during shop maintenance, testing, and repair), yard traction power (to facilitate movement of vehicles and trainsets within the yard area by means of the on-board vehicle propulsion systems, energized through contact rail), and yard lighting. Traction power systems include not only the "positive" DC connection (nominal 700 volts DC) at the stingers, car receptacles, and contact rails, but also the return (negative) connections and paths via the tracks/running rails.
- C. Work includes installation of all electrical power, wiring, and equipment from identified existing or new power sources to final served loads. This includes conduits and raceways (both exposed and embedded) for trackwork and traction power systems. Service to lighting systems includes feeders and branch circuits associated with exterior (yard) lighting. Areas covered by this contract include interior portions of the shop buildings and the yard areas. Applicable technical provisions include but are not necessarily limited to:
- 16060 Grounding and Bonding
 - 16118 Fiberglass Conduit
 - 16119 Medium Voltage Cable
 - 16120 Wire, Cable, and Busways
 - 16121 DC Stinger System and Control
 - 16122 Contact Rail Cable Connector Assemblies For Traction Power
 - 16123 Contact Rail Insulator Assembly for Traction Power
 - 16124 Contact Rail Protection Cover Assemblies
 - 16125 Wire Connection Accessories
 - 16126 Contact Rail Anchor Assembly for Traction Power
 - 16127 Contact Rail System Installation for Traction Power
 - 16128 Wire and Cable For Traction Power
 - 16129 2000 Volt Shielded Cable
 - 16130 Raceways, Boxes, and Cabinets
 - 16131 DC Pedestal and Wall Mounted Contactor System
 - 16294 Contact Rail Heating System for Traction Power
 - 16341 DC Switchgear, Switchboard, and Related Equipment
 - 16526 Lighting Fixtures and Mounting Poles
- D. The work shall include furnishing, installing, connecting, energizing and testing of all materials, equipment, labor, transportation and handling, construction equipment, tools and all other incidental necessary for the execution, testing, connection, interconnection and

energizing of equipment and systems as indicated.

1.02 REFERENCES

- A. Codes, regulation, reference standards and specifications.
 - 1. Codes and regulation jurisdictional authorities.
 - 2. National Electrical Code (NFPA 70)
 - 3. IEEE: 141,242
 - 4. IES Lighting Standards

1.03 SYSTEM DESCRIPTION

- A. General: The Contractor shall install all required equipment. The work shall be in accordance with the drawings and specifications included in this contract and comply with the "Information Drawings" and equipment vendor drawings. The following systems and components are included:

- 1. Provide wire and cable. Included are cable connections using unshielded and shielded 1000 kcmil and 500 kcmil cable as follows for DC negative track jumpers and for DC positive jumpers between contact rail sections:

Unshielded 1000 kcmil cable (127 strand, per specification section 16128) shall be utilized for jumper connections (nominal 750 VDC negative) between tracks (running rails) at the Shady Grove Yard and Shop.

Unshielded 500 kcmil cable (127 strand, per specification section 16128) shall be utilized for jumper connections (nominal 750 VDC negative) between tracks (running rails) and for negative return connections from tracks to traction power rectifier at the Brentwood Yard and Shop.

Shielded 1000 kcmil cable (127 strand, per specification section 16129) shall be utilized for positive DC jumper cables between yard contact rails, except that the final connection (short lengths) at the contact rails shall be made with unshielded 1000 kcmil cable (427 strand, per specification 16128.)

- 2. Conduit for conductor containment. All below grade conduits shall be fiberglass reinforced epoxy (FRE) and shall be concrete encased. Conduits containing positive or negative traction power cables (including yard area cables, stinger circuit power cables, and car receptacle circuit power cables) shall be fiberglass reinforced epoxy if below grade. Conduits containing positive or negative traction power cables (including yard area cables, stinger circuit power cables, and car receptacle circuit power cables) shall be aluminum or fiberglass reinforced epoxy if above grade. All fiberglass reinforced conduit shall be UL listed as type "AG".

Conduit for positive feeders and jumpers to contact rail, and for negative returns or rail bonding of yard tracks, shall be 4" trade size FRE unless otherwise indicated. Total of all bends between any two pulling points shall not exceed 225 degrees.

3. Provide "stinger" systems to provide power to vehicles for movement within the shop buildings. Each stinger shall provide 750 volts (nominal) DC to vehicle shoes, and shall be controlled via a dedicated 1250 amp 1000 volt rated contactor (fused at 500 amps). Each stinger shall include all remote controls to allow for remote operation of the respective contactor by the stinger operator. Each stinger system's design shall be similar to that of the stinger systems described on applicable as-built drawings for other WMATA shop facilities. Refer to specification section 16121.
4. Provide "car receptacle" systems to provide power to vehicles within the shop buildings for operation of the vehicle auxiliary systems during maintenance, testing, and repair. Each car receptacle system provides 750 volts (nominal) DC to vehicle shore power receptacles, and shall be controlled via a dedicated 150 amp contactor (fused at 150 amps). Each car receptacle system shall include all remote controls (shop floor control station) to allow for remote operation of the respective contactor. Each car receptacle system's design shall be similar to that of the car receptacle systems described on applicable as-build drawings for other WMATA shop facilities. Refer to specification section 16122.
5. Contactors for stingers and car receptacle circuits shall be rated at 750 volts DC, continuous current rated, and load break rated, and shall be normally open, electrically held, single pole.
6. Make modifications to existing contact-rail heating system. Remove and reinstall existing contact rail heating controllers and devices as required for contact rail affected by this work (Shady Grove Yard bypass track relocation); install WMATA-furnished replacement contact rail heater cables. Refer to specification section 16294.
7. Provide grounding and bonding as required and specified. Refer to specification section 16060.
8. Provide cutting, patching and core drilling: The Contractor shall provide wall and floor openings or enlarge openings as required to accommodate bus duct, cable tray or conduit furnished. All unused conduit, sleeves, openings around bus ducts, cable trays etc. shall be sealed using fireproof material to meet occupancy jurisdictional codes for the room.
9. Fabricate plastic sheets to close sections around bus duct passing through floor openings (if applicable).
10. Assemble equipment: switchgear shipping sections shall be assembled for proper alignment, leveling, and bonding of adjacent sections. Electrical connections between shipping breaks shall be made according to manufacturer's shop drawings.
11. At the Brentwood shop, an existing DC traction power substation within the shop building provides power to 11 existing stingers and 21 existing car receptacle circuits. Stingers and car receptacles are fed from circuits which are fused at an existing DC switchboard; local enclosed contactors in the vicinity of the stinger trolleys and at the car receptacles provide for control of stinger and car receptacle power. The capacity of the existing rectifier-transformer (2 MW) has been determined to be adequate to serve the existing stingers and car receptacles along with the new stingers and car receptacles. The existing DC switchboard is considered to be in poor condition, and is inadequate to serve both the new and existing stinger/car receptacle requirements. Therefore, the existing DC switchboard

and the existing positive DC buswork from the rectifier to the DC switchboard are to be replaced by the Design-Builder as part of this work. Replacement DC switchboard and replacement DC positive buswork are each to be rated at 6000 amps. The replacement DC switchboard is to include fused overcurrent devices (fused switches) to serve not only the 11 existing stingers and 21 existing car receptacle circuits, but also 4 new stingers and 12 new car receptacle circuits. The four new stinger systems are to each include a single trolley assembly of approximately 150 foot length. Between tracks 9A and 9B, one stinger/trolley assembly is to be provided located adjacent to the south shop doors, and one stinger/trolley assembly is to be provided located adjacent to the north shop doors. Both stinger/trolley assemblies shall be capable of serving either track (9A or 9B). Between tracks 9B and 9C, one stinger/trolley assembly is to be provided located adjacent to the south shop doors, and one stinger/trolley assembly is to be provided located adjacent to the north shop doors. Both stinger/trolley assemblies shall be capable of serving either track (9B or 9C). Electrical interlocks are to be provided to prevent simultaneous operation of the four new trolley/stinger systems. Car receptacles are to be located so as to serve tracks 9A, 9B, and 9C; final locations for the car receptacles at the tracks will be determined by WMATA. Each stinger requires a dedicated 600 amp fused switch power source and each car receptacle circuit requires a dedicated 150 fused switch power source; the fused switches are to be located within a DC switchboard. Contactors for the new stingers and new car receptacles are to be located in the shop areas, in non-metallic enclosures. It is anticipated that the replacement DC switchboard will be considerably larger than the existing DC switchboard (to be removed as part of this work); contract drawings indicate proposed expanded limits for the substation room to accommodate the larger switchboard. The Design-Builder is to expand the room limits of the existing substation room as required to perform this work. All work is to conform to NEC requirements with respect to presence of overhead mechanical equipment and piping, clearances, working space, emergency egress, and equipment access. The Design-Builder is to remove and replace with new control and power circuits: all control and power circuits from the existing DC switchboard to existing stinger contactors/controls, and all control and power circuits from existing DC switchboard to existing car receptacle contactors/controls; the existing control/power circuits are not to be reused or extended. Provide bus bracing and equipment interrupting/withstand capability at the DC equipment of 50000 amps (output from the existing rectifier.) Refer to specification section 16341.

12. To minimize service disruptions at the Brentwood shop associated with changeover of DC power systems from the existing to the new DC switchboard, develop a phasing plan for transitioning and work in conjunction with Authority Representative.
13. At the Shady Grove shop, an existing DC traction power substation within the shop building provides power to 5 existing stingers and 26 existing car receptacle circuits. The capacity of the existing rectifier-transformer (2 MW) has been determined to be adequate to serve the existing stingers and car receptacles along with the new stingers and car receptacles. The existing DC switchboard is considered to be in good condition, and is to remain in service to serve the existing stingers and car receptacle circuits. Power for 5 new stingers and 18 new car receptacle circuits in the new shop area are to be provided from a new 4000 ampere DC switchboard to be installed in the new shop area (Design-Builder shall provide a dedicated electrical equipment room and space for this equipment.) Each new stinger systems shall include a single trolley assembly of approximately 150 foot nominal length. Between tracks 7 and 8, one stinger/trolley assembly is to be provided located adjacent to the south shop doors, and one stinger/trolley assembly is to be provided located adjacent to the north shop doors. Both stinger/trolley assemblies shall be capable

of serving either track (7 or 8). Between tracks 9 and 10, one stinger/trolley assembly is to be provided located adjacent to the south shop doors, and one stinger/trolley assembly is to be provided located adjacent to the north shop doors. Both stinger/trolley assemblies shall be capable of serving either track (9 or 10). Electrical interlocks are to be provided to prevent simultaneous operation of any of the four new trolley/stinger systems at tracks 7, 8, 9, and 10. A fifth new stinger/trolley assembly is to be provided to serve the new construction (blow pit) area for tracks 2 and 3; this stinger/trolley assembly shall be located between tracks 2 and 3, to serve either track, and shall provide power not only to the new blow pit construction area (approximately 85 feet in length) but also the existing blow pit area at tracks 2 and 3. For car receptacle power, (16) new car receptacles are to be located so as to serve tracks 7, 8, 9, and 10, and (2) new car receptacles are to be located to serve the new and existing blow pit area (at tracks 2 and 3); final locations for all car receptacles at the tracks will be determined by WMATA. Control of car receptacle circuits shall be via local enclosed contactors in the vicinity of the car receptacles. Control of stinger assemblies shall be via contactors which shall be installed within dedicated enclosures in the shop area. Enclosures for stinger contactors and car receptacle contactors shall be non-metallic. Within the existing shop, the existing DC switchboard is fed from a 4000 amp DC breaker within an existing DC metal clad switchgear lineup (Impulse equipment, rated 800 VDC with 10000 amp rated horizontal copper bus); the Design-Builder is to add a new feeder cubicle and new DC feeder breaker (rated 4000 amps) to serve the new DC switchboard. The new feeder breaker cubicle and feeder breaker shall be enclosed, drawout, single pole, semi-high speed or high-speed, rated 750 VDC nominal, 800 VDC maximum, of metal clad switchgear construction. The Design-Builder is to extend the existing 10000 amp buswork at the existing DC switchgear into the new feeder breaker cubicle. The Design-Builder is to provide 4000 amp rated buswork (or equivalent cable-in-conduit) from the new 4000 amp feeder breaker to a new DC switchboard. The new DC switchboard is to include all necessary control devices (overcurrent devices, relays, etc.) to serve the 5 new stingers and 18 new car receptacle circuits. At the new DC switchboard, each stinger will require a 600 amp fused switch and each car receptacle circuit will require a 150 amp fused switch. Provide bus bracing and equipment interrupting/withstand capability at the DC equipment of 50000 amps (output from the existing rectifier.) Refer to specification section 16341.

14. Design-Builder shall be particularly diligent in design of shop stinger systems and overhead bridge crane systems to minimize conflicts between these systems and to facilitate safe operation of both the stinger systems and the bridge crane systems. Provide interlocks and warning signals to minimize possibility of damage resulting from conflicts between these two systems. Provide audible and visual indications (warning signals) of system operation similar to existing stinger systems.
15. Provide yard lighting at Greenbelt, Brentwood, and Shady Grove yards; refer to specification section 16526. Lighting systems shall be designed in accordance with IES recommendations and procedures. Design shall be based on light loss factor of 64%. Provide design which minimizes glare which would tend to interfere with observation of track by train attendants. Select, locate, and aim luminaires to accomplish primary purpose of illumination while producing a minimum of objectionable glare and interference with vehicular traffic and neighboring surroundings. Where yard tracks are located adjacent to railroad operating tracks, pay particular attention to placement and direction of lighting fixtures to avoid interference with railroad signals or operations. Light sources for yard lighting shall be high pressure sodium. Special trackwork areas within the yards shall be lit to 3.0

footcandles maintained; other areas of yards shall be lit to 1.0 footcandles maintained. Yard lighting shall be controlled by control systems similar to that of the existing yard lighting systems. Do not re-use any lighting fixtures, poles, or hardware affected by the Design-Builder's work; provide new lighting fixtures, poles, and hardware. New poles and fixtures shall be similar in materials, construction, photometrics, and finish to existing poles and fixtures. Height of new poles shall not exceed height of existing poles within the yards. Provide branch circuit wiring from shop building to lighting poles/standards which limit branch circuit voltage drop to not more than 2.5 percent.

16. At Brentwood and Shady Grove yards, provide contact rail jumpers and track (running rail) jumpers as indicated. Provide insulating joints in tracks to ensure electrical isolation between yard and shop tracks.

At the Shady Grove Shop, provide jumpers from the new tracks to the existing tracks for negative return current. The jumpers are to be 1000 KCMIL in size and are to be arranged as shown on train control drawings.

At the Brentwood Shop, provide jumpers between the new tracks, and from new track(s) to the existing negative switchboard, for negative return current. The jumpers are to be 500 KCMIL in size and are to be arranged as shown on electrical (traction power) drawings. Connections to shop rails shall be via exothermic welds. The location and design of the shop rail connections shall facilitate inspection, maintenance, and repair. Provide any necessary modifications at the existing negative switchboard to facilitate connection of the new negative return cables.

At all shops, maintain electrical integrity and continuity, and isolation (from ground) of all tracks within the shop areas to facilitate negative return current flows associated with stinger and car receptacle power circuits. Provide bonding jumpers as required from rail to rail to maintain continuity around any physical discontinuities in the rails.

17. Provide labor and miscellaneous hardware/materials to disconnect, relocate, and reconnect existing contact rail disconnect switches (rated 1200 amps) in yards. Provide new 1200 amp rated disconnect switches at the Shady Grove Yard as indicated.
18. New DC positive switchboards at Brentwood and Shady Grove shop buildings shall each be designed, constructed, and tested in accordance with ANSI C37.20. Respective fused switches, fuses, and contactors shall not be rated at less than 750 VDC. Refer to specification section 16341.
19. Conduct system-wide integrated testing to demonstrate continued proper functioning of all ETS trip functions upon completion of work associated with yard tracks. All remote control and indication functions shall be verified.
20. Within shop areas, provide insulation of tracks (running rails) from building structure. Negative return currents for the 750 VDC stinger and car receptacle power circuits shall flow entirely through dedicated negative return feeders or jumpers; the building structure shall not be utilized as a path for negative return currents.
21. For each new section of contact rail associated with new tracks, provide a contact rail anchor assembly at approximately midway between the two end approaches.

22. At the Shady Grove shop traction power substation, repair the existing ventilation damper assemblies to make operational.
23. Existing manholes containing ETS circuits (contact rail Emergency Trip Systems) may be affected by this work. Provide relocation, and extension/reconnection/testing of ETS circuits, as necessary.
24. DC positive switchboards and switchgear shall be provided with enclosures which are ungrounded. Provide hot-structure and ground detection relays for structures in accordance with WMATA standards. Provide insulated floor topping, and secure enclosures to floor with insulated attachments, to maintain isolation/insulation.
25. Provide power to yard rail lubricators.

1.04 SUBMITTALS

Submit the following for approval in accordance with Special Conditions and with the additional requirements as specified for each:

- A. Shop drawings:
 1. For equipment furnished in this contract, provide complete shop drawings and documentation as specified elsewhere in this specification.

1.05 QUALITY ASSURANCE

- A. For codes, regulations, reference, standards and specifications, refer to article 1.02 above.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store all equipment in secure and dry storage facility before installation at no additional cost to the Authority.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. As specified in other sections of these specifications.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide oversight and supervision to ensure that all equipment are installed in accordance with manufacturers' recommendation and approved shop drawings.
- B. Install equipment as shown and specified in other sections of this specification.

3.02 FIELD QUALITY CONTROL

A. Field Testing and Inspection:

1. General requirements:

- a. Correct any deficiencies found during field testing and retest at no additional cost to the Authority.

2. Field Inspection

- a. Prior to field testing, check DC drawout breaker equipment installation in accordance with manufacturer's recommendations and IEEE 141 as applicable including, but not limited to, verification of the following:

- 1) Integrity of bus insulation.
- 2) Tightness of connections.
- 3) Adequate support of bus bars.
- 4) Correct grounding, anchoring and alignment of switchgear in accordance with manufacturer's drawings. Correct insulation of rectifier and dc switchgear from ground.
- 5) Ease of racking draw out breakers in and out of cubicle.
- 6) Physical interchangeability of similar circuit breakers.
- 7) Adjustment of circuit breaker main and secondary contacts.
- 8) Functioning of interlock and closing of safety shutter with breaker in disconnect or withdrawn position.
- 9) Verify mechanical clearances and proper operation of disconnecting and grounding devices associated with potential transformers.
- 10) Tightness of bolted bus joints by calibrated-torque-wrench method, based on manufacturer's recommended values.

3. Field Testing:

- a. The Contractor shall coordinate with the Authority Representative to establish the specific testing schedule for each facility. Notify the Authority Representative one week in advance of each test. Conduct test in presence of Authority Representative.
- b. Furnish test equipment, labor and services of manufacturers' engineering representative to perform specified tests.
- c. Submit certified test reports within ten days of substantial completion inspection. For each item, submit for approval and perform approved tests but not limited to those specified.

d. Perform insulation resistance test of 60-second duration on all equipment in accordance with the following requirements:

1) Test voltage:

<u>Voltage Rating</u>	<u>Test Voltage</u>
(a) 150-600V	1,000V, dc
(b) 601-5,000V	2,500V, dc
(c) Above 5,000V	5,000V, dc

2) Insulation resistance: kV rating plus one megohm but not less than minimum value recommended by manufacturer.

3) Ensure insulation resistance is equal to or greater than minimum value specified before performing dielectric withstand test.

e. Perform functional and set-up tests on metering, control, interlocking, blocking and supervisory circuits, including verification of interconnections between equipment and interface points. Verification of these tests to be substantiated by lined-in schematics, signed by the Contractor and the Engineer.

f. Positive dc busducts:

1) Test resistance of all busway connections. Resistance not to exceed value recommended by manufacturer.

2) Test insulation resistance from bus bars to ground and between insulated busbar.

3) Perform dielectric withstand test of one minute duration at 75 percent of specified factory test value.

g. Metal-enclosed dc switchgear:

1) Test protective devices/relays in accordance with IEEE 141 procedures, modified as necessary, for compliance with approved coordination study.

2) Test operation of each circuit and control in accordance with approved sequence.

3) Test interlock system as follows:

(a) Make closure attempt on locked-open devices.

(b) make opening attempt on locked-closed devices.

4) Perform dielectric withstand test of one minute duration on entire assembled and erected switchgear. Test at a voltage of 2775 volts, rms, 60 Hertz or 3900 volts dc on live parts and 1500 volts, rms, 60

Hertz on control wiring. Isolate all electronic timers and devices during the test.

- h. Test ETS system for proper operation.
 - i. DC cable tests, and tests on cable shield monitoring system.
- B. Field Testing Personnel:
- 1. Provide services of qualified engineering representatives of the equipment manufacturers to conduct specified field testing program.
 - 2. When more than one representative is involved, the Contractor is responsible for coordination of testing effort.
- C. Submit five (5) copies of certified test reports within 10 days of Substantial Completion (SCI) for each station.

END OF SECTION

PROGRAM CRITERIA
YARDS AND SHOPS

1.01 GENERAL

- A. This program criteria includes design requirements for yards and shops for the Washington Metropolitan Area Transit Authority Metro Rail System. The yards will store the rapid transit trains, provide a storage area for the system maintenance and support the shops. The shop will perform service and inspection for the individual transit cars.

- B. Transit Car Maintenance Philosophy
 - 1. Efficient operation of the Metro Rail System requires the availability of a completely reliable service fleet of revenue cars sufficient to maintain scheduled service, while minimizing the total number of cars required.
 - 2. Routine maintenance, sometimes referred to as preventative maintenance involves the detection and resolution of minor maintenance problems before the malfunction either necessitates major overhaul of the transit car or causes a breakdown in service. Running repairs also are to be included in routine maintenance.
 - 3. Routine maintenance work will be performed at the Service and Inspection Shop, referred to hereafter as S&I Shop.

- C. The following characterize the maintenance activities of the S & I Shop:
 - 1. Cars are handled as married pairs.
 - 2. Unit parts and components are replaced.
 - 3. Major disassembly is not involved, except for truck.
 - 4. Portable hand tools are the worker's primary aid. Machine tools are seldom utilized.
 - 5. Majority of work is on-car, requiring relatively small work support areas.
 - 6. Complete pairs of cars are rapidly cycled.
 - 7. Lubricants are replenished.

1.02 SERVICE AND INSPECTION SHOP

- A. The shop shall be designed to facilitate the performance of scheduled inspection, minor repair, interior/exterior car cleaning, major truck repair, body repair and painting.

- B. The shop layout shall provide for segregation of work functions into designated areas to minimize interference with other functions and time lost in material handling.

- C. Aisles shall be kept clear of fixed equipment to allow free flow of materials.

- D. The layout shall be based on servicing 75 foot transit cars coupled into 150 ft. married pairs.

1.03 SHOP TRACKS AND TRUCK TRACKS TRACKWORK

- A. All trackwork design shall be performed with the objective of obtaining an optimum degree of constructibility and maintainability. Alternative analyses of major cost items of trackwork shall be made using life cycle and other analytic procedures which address the following principles:
 - 1. Selection of materials, configurations, and tolerances (manufacturing and construction) shall be based on lowest life cycle cost which meets the level of quality established by Metro standards, good engineering practice, and the level of service intended, with consideration of constructibility and maintainability. WMATA standard shall be utilized to provide interchangeability and reduce maintenance stockpiles.
 - 2. Constructibility shall be considered from initial design development to final detailing.

3. Maintainability encompasses the selection of materials and configurations that result in highly durable, easily accessible and easily repaired or replaced components and systems. Durability is achieved by materials which resist wear, fatigue and deterioration due to environmental conditions. Accessibility is achieved by configuring materials, particularly fasteners, and clearances to permit inspection, adjustment, repair and replacement with minimum disturbance to other components. Maximum accessibility should be provided to these components requiring most frequent maintenance. Repair ability is achieved by providing materials and configurations which require minimum quality control effort in the field to inspect, adjust, repair or replace by avoiding complex sequences of steps to mix, place, cure, tighten, finish, or adjust and which require minimum tolerancing to be acceptable.
 4. Where a conflict between constructibility and maintainability occurs, preference shall be given to maintainability. Within maintainability, preference shall be given to durability over accessibility and repair ability.
- B. Shop trackwork is track constructed in shop buildings for inspection, maintenance, repair, testing, servicing, cleaning, painting, washing, etc. of WMATA revenue and non-revenue rail vehicles as described in Section 1.01 and 1.02 above.
 - C. Truck trackwork includes the truck repair track and the truck transfer tracks used to transfer trucks between the shop tracks and the truck repair track.
 - D. The layout of the shop tracks and truck tracks are determined during the shop layout design as guided by the shop program criteria.
 - E. The shop tracks' limits are the insulated joints where the shop tracks and yard tracks join.
 1. The insulated joint locations are determined by the Train Control designer as guided by the Program Criteria.
 2. The desirable track design location for insulated joints and track bonding cable connections is in the ballasted track beyond the track approach slab at the end of the shop building apron and not within the limits of roadway crossing panels.
 - a. Where the application of other program criteria will not permit the insulated joints or track bonding cables to be located in the desired ballasted track location, then the embedded track or roadway grade crossing shall be designed to provide easy maintenance access and electrical isolation of the insulated joint and track bonding cables and connections as guided by the train control and electrical Program Criteria and approved by the Authority.
 - F. Road surfaces adjacent to the shop building and crossing the shop tracks shall be included in the shop building apron. The shop tracks shall be embedded into the concrete apron.
 - G. The concrete apron shall include a concrete reinforced ballasted track approach slab for each shop track.
 1. The ballast approach slab shall be designed and poured monolithically with the apron and extending a minimum of 3 feet beyond the end of the top of the apron (which is also the end of the embedded track construction).
 2. The ballast approach slab shall be 12 feet wide; 6 feet either side of the shop track centerline.
 3. At the end of the apron, the top of the ballast approach slab shall be 1' – 11" below top of rail/apron. At the end of the ballast approach slab, the top of the ballast approach slab shall be 2' – 3" below top of rail.
 4. The structural design of the ballast approach slab shall be guided by the structural Program Criteria.

- H. At the stub ends of the truck tracks, wheel stops shall be placed on both rails. The wheel stops shall be made of steel, shall fill the flangeways, and shall be flush with the top of rail and shop floor. The wheel stop shall be 2 ½" x 2 ½" x 1'. The wheel stop shall be welded to the truck track rail for the full length of the wheel stop.
- I. Shop and truck trackwork shall structurally support live loads and be designed in accordance with the structural Program Criteria.
- J. The design speed for shop and truck tracks is 2 MPH.
- K. Shop trackwork shall be electrically isolated from the shop and shall be connected to the negative switchboard as guided in the traction power Program Criteria.
- L. The ballasted shop tracks shall be designed and constructed the same as yard tracks.
- M. Between the ballasted track approach slabs, shop tracks have three construction types; open track, pedestal track and embedded track.
 - 1. Open track with 115 RE rail, WMATA standard F-17 DF or Transit Products F20R0 DF rail fastener with Pandrol left hand spring rail clips, grout pads, and female inserts coated with electrical insulating material. DF rail fasteners are spaced on 30 inch centers. Example use is wash track.
 - a. The DF rail fastener electrically isolates the rail from ground.
 - b. Nominal grout pad thickness is 7/8 inch thick with a minimum thickness of ¾ inch. Invert shall be chipped as necessary to achieve minimum grout pad thickness. Grout pads over 2 inches thick shall be reinforced.
 - c. Female inserts shall be of sufficient length to be embedded a minimum of 4 inches into the concrete invert, that is, the grout pad is not included as part of the insert embedment depth.
 - 2. Pedestal track with 115 RE rail and industry standard DF rail fastener with rigid bolted rail clips (satisfying the performance criteria herein). DF rail fasteners are bolted to a cap plate on top of rail posts that are spaced a maximum of 60 inch on centers. Example use is inspection pit track.
 - a. The DF rail fastener electrically isolates the rail from ground.
 - 3. Embedded track with 115 RE rail, industry standard DF rail fastener with rigid bolted rail clips, grout pads (satisfying the performance criteria herein), female inserts coated with electrical insulating material, and track embedment material. DF rail fasteners are spaced on 30 inch centers. The plane across the top of the rails shall be set at the top of the shop floor. The embedment material shall be placed to the top of the rail and shop floor with a 2 ¾ inch by 2 ¾ inch flangeway on the gauge side of the rails. Example use is repair track.
 - a. The DF rail fastener provides electrical insulation between the rail and ground. The track embedment material shall provide electrical insulation between the rails and ground. The DF rail fastener and embedment material system shall electrically isolate the rails from ground.
 - b. Concrete and cement grouts shall not be used for the embedment material. The embedment material shall be sufficiently flexible and elastic so that it will be compliant with the rail deflections with out cracking, tearing or separating. The rail deflections shall consider the rail support provided by the DF rail fastener, the embedment material, thermal conditions and loads, and, in the areas adjacent to ballast track, a 1/4 inch subsidence of the ballast support beneath the ties.
 - c. Nominal grout pad thickness is 7/8 inch thick with a minimum thickness of ¾ inch. Invert shall be chipped as necessary to achieve minimum grout pad thickness. Grout pads over 2 inches thick shall be reinforced.

- d. Female inserts shall be of sufficient length to be embedded a minimum of 4 inches into the concrete invert, that is, the grout pad is not included as part of the insert embedment depth.
4. An alternative embedded track design that uses a rail section different from 115RE rail or an alternative metal section for the rail or uses an alternative anchoring and embedment system that meets the following requirements may not be installed before approved by the Authority.
- a. The alternative embedded track system (including the transition rail and additional 115RE rail section that may be used) shall be electrically isolated from the shop building, floor and apron and shall be connected to the negative switchboard as guided in the traction power Program Criteria.
 - b. The top and gauge face of the alternative rail or metal section shall have the same cross section shape as 115RE.
 - c. The alternative rail or metal section shall meet AREMA rail straightness requirements.
 - d. The chemical and mechanical properties of the alternative rail or metal section shall be consistent with the structural analysis prepared in accordance with the structural Program Criteria.
 - e. The surface hardness of the alternative rail or metal section head and gauge face shall be sufficient to resist permanent deformation and damage from wheel contact stress from a WMATA revenue car with the WMATA wheel profile but, in order to minimize brittleness, shall not be harder than needed.
 - f. A single alternative rail or metal section shall not have an electrical resistance in excess of 0.025 ohms per 1000 feet at 20°C.
 - g. The alternative rail or metal section shall be welded into CWR strings as required for 115 RE rail. Welds shall be full section welds with structural strength meeting or exceeding the strength determined to be necessary in the structural analysis and with electrical resistance not exceeding the maximum resistance given herein.
 - h. A transition rail shall be used to transition between the alternative rail or metal section and 115 RE rail.
 - (1) The transition rail section shall be cast steel or milled from a steel bar. The chemical, mechanical, surface hardness, and electrical properties shall be the same as indicated herein for the alternative rail or metal section.
 - (2) The alternative rail or metal section portion of the transition rail shall have the same cross section as the alternative rail or metal section and shall be welded to the alternative CWR rail or metal section.
 - (3) The 115 RE portion of the transition rail shall have the 115 RE rail cross section and shall be a minimum of 60 inches long.
 - (4) A minimum of 60 inches of rail with 115 RE rail section rail shall be in embedded track.
 - (5) The 115RE rail end of the transition rail shall either join to the the yard track with an IJ joint or shall be welded to a piece of 115RE rail that is 19 feet or longer in length.
 - i. The alternative rail or metal section shall be supported in the vertical, lateral and longitudinal directions.
 - (1) At a maximum of every 4 track feet, the base of the alternative rail or metal section shall attach to a gauge bar that holds the alternative rail or metal sections at 4' – 8 ½" gauge. The gauge bar shall be a minimum of 6 feet long and extend a minimum of 7 ¾ inches from both gauge lines.
 - (2) Between the gauge bars, equally spaced ½" minimum diameter anchor bars of sufficient length and depth to anchor the alternative

- rail section shall attach to the alternative rail or metal section.
- (3) When a turntable or elevator is included in the shop track, the design and spacing of the gauge bars and anchors shall consider longitudinal rail loads and deflections due to thermal rail loads per the criteria herein.
 - (4) The gauge bars and anchor bars shall be embedded into the concrete invert to anchor the alternative rail or metal section at the design horizontal and vertical alignment, cross-slope, rail cant, and gauge.
 - (5) If the alternative rail or metal section is detachable from the gauge bar or the anchors, then the gauge bars and anchors shall have shoulders with rigid bolted rail clips that holds the alternative rail or metal section to the design horizontal and vertical alignment, cross slope, rail cant and gauge before the alternative rail or metal section is embedded and when the embedment material is subsequently removed.
- j. The portion of the transition rail with the 115RE rail section that is embedded shall be supported with DF rail fastener spaced at a maximum of 30 inches, grout pads, female inserts coated with electrical insulating material, etc. as described herein for embedded track with 115 RE rail.
 - k. The embedment material shall be designed or configured to provide a 2 3/4 inch by 2 3/4 inch flangeway on the gauge side of the rails.
 - l. Structural analysis shall be made and submitted to the Authority
 - to determine the shape and material properties of the alternative rail or metal section and of the transition rail,
 - to determine the spacing and pull out strength needed for the alternative rail or metal section gauge bars and anchors,
 - to determine the strength, flexibility and elasticity the electrical insulating and embedment materials need so that it will be compliant with differential movements in the embedded track without tearing, cracking, or separating.
 - (1) The analysis shall consider the strains resulting from the geometric and mechanical properties of the concrete invert and its support, and of the alternative rail or metal section, 115 RE rail and the transition rail and their supports.
 - (2) In the areas adjacent to ballast track, the analysis shall consider a 1/4 inch subsidence of the ballast support beneath the ties.
 - (3) The structural analysis shall include the loads due to thermal rail loads from a temperature rise of 50°F and a temperature fall of 100°F in the rails outside of the shop. The thermal rail loads to use in the structural analysis for the rails inside the shop shall be determined from a thermal mechanical analysis of the shop.
- N. Restraining rail shall be provided on the gauge side of the inside running rail for curves in the shop tracks where the curve radius is less than 450 feet.
1. The applicable curves and the restraining rail limits are shown on the track construction plan drawings in the contract documents. The limits include a minimum of 15 feet of restraining rail on tangent.
 2. The restraining rail shall be stand up 132 RE rail and bolted to the running rail with separator blocks and three 1/8 inch adjustment shims as shown in the contract documents.
 3. The top of the restraining rail shall be 3/4 inch above the top of the running rail.
 4. The flangeway shall be 1 7/8 inches.
 5. Restraining rail shall be made from stick rail with minimum and maximum stick

- lengths of 20 and 40 feet, respectively.
6. Restraining rail sticks shall be joined with restraining rail joints as shown in the contract drawings.
 7. The end sections of restraining rail shall have an end flare and bevel per AREMA.
 8. Track gauge of 4' - 8 1/2" shall be used except, when the curve radius is less than 350 feet.
 9. When the curve radius is less than 350 feet.
 - a. Both running rails and the restraining rail shall be shop precurved to the prescribed radius.
 - b. The track gauge is 4' - 9 1/4".
 - (1) Gauge widening shall occur linearly over a gauge transition section on tangent track with a transition length of not less than 15 feet.
 - (2) Over the transition length, the inside rail and the restraining rail shall shift 3/4 inch towards the curve center to accomplish the gauge widening. The outside rail does not shift from its standard gauge line offset of 2' - 4 1/4" from track centerline.
 - (a) The restraining rail and inside running rail shall be shop bent at the beginning and end of the gauge transition section as necessary for the gauge transition.
 10. The inside running rail and the restraining rail shall be supported by an industry standard DF rail fastener with rigid rail clips and shall be spaced at 30 inches. The industry standard DF shall meet the requirements in paragraph 1.04 of this Program Criteria except as follows.
 - a. The maximum length requirement of 17 inches is waived.
 - b. The anchor bolt hole location in the DF body and the anchor insert location requirements are waived.
 - c. The requirement for a full bottom plate is waived.
 11. As applicable for open, pedestal and embedded track, paragraphs 1.03 M.1. in this Program Criteria applies to restraining rail.
 12. If an alternative embedded track design that uses a different rail section from 132 RE or an alternative metal section for the restraining is proposed, then paragraph 1.03 M.4. shall be applied.
- O. The 115 RE rail shall meet AREMA chemical, mechanical, section, manufacturing, hydrogen elimination, interior condition, surface condition, workmanship, etc. requirements for rail and as approved by the Authority.
1. The 115 RE running rails not used with restraining rail shall meet AREMA requirements for standard rail and AREMA tolerances for rail.
 2. The 115 RE running rails used with restraining rail and the 132 RE restraining rail shall meet AREMA requirements for high-strength rail (fully heat treated or head hardened) and AREMA tolerances for trackwork rail.
- P. The 115 RE rail shall be welded into CWR strings with a moveable permanent electric flash butt welding plant. Exothermic thermite welds are only to be used when construction sequencing requires field welding. Electric flash butt and thermite welds shall meet AREMA welding standards except as approved by the Authority.
1. No bolted rail joints shall be used in the shop and truck tracks.
 2. Insulated rail joints shall be bonded.
- Q. Truck tracks have one construction type; embedded track. Alternative truck track designs shall be approved by the Authority.
1. Truck tracks are not electrically isolated from ground and they shall be grounded in accordance with electrical Program Criteria.
 2. The rail for truck track is a continuous steel bar 2 1/2 inch square in section.

- a. The top gauge corner of the square rail section shall be chamfered ¼ inch.
 - b. The surface hardness of the square rail section shall be sufficient to resist permanent deformation and damage from wheel contact stress from a WMATA truck with the WMATA wheel profile but, in order to minimize brittleness, shall not be harder than needed.
 - c. The steel bar shall meet AREMA rail straightness requirements.
 - d. The chemical and mechanical properties of the alternative rail shall be consistent with the structural analysis prepared in accordance with the structural Program Criteria. The live load is the weight of a WMATA revenue truck.
 - e. The square rail section shall be welded into CWR strings as required for 115 RE rail. Welds shall be full section welds.
3. The square steel bar shall be supported in the vertical, lateral and longitudinal directions.
- a. Every 4 track feet, the square rail sections shall be welded to a gauge bar that holds the square rail sections at 4' – 8 ½" gauge. The gauge bar shall be a minimum of 6 feet long and extend a minimum of 7 ¾ inches from both gauge lines. The gauge bar shall be a 2" x 9/16" x 3/16" at 1.76 lbs./ft channel.
 - b. Two ½" diameter anchor bars shall be spaced 1' – 4" between the gauge bars and welded to the square rail sections. The anchor bar shall be 16 inches long and configured to provide equal length legs that are angled down and transverse to the square rail section at a rise to run slope of 1 to 2.
 - c. The gauge bars and anchor bars shall be embedded into the concrete invert to anchor the square rail section at the design horizontal and vertical alignment, cross-slope, and gauge.
4. The plane across the top of the square steel bar sections shall be set at the top of the concrete floor. The concrete floor shall be formed to provide a 2.5 inch by 2.5 inch flangeway on the gauge side of the rails. A continuous 1 ½" x 1 ½" angle bar shall be embedded in the concrete floor to make the top flangeway corner that is opposite the square rail. 3/8" x 4" studs shall be welded to the angle bar at 18" centers. The studs are embedded into the concrete floor and they anchor the angle bar.

1.04 INDUSTRY STANDARD DF RAIL FASTENER WITH RIGID, BOLTED RAIL CLIPS AND DF TRACK FOR SHOP TRACKS

- A. The Design Builder shall supply and install direct fixation (DF) rail fasteners for the shop tracks that perform the following primary functions:
- 1. The DF rail fastener shall be comprised of as few components as is economically and technically feasible for ease of assembly, disassembly and maintenance, and shall be designed to permit installation and replacement of the entire assembly or any of its components by one man using standard, conventional hand stools.
 - 2. Provide vertical, lateral and longitudinal stability, and provide for vertical and lateral adjustments.
 - 3. Provide rigid bolted rail clamps to control the rail in the longitudinal direction.
 - 4. Provide electric insulation for the rail.
- B. The Design Builder shall require a DF rail fastener be supplied that provides the following minimum performance requirements. The Design Builder shall certify that the DF fastener supplied comply with the following requirements, certify that the tests listed below and the tests the Design Builder designer specifies were performed as required, and certify that the test results for the tests listed below and the tests the Design Builder designer specifies meet the specified requirements.
- 1. The fastener shall be designed for 115 RE Rail section.

2. The DF fastener includes a molded fastener body; rigid bolted rail clamps; the rail clamp's bolt, washer and nut; anchor bolts; lateral adjustment components; shims; and female inserts.
3. The DF fastener shall have a maximum length of 17 inches measured normal to the rail and a maximum thickness at the rail seat of 1 3/4 inches. The nominal rail centerline at the rail base is at the DF fastener centerline located midway between the DF fastener's two ends.
4. The holes in the body of the DF fastener for the anchor bolts and the female inserts shall be located 5-1/4 inches from the nominal centerline of rail at the rail base measured normal to the rail and 1-3/4 inches from the centerline of fastener measured parallel to the rail. The anchor bolt holes and female inserts shall be symmetrically located in the upper right quadrant and lower left quadrant of the DF fastener when standing on the rail centerline and looking along the centerline of rail.
5. The lateral mechanical properties of the DF fastener shall be the same in both lateral directions. The longitudinal mechanical properties of the DF fastener shall be the same in both longitudinal directions.
6. Adjustment Requirement.
 - a. Lateral Adjustment:
 - 1) The rail fastener shall provide a minimum of plus or minus 1/2 inch rail lateral adjustment in 1/8 inch increments.
 - 2) Friction shall not be used as a means for adjustment or for preventing lateral movement.
 - 3) If lateral adjustment employs serrations on any component, each serrated interface shall have at least three engaged serrations. There shall be a minimum of three linear inches of serration engagement per fastener. Serrations shall be machined or cast to a minimum depth of 1/16 inch. Cap plates, if used, shall cover the opening to any electrical ground potential in every position of adjustment and form a reasonable seal to prevent the intrusion of dirt, metallic particles, and other material.
 - 4) Components of the rail fastener shall not be replaced or added to the basic configuration in order to laterally adjust the rail.
 - b. Vertical Adjustment:
 - 1) Vertical rail adjustment capability shall be a minimum of 1/2 inch in 1/16 inch increments, provided by shims. The one-sixteenth-inch shims shall be made of steel and shall provide full bearing support to the bottom of the fastener.
 - c. All requirements of these Specifications shall be satisfied for all increments of fastener adjustment.
7. The body of the fastener is a metal base element and a metal top element with an elastomeric pad bonded between them. Bonding shall occur during the vulcanization process.
8. Elastomer shall be a blend of natural rubber and chloroprene. The proposed elastomer shall meet following requirements. The following requirements are not the QC requirements. The QC requirements shall be set from these test results or from a history of test data the manufacturer can provide for the proposed compound.
 - a. Each test listed below shall be performed on two specimens.
 - b. The specimens used for the test shall have been taken from the production size batch used for making the fastener and to have cured in a manner equivalent to the cure used for the fastener.
 - c. Prior to the testing, all elastomer specimens shall be conditioned for not less than two days at 23 deg, C plus or minus 2 deg. C and 50% plus or minus 5% relative humidity
 - d. Tests performed on specimens are:

- 1) The elastomer shall be tested for 22 hours in accordance with ASTM D395, Method B. The test shall be conducted at 70 deg. C. And the set shall not exceed 25 percent.
 - 2) When tested at minus 10 deg. C for 70 hours in accordance with ASTM D1229, the compression set at 30 minutes after release (t@30 reading) shall not exceed 37 percent
 - 3) Oil Absorption Test
 - a) One test shall be conducted with ASTM No. 3 oil at 23 deg. C for 70 hours in accordance with ASTM D471. The volume change for the No. 3 oil shall not exceed 60 percent.
 - b) A second test using a different sample shall be conducted with ASTM No. 1 oil at 23 deg. C for 70 hours in accordance with ASTM D471. The volume change for the No. 1 oil shall not exceed 10 percent.
9. Molding
- a. Contractor's name or trademark shall be molded into the elastomer.
 - b. The base of the fastener is parallel to the rail seat so as to provide no cant to the rail. The slope tolerance is plus and minus 0.37%. The rail seat area is flat having maximum convexity and concavity of less than 0.001 inch per inch when measured from a straight edge.
 - c. The bottom of the base element shall be free of elastomer except that minimal flashing will be acceptable providing it does not interfere with retention of proper anchor bolt tension.
10. Rigid rail clips shall be configured to bear against the side and top of the toe of the rail. The rail clip configuration and the material shall be chosen by the Design Builder to perform to the vertical and lateral loads given here-in and to allow the rail to slip in the longitudinal direction in the load range given here-in.
11. All threaded elements shall be high strength type conforming to the chemical composition and mechanical requirements of ASTM A 325, Type 3, including nuts and plain hardened washer, with chromium, nickel and copper in such combination to achieve maximum corrosion resistance consistent with strength and hardness requirements. Thread fit shall be 2A and 2B. Thread length may vary from that specified for structural bolts.
12. The rail clip bolt length, diameter, and head design shall be as needed to provide vertical and lateral rail stability and rail slippage in the longitudinal direction in the load range given here-in. The installed bolt tension shall be 75% of the proof load for the rail clip bolt size.
13. Anchor bolts
- a. The anchor bolts shall be 7/8 inch in diameter with a heavy hex head.
 - b. The anchor bolts shall secure the fastener to the concrete trackbed with a tension of 30,000 pounds per anchor bolt.
 - c. The anchor bolts shall be threaded into female threaded inserts set in the concrete trackbed.
 - d. The anchor bolts engage not less than one inch and not more than one and one -half inches of the threaded insert in the installed position.
 - e. Other than the standard protective coating applied by the bolt and insert manufacturers, no oil, sealant or other compound shall be applied to the threads.
14. For material requirements for grout pads, female inserts and insert anchoring material for DF track construction, the Design Builder shall use Specification SECTION 05653, Direct Fixation Track Construction.
15. Mechanical and Electrical Requirements. Two fasteners shall be tested, either individually or as a pair in a two fastener test rig. The vertical, lateral and longitudinal tests shall all be done individually or as a pair and all subsequent tests for production

lots shall be done in the same manner.

- a. Vertical Load: No components of a DF fastener (including the grout pad and female insert anchoring material) shall fail, yield or slip when a downward 12 kip vertical load is applied to a single fully assembled and anchored DF fastener for all positions of lateral adjustment. A 12 inch minimum length 115 RE rail section shall be attached per the designers specifications. The 12 kip vertical load shall be applied to the rail head and shall pass through the intersection of the rail's longitudinal centerline and the DF fastener's transverse centerline for each position of lateral adjustment. The vertical deflection of the rail head at the DF centerline shall be measured to the nearest 0.0001 of an inch and recorded.
 - 1) A two fastener test rig may be used with a longer rail section and 24 kips of vertical load. The center lines of the two fasteners may be spaced 10 to 30 inches apart. The vertical load shall be applied midway between the two fasteners. The vertical deflection of the rail head at both DF center lines shall be measured to the nearest 0.0001 of an inch and recorded.
- b. Lateral Load: No components of a DF fastener (including the grout pad and female insert anchoring material) shall fail, yield or slip when a 6 kip lateral load is applied to a single fully assembled and anchored DF fastener for all positions of lateral adjustment and with 1/2 inch of vertical adjusting shims. A 12 inch minimum length 115 RE rail section shall be attached per the designers specifications. The 6 kip lateral load shall be applied to the rail base and shall align with DF fastener's transverse centerline. The lateral deflection of the rail base and at 5/8 inch below the top of rail at the DF centerline shall be measured to the nearest 0.0001 of an inch and recorded.
 - 1) A two fastener test rig may be used with a longer rail section and 12 kips of vertical load. The center lines of the two fasteners may be spaced 10 to 30 inches apart. The lateral load shall be applied midway between the two fasteners. The lateral deflection of the rail base and at 5/8 inch below the top of rail at both DF center lines shall be measured to the nearest 0.0001 of an inch and recorded.
- c. Longitudinal Restraint: No components of a DF fastener (including the grout pad and female insert anchoring material) shall fail, yield or slip when a 7.5 kip longitudinal load is applied to a single fully assembled and anchored DF fastener for all positions of lateral adjustment. A 12 inch minimum length 115 RE rail section shall be attached per the designers specifications. The 7.5 kip longitudinal load shall be applied to the rail base and shall align with the rail's longitudinal centerline. The longitudinal load shall then be increased above 7.5 kips and the rail shall slip through the rail clamps and DF rail seat before a 10 kip longitudinal load is reached. No other components of a DF fastener (including the grout pad and female insert anchoring material) shall fail, yield or slip for longitudinal loads up to and including the rail slip load. The longitudinal deflection of the rail base and of the DF rail seat plate shall be measured to the nearest 0.0001 of an inch and recorded.
 - 1) A two fastener test rig may be used with a longer rail section and the rail shall not slip with a 15 kips of longitudinal load but shall slip through the rail clamps and DF rail seat before a 20 kips longitudinal load is reached. The center lines of the two fasteners may be spaced 10 to 30 inches apart. The longitudinal load shall be applied at the rail base in line with the rail's longitudinal centerline. The longitudinal deflection of the rail base and of both DF rail seat plates shall be measured to the nearest 0.0001 of an inch and recorded.
- d. Electrical Resistance: A complete fastener body shall be fully immersed for

70 hours in distilled boiling water. After 70 hours, the fastener body shall remain in the water until the water and fastener body cools to an ambient temperature of 70 F plus or minus 5 F. Once reaching 70 F, the fastener body shall be quickly removed without drying from the water and fully assembled with a section of rail and anchored. With both anchor bolts and the DF fasteners bottom plate electrically grounded, 100 volts DC shall be applied to the rail head for 3 minutes. The actual current flow shall be measured to the nearest 0.1 microampere and recorded. The maximum current for 100 volts DC shall be 1.0 microampere. If the maximum current of 1.0 microampere is exceeded, then current readings shall be taken every 15 minutes until 1.0 microampere or less is reached. The DF rail fastener shall not be dried with fans, lamps, etc. At each current reading the fastener's surface body temperature and the humidity in the air shall be measured and recorded. The DF fastener's body temperature shall be kept at 70 F plus or minus 5 F and the air's relative humidity at 50% plus or minus 5%.

- 1) The electrical test shall not be done in a two fastener rig. The two fasteners may be tested during the same time period but while one DF is tested, the other DF shall not be electrically connected to the DF being tested in any manner.

16. Qualification Tests

- a. For an industry standard DF fastener, previously performed certified test reports inclusive of the herein specified elastomer, mechanical and electrical tests shall be submitted as qualification tests for approval and for establishing QC/production test result criteria prior to beginning production.
 - 1) When previously performed test reports are not available for all or some tests, then qualification tests shall be performed for those tests for which data is not available.
 - 2) When the elastomer compound or the DF design of an industry standard DF fastener is modified, then all elastomer, mechanical and electrical tests shall be performed.
- b. When the proposed DF fastener is not an industry standard design, then all elastomer, mechanical and electrical tests shall be performed and approved prior to production.
- c. Qualification tests shall be performed on samples manufactured with the same materials, components, processes, procedures, molds, etc. as will be used for full production. Elastomer test samples shall be taken from a full production size batch. DF fastener test samples shall be chosen from a production type run of at least 20 fasteners.

C. The Design Builder shall require a packaging, shipping and storage plan to be developed and implemented.

1. Fasteners shall be packed and shipped in a manner that shall prevent a load on any fastener from exceeding 1,000 pounds.
2. Fasteners shall not be stored in a wet location or where the ambient temperature will exceed 120 deg. F.
3. Fasteners shall be packaged on wood pallets and wrapped in minimum 6 MIL plastic to permit outdoor storage in a secured area. Rail hold-down assemblies, shoulders, bolts, nuts and other loose items shall be packaged by component type in secure shipping kegs or boxes and clearly identified.
4. Fasteners used in the production quality control testing shall be packed and labeled separately from the rest of their lot.

D. For installation procedures for grout pads, female inserts, DF fasteners, and rail laying and

adjustment, the Design Builder shall use Specification SECTION 05653, Direct Fixation Track Construction.

- E. The Design Builder shall develop and maintain a quality control program.
1. The quality control program shall require regulated methods, procedures, processes and tests to ensure compliance with standards of quality required by the Contract Documents. The program shall include:
 - a. Establishing the material and configuration requirements for each component and product.
 - b. Establishing procedures and frequencies for sampling, testing and measurement for each component and product.
 - c. Performance of sampling, testing and measurements.
 - d. Verification that the dimensions and test results conform to the configuration and material requirements.
 - e. Develop corrective action when non-conforming materials and products are found.
 - f. Disposition of non-conforming materials and products.
 2. When testing or measurement cannot be done in a timely manner, for example, because of lengthy cure time, or when the volume of a material is large or difficult to isolate and replace, or when QC testing is destructive or difficult and time consuming to do, such as, QC testing to determine proper thermal rail adjustment, then the Design Builders quality control program shall place additional emphasis on monitoring that the correct raw materials, handling, production procedures and processes, and workmanship are being used.
 3. Elastomer, mechanical and electrical QC test result requirements shall be developed from the qualification test result values or from historical data the manufacturer provides for the elastomer and DF fastener proposed for this project.
- F. The Design Builder shall require as a minimum the following submittals to the Authority for approval.
1. The quality control program and quality control reports.
 2. Shop drawings and other data, including design calculations. Shop Drawings are to be complete and detailed.
 3. The method and materials for packaging the shipment and for storage.
 4. DF track construction work plan.
 5. Test reports
 - a. DF rail fastener elastomer, mechanical and electrical qualification tests, or, when permitted by this program criteria, previously prepared test reports inclusive of tests specified herein for the same elastomer and DF design proposed for this project.
 - b. Elastomer tests for each elastomer batch used to make DF fastener bodies.
 - c. Mechanical and electrical tests on 2 samples from each production lot of 2000 or less DF rail fasteners.
 - d. Others.
 6. Certifications
 - a. DF fasteners, grout pads, and female insert anchoring material comply with the specified requirements,
 - b. The specified tests were performed as required,
 - c. The test results meet the specified requirements.

END OF SECTION

PROGRAM CRITERIA

YARD SIGNAL CONTROL AND INTERLOCKING SYSTEMS

1. GENERAL

1.01 Criteria Coverage

A. Scope

These Criteria include design and functional requirements for the Washington Metropolitan Area Transit Authority (WMATA) METRORAIL Yard Signal Control and Interlocking Systems changes and additions being implemented under the Metro Matters Project.

B. Intent

The intent of these Criteria is to establish acceptable standards for Yard Signaling and Interlocking Control Systems and equipment which must be specified, designed, properly implemented, tested, and documented, to result in systems which shall control the movement and operations of trains in a safe and expeditious manner, and in complete compatibility with the current Train Control Systems in use on the WMATA METRORAIL System.

1.02 Standards

The design of the Yard Signal Control and Interlocking Systems must be coordinated with the design standards of current and new transit car equipment, propulsion power equipment, and communications equipment, and with the current WMATA Train Control Systems.

A. Organizational Standards:

The design and implementation of Yard Signal Control and Interlocking Systems shall be guided by the requirements of:

1. Title 49, Part 236 of the Code of Federal Regulations (49 CFR 223) - Rules, Standards, and Instructions Governing The Installation, Inspection, Maintenance, and Repair of Signal and Control Systems, Devices and Appliances, the: rules and regulations prescribed by the Department of Transportation - Federal Railroad Administration - Office of Safety;
2. The National Electrical Code and all applicable local codes.
3. The recommendations of applicable Parts of the Signal Section Manual of the Association of American Railroads/American Railway Engineering and Maintenance-of-Way Association (AAR/AREMA Signal Manual of Recommended Practice), unless otherwise specified.

B. WMATA Standards and Practices:

The design and implementation of Yard Signal Control and Interlocking System changes and additions shall comply with the requirements of:

1. Current WMATA METRORAIL clearance standards;
2. Current WMATA METRORAIL Standard Operating Procedures;
3. Current WMATA METRORAIL wayside signal aspects, names, and indications;
4. Current WMATA METRORAIL nomenclature, terminology and definitions of terms.
5. Current WMATA METRORAIL "Automatic Train Control System Integrity Maintenance Practices".
6. Program Criteria as described herein.

1.03 Environmental Requirements:

A. Physical:

1. All Yard Signal Control and Interlocking System equipment housed in Train Control Rooms shall function in accordance with specified requirements over a room temperature range of -22 degrees F to +158 degrees F at relative humidities of 5 percent non-condensing to 95 percent, inclusive.
2. All wayside Yard Signal equipment not housed in Train Control Rooms shall function in accordance with the specified requirements over a temperature range of -40 degrees F to +158 degrees F at relative humidities of 5 percent non-condensing to 95 percent, inclusive.
3. All Yard Signal equipment housed in Train Control Rooms shall be constructed and installed so that it will remain fully operational while subjected to acceleration and frequency as listed below:

<u>Sweep Frequencies</u>	<u>Peak to Peak Displacement</u>	<u>Acceleration</u>
5-12 Hz	0.02 Inches	---
12-1000 Hz	—	0.14g peak or 0.10g rms

4. All Yard Signal equipment not housed in Train Control Rooms shall be constructed and installed so that it will remain fully operational while subjected to acceleration and frequency as listed below:

<u>Sweep Frequencies</u>	<u>Peak to Peak Displacement</u>	<u>Acceleration</u>
5-20 Hz	0.2 Inches	---
20-1000 Hz	—	4.2g peak or 3.0g rms

5. All electrical contacts on Yard Signal equipment (including relay contacts, jack

contacts and switch contacts) shall be protected from dust and moisture.

B. Electrical:

All Yard Signal Control and Interlocking System equipment and systems provided shall be constructed so that they function properly in the unfavorable electrical environment of the WMATA METRORAIL Rapid Transit System, which will tend to cause electro-static, electromagnetic, inductive, conductive and radiated interference.

1.04 Current Yard Signal Control and Interlocking System Configurations:

A. Yard Signal Control and Interlocking Systems shall conform to current WMATA Yard Train Control System practices as follows:

1. Yard Signal Control and Interlocking Systems are controlled by vital and non-vital Train Control (TC) equipment installed in Train Control Rooms (TCR)s located at strategic points in the Yard.
2. The Yard Signal Control and Interlocking System equipment in the TCRs is hard-wired to the various switch machines, signals, snowmelters, dragging equipment detectors and other trackside equipment in accordance with WMATA standard practices.
3. The Train Control Room shall conform to the following configuration:
 - a. Racks and Cable Trays:

Cable trays and 19-inch equipment racks for Train Control equipment, power supplies, and cable entrance terminations, shall be installed in rows in the TCRs, in compliance with WMATA standard spacing requirements and in coordination with lighting, power source, grounding and HVAC equipment installed by others.
 - b. Train Control Power:

Automatic power transfer and bypass-isolation equipment shall be wall-mounted in the TCRs with regard for accessibility and equipment clearances.
 - c. Maintenance Furniture and Equipment:

Maintenance furniture and equipment shall be provided at appropriate locations in each yard.

 - (1) Appropriate tables, storage cabinets, lockers, ladders, and other maintenance furniture and equipment shall be provided in each TCR.
 - (2) Appropriately sized and constructed Gang Boxes (for storage of tools and equipment) shall be provided in the field, at interlocking locations.
4. A Yard (Interlocking) Control Machine shall be provided in the Yard Control Room to

enable WMATA Interlocking Operators to supervise the movement and routing of transit cars and railborne maintenance/ service equipment, within the limits of the yards. The Yard Control Machine shall consist of one or more consoles which will support control and indication panels (face plates), which will display a diagram of all tracks and interlockings within the yard limits and the associated mainline station platform. These panel face plates shall be large sectional engraved phenolic plates.

- a. Right-hand track switches (in the field) shall be engraved as right-hand switches on the control panel, and left hand switches (in the field) shall be engraved as left-hand switches on the control panel. A small "dot" shall be engraved on the panel next to the applicable diverging track indicator LED for each power switch layout to indicate the arbitrarily designated "NORMAL" alignment for that switch.
- b. The base(s) of these control machine consoles shall be used to house Train Control system equipment such as Computerized Yard Control System modules, on roll-out or swing-out racks.
- c. Pushbuttons, toggle switches and LED indicators are mounted on the control panel faceplates to initiate safe routes for trains, manually control track switches for test and maintenance purposes, interface with Central Control, and monitor train movements, dragging equipment detectors, snowmelters, and various alarm conditions. Audible alarm devices shall be mounted within the control machine console.
- d. Control Machine Controls
 - (1) A Key Switch shall be provided to control energization of the Yard Control Machine.
 - (2) Train routing shall be initiated by a non-vital Entrance/ Exit system.
 - (3) Appropriate pushbuttons shall be provided to request routes for train movement and signal fleeting.
 - (4) Individual Test Keys (toggle switches) shall be provided for the independent operation of track switches and crossovers.
 - (5) Appropriate pushbuttons shall be provided to check (momentarily energize) all indicator lights on the Yard Control Machine.
 - (6) Pushbuttons shall be provided to cause the display of the current alignment of all electrically powered switches in the yard.
 - (7) Appropriate pushbuttons shall be provided for Transfer of Control of the mainline interface portion of the yard to and from Central Control.
 - (8) A pushbutton shall be provided to acknowledge alarm conditions and silence audible alarms.
 - (9) A toggle switch shall be provided for the control of yard snowmelter

layouts.

- (10) A device shall be provided on the outside of the Control Machine Console which uniformly controls the light intensity of the variously colored indication LEDs.

e. Control Machine Indications

- (1) Light Emitting Diodes (LEDs) and appropriate circuitry shall be provided for all visual indications, to include:

- (a) Track Occupancy
- (b) Traffic Direction
- (c) Route Locked
- (d) Switch Locked
- (e) Switch Position
- (f) Available Exit Points
- (g) Wayside Signal Status and Fleeting
- (h) Snowmelter Status
- (i) Blown Fuse
- (j) Power Status
- (k) Grounding Status
- (l) Microprocessor Status
- (m) Dragging Equipment Status
- (n) Individual Snowmelter Failure
- (o) Next Train Needed
- (p) Central/Local Control
- (q) Dispatch Warning

- (2) Audible indications are provided as follows:

- (a) A single-stroke bell to indicate a change in status of certain normal operational features.
- (b) An acknowledgeable (cancelable) bell or buzzer to indicate alarm conditions.

f. Control Machine Furniture

An appropriate armchair and a file cabinet, both on casters, shall be provided for the Yard Interlocking Operator in the Yard Control Room.

1.05 Yard Signal Control and Interlocking System Functions, Principles and Operational Requirements

A. Component or System Failures:

1. Component or system failures which are not self-detecting shall not cause unsafe conditions, even if added to other failures.
2. Any number of simultaneous components or system failures attributable to the same causes or related causes shall not cause unsafe conditions.
3. Any component or wire becoming grounded or any combination of such grounds shall not cause unsafe conditions.

B. Circuit Requirements:

1. Vital Circuits:

- a. Regardless of how they are implemented, vital circuits shall be fail-safe design.
- b. Electronic fail-safe circuit design shall provide protection against the following types of component failures:
 - (1) Two terminal devices: open, short, partial open or partial short.
 - (2) Multi-terminal devices: any combination of opens, shorts, partial opens or partial shorts.
- c. Vital circuits shall be based on closed-loop principles: i.e. broken wires, damaged or dirty contacts, a relay failing to respond when energized, or a loss of power supply energy shall not result in unsafe conditions.
- d. When the number of contacts required in vital circuits demand the use of repeater relays, minor circuits shall be operated by contacts of the repeater relays. Minor circuits are defined as those involved in panel illuminations and similar applications.
- e. The circuits controlled by the prime relay and its repeaters shall be coordinated so that unsafe or undesirable conditions cannot occur if a repeater relay fails to pick up.
- f. Except when specified otherwise, all circuits which energize a vital relay located outside of a Train Control Room and all circuits which energize a vital relay located inside of a Train Control Room but which contains contacts located outside of the Train Control Room in which the relay is located, shall

be two-wire, double break circuits and shall be energized from an ungrounded power supply.

- g. If non-vital relays are used in vital circuits, it shall be assumed that these relays can fail so that front contacts weld, back contacts weld, or any combination of these events may occur. It shall be assumed that the welding of a front contact will not prevent back contacts from conducting when the relay is deenergized, and that the welding of a back contact will not prevent front contacts of the relay from conduction when the relay is energized. It shall also be assumed that an armature may stick in any position. None of the above events when they occur, shall cause unsafe conditions.
- h. Switch Operation circuits shall be two-wire, polar, double break circuits. Overload Stick Relays shall be circuited to meet operating requirements. The remaining vital circuits shall be positive energy, single break circuits. All of the relays used in these circuits shall have one side of each relay, or each individually controlled relay coil, connected directly to negative energy (common).
- i. The following types of circuits shall be considered vital to the safety of the Yard Signal Control and Interlocking System:
 - (1) Interlocking Track Circuits
 - (2) Switch Operating Circuits
 - (3) Switch Locking Circuits

2. Non-Vital Circuits:

- a. Non-vital logic relays shall be plug-in, dc, neutral relays with a nominal operating voltage of 28 volts.
- b. Non-vital logic relays shall be manufactured specifically for railroad and transit applications and shall conform to the recommendations established by the AREMA Signal Manual, Part 6.3.5 (Detachable DC Non-vital Relay).
- c. Arc suppression for non-vital logic and heavy duty interfacing relay coils shall be built into the relays or into their plugboards.
- d. Non-Vital circuits shall utilize non-vital relay or solid state technology. Failures of non-vital equipment shall not affect the safety of the system.
- e. Non-Vital circuits shall employ closed-loop circuit design principles and be based on fail-safe concepts.
- f. The following types of circuits shall be considered non-vital in the Yard Signal Control and Interlocking System.
 - (1) Shop Lead Track Circuits

- (2) All circuits except those specifically identified as Vital Circuits.

C. Computerized Yard Control System

1. Non-vital functions

Non-vital functions of the Yard Signal Control and Interlocking System shall be performed by solid-state, electronic processors (computers) unless otherwise specified. These "computers" shall be configured in a manner approved by the Authority and shall meet the Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR) requirements shown in the graph on Criteria Diagram TC-7.

2. Quality

The logic and operation of the computerized system shall be at least equivalent in safety and speed of operation as the best operation achievable by a system implemented with non-vital relays and discrete component circuitry.

3. Documentation

Complete documentation shall be furnished for all software and hardware to be included in the Computerized Yard Control System. This shall include both conventional relay logic drawings and computer-equivalent circuit drawings (or equivalent software logic statements) for all of the non-vital functions which are to be performed by the "computers" in the Computerized Yard Control System, and a complete test and inspection program for all hardware and software included in the system.

4. Compliance

The Computerized Yard Control System shall comply with all basic environmental, mechanical, electrical, programming diagnostic, and spare requirements and current practices for WMATA Yard Train Control Systems.

D. Train Detection:

Determination of train location on the tracks within the yard shall be accomplished by means of shunts applied to track circuits by the wheel-and-axle sets of the transit cars. The running rail portion of every track circuit (or contiguous portion thereof) shall be at least 50 feet in length (to avoid the possibility of being straddled by the transit car wheelbase).

1. Vital, single-rail, AC power frequency (60 Hz) track circuits using vane-type vital track relays shall be used for train detection purposes on yard interlocking, yard lead, and yard running tracks, and as otherwise specified. These track circuits shall provide train detection for up to 0.6 ohms shunting resistance.
2. Non-vital, series-type, alternating current (60 Hz) track circuits shall be used for train detection purposes on yard storage, wash track, and shop lead tracks. These track circuits shall provide train detection for up to 0.6 ohms shunting resistance.
3. The Track Circuit Design shall perform these basic functions:

- a. Provide track circuit blocks for safe train operation, i.e. train separation for both "ideal" and "worst case" trains, at all times.
- b. Provide such track circuit boundaries for crossbonding and negative propulsion return requirements;
- c. Provide such track circuit boundaries for safe definition of interlocking boundaries.

E. Traffic Control:

Yard running tracks shall be equipped with non-vital traffic and traffic initiation circuits configured to prevent clearing of opposing signals into a section of track between two interlockings or intermediate signals.

F. Train Routing:

1. Route request and initiation shall be accomplished by identifying the desired route in terms of the entering signal and exiting signal on the Yard Control Machine.
2. The desired entrance point (home signal) control device shall first be activated. Once this has been done, the Entrance-Exit system circuits (logic) shall determine the "status" of all possible routes emanating from the chosen entrance point, based upon conditions in the field, and shall indicate which of these possible route exit points are "available," i.e., can safely accept a train exit movement from the interlocking without conflicting with any other route previously granted or requested. (A route request originating at an intermediate or hold-out signal has only one possible route "exit." The "availability" of this route will depend upon the current availability of the desired "traffic" direction on the applicable exit track.)
3. The desired route through the interlocking shall be "selected" by activating the control device at the "available exit" point desired.

G. Route Completion

After the route initiation is completed, by identifying both the entering signal and the exiting signal, the route completion circuits (logic) shall complete the route by requesting the proper switch positions, de-energizing the unselected "available exit" relays, making a preliminary check of the route integrity, initiating the locking, and initiating the request for signal clearing.

H. Time Released Approach Locking:

1. Approach locking with timed release shall be provided for all controlled signals. One such locking circuit shall be provided for each signal or group of converging-route signals. This form of locking shall remain in effect until released by one of the following:
 - a. The signal is accepted by the train (two track release).
 - b. The signal is set to stop and no train is within the approach limits.

- c. The signal is set to stop and a predetermined "approach" time has expired.
 - 2. The approach locking relay circuits shall be arranged such that a momentary interruption of track circuit energy will not release the locking. This shall be accomplished by using a "two track release" (the last track circuit within the interlocking, and the first, "exit" track circuit beyond the interlocking). The two track circuits shall be driven from different branch fuses, and the approach locking relays shall be cross checked so that, if opposing relays are both de-energized, as would be the case with a dc bus failure, time must be run to release the locking.
- I. Route Locking
- 1. Route locking shall be provided to maintain security of the route ahead of the train as it progresses through the interlocking. Route locking shall be initiated by the initiation of approach locking and shall be released when approach locking is released and there are no occupancies in the route. In some cases the route shall be divided into contiguous sections for route locking purposes and locking of the section(s) of the route behind the train shall be released (sectional route release) as the train progresses through the route.
 - 2. Sectional Route Release shall be provided in the control of long or complex interlockings in order to reduce delays to trains and improve yard throughput.
- J. Detector Locking:
- Detector locking shall be established by the track relay(s) for the track circuit(s) in which each switch (or crossover) in the route is located and shall prevent switches from being thrown under a train. Detector locking shall also lock any switch(es) which could be fouled by train occupancy of an adjacent track when the track relay of that adjacent track circuit is down..
- K. Switch Locking:
- 1. Switches shall be locked by Time Locking, Route Locking and Detector Locking. Switch Locking shall only be released when applicable Time Locking, Route Locking and Detector Locking are all released for the switch(es) involved, i.e. when all Lock Relays governing the switch(es) involved are picked up.
- L. Traffic Locking:
- 1. Traffic Locking shall prevent clearing opposing signals into a section of track between consecutive interlockings or between an interlocking and an intermediate opposing signal. Individual Traffic Locking circuits shall be provided for each direction on each such section of track.
 - 2. The direction of Traffic Locking shall be locked for a section of yard running track over which Traffic Locking is provided whenever any of the following conditions exist:
 - a. Any track circuit within that track section is occupied.
 - b. Traffic direction is requested into that track section.

- c. Time Locking is effective for a signal which had been cleared into that track section.
3. A signal governing movement into a section of track for which Traffic Locking is effective shall not clear until traffic direction has been established and locked in the direction of movement for which the signal governs.

M. Switch Control and Indication:

1. The switch control relays shall be driven from the switch call relays in the route completion network. The switch control relays shall be circuited to provide storage of the switch call, provide premature indication prevention, and prevent preconditioning.
2. Switch correspondence relays shall be provided to verify that the switch repeater relays are indicating that the switch is in the position required by the switch control and switch operating relays.

N. Signal Control:

Signals shall be controlled by home signal relays which are energized by route check network relays. The following checks shall be included in these networks:

1. Approach locking is in effect.
2. Route locking is in effect.
3. Traffic locking beyond the exit signal is in effect.
4. Lock relays are deenergized.
5. Switches are in proper correspondence.
6. Route is not occupied.
7. Timers associated with release of locking are at zero time.
8. There has not been an overrun of a red signal at the interlocking.

O. Signal Clearing:

Once the desired route has been aligned and checked, locking activated, and, where applicable, suitable traffic direction established, the Yard Signal Control and Interlocking System shall:

1. Cause the applicable wayside signal to display the appropriate "clear" aspect. Signal lighting energy shall be controlled through front and back contacts of the home signal relays. (The two red lenses of the STOP aspect shall be independently lighted from separate energy buses.)
2. The System shall then indicate , to the Yard Control Panel, the route aligned and locked, and the cleared signal.

P. Yard Controlled Signal Aspects:

<u>ASPECT</u>	<u>NAME</u>	<u>INDICATION</u>
Red Over Red	STOP	Stop
Lunar White	CLEAR	Proceed

Yard signals shall display stop indications at all times except when cleared for train movements.

Q. Clearance Requirements:

All wayside Yard Signal Control and Interlocking System equipment shall be designed and installed to provide 4-inch clearance between wayside equipment and the dynamic outline of the METRO transit cars. This shall include allowances for the end and center overhang of transit cars on curved track and when passing through crossovers and diverging turnouts. In all cases where a 4-inch transit car clearance envelope cannot be maintained, an absolute minimum 2-inch clearance envelope shall be maintained. See Criteria Diagrams TC-1, TC-2, TC-3, TC-4 and TC-5.

R. Maintainability:

1. All Yard Signal Control and Interlocking equipment shall be designed and installed in such a manner to be consistent with existing WMATA procedures for maintenance and replacement of similar equipment.
2. All adjustable equipment and components shall be designed to operate within their 25-percent-to-75-percent adjustment range under all normal conditions.
3. All test points, indications and components requiring adjustment or replacement shall be visible and accessible while mounted in their normal position, without disassembly of other components.
4. Test points for checking essential voltages and wave forms shall be clearly labeled and shall be provided whenever required for trouble shooting and routine maintenance, and shall be capable of accepting probes and connectors used with standard equipment such as voltmeters and oscilloscopes. Accessible points shall also be provided where signals need to be injected for testing.
5. Built in indicators or meters shall be provided as necessary when frequent observations or adjustments are necessary. All electronic modules shall be equipped with LED or other approved indicators. They shall at a minimum demonstrate that each function of the module is performing correctly. All indications shall be labeled.

1.06 Basic Criteria for Yard Signal Control and Interlocking System Wayside Equipment

A. Yard Track Switch Layouts

Trailable switch machine layouts, complete with switch point detection, and all necessary rods and connecting hardware, shall be provided for all power track switch layouts in the yard. The switch machines shall exert at least 1000 lbs. closing force on the switch points. The switch

layouts shall be trailable at low speeds without damage to the switch machines, rods, or special trackwork.

B. Wayside Signal Layouts:

Controlled and marker signal layouts provided shall be complete, with the following features, as appropriate:

1. signal heads having three lamp compartments;
2. appropriate signal-head lamp adjusting transformers;
3. appropriate lamps, adjustable lamp holders, lenses, blanking plates, terminal blocks and lens hoods.
4. appropriate masts and bases;
5. appropriate signal number plates;
6. appropriate foundations for all ballast-mounted signals;
7. appropriate ladders or climbing steps;

all fabricated, assembled and mounted in the WMATA prescribed manner.

C. Cases and Junction Boxes

Appropriately sized and equipped cases and junction boxes, complete with applicable foundations or pedestals, shall be provided for all yard wayside Yard Signal Control and Interlocking System cabling. These housings shall be so located and constructed that they meet all transit vehicle clearance criteria. All metallic cases shall be made of stainless steel, and shall be equipped for proper grounding. All cases and junction boxes shall be suitably equipped for waterproof closure and, where applicable, locking.

D. Snowmelter Layouts

All power operated track switches shall be provided with special snowmelter layouts to prevent buildup of snow and/or ice in the area of the switch points and rods. These snowmelter layouts shall consist of two types of heaters (one type for the switch points and a second type for the switch rods); a non-metallic wayside control case to control the operation of these heaters, and; all necessary associated control and indication circuitry and installation hardware, all in conformance with current WMATA practices.

E. Cable and Wiring

1. All Yard Signal Control and Interlocking System cable and wiring provided shall meet all the requirements specified for such cable and wiring in the Yard Signal Control and Interlocking System Specification Section 16949.
2. All TC cable and wiring conductors shall be sized to provide equipment-rated current and voltage, within specified tolerances, at each piece of signal equipment supplied under full load conditions.

3. The types of cable, insulation, and number of conductors provided for each type of application shall be in accordance with the requirements of the Yard Signal Control and Interlocking Specification Section 16949.
4. Yard Signal cable shall be terminated on binding post terminal blocks meeting applicable AREMA requirements. Splicing of yard signal cables is not permitted as a normal installation practice and shall be allowed only with prior written approval by the Authority's Representative.

F. Crossbonding:

Negative propulsion return cross-bonding of yard tracks shall be provided to incorporate all tracks equipped with traction power third rail.

G. Track Circuit and Negative Return Rail Connections:

1. Track Circuit Rail Connections:

All power-frequency track circuit leads and bonding shall be provided.

- a. Power frequency track circuit leads shall be connected to the running rails by means of rail-web, pin-type connectors of the specified type and size.
- b. Signal rails shall be bonded by means of exothermically connected rail-head bonds of the specified type wherever possible, and by rail-web, pin-type bonds where necessary.

2. Negative Propulsion Return Current Connections:

The Yard Signal Control and Interlocking Systems shall include all running rail connections of the types and sizes required for negative-return rail transposition purposes, for current equalizing purposes, and for the return of propulsion current from the trains, through the running rail(s), to the substation return conductors. This shall include compression-cone type, compression-eyelet type, compression-bolted type, and base-of-rail-clamped type bonds.

3. Snowmelter Related Rail Connections:

All rail connections necessary for the safe operation of switch point snowmelters and switch rod heater units shall be provided. This shall include:

- a. Exothermic connection of snowmelter and rod heater unit negative return leads to the center of the web of the proper negative return rail(s).
- b. Exothermic connection of snowmelter case-heater negative return leads to the proper negative-return rail.
- c. Base-of-rail exothermic connection of the snowmelter fuse box positive energy lead to the appropriate traction power third rail.

H. Cable Surface Trench, Ductbank and Conduits:

1. Cabling between Train Control Rooms within a yard and between a Train Control Room and wayside equipment shall be installed in a network of surface trenches, duckbanks and conduits.
 - a. Surface trench shall be constructed of high density polymer concrete. Surface trench channel sections and covers shall meet AASHTO Heavy Traffic requirements of 32,000 LBS axle loading.
 - b. Manholes, concrete encased ductbanks and conduits in trackbed areas shall meet the requirements described in WMATA Standard Specification Section 02585, "Underground Electrical and Communications Distribution Systems."
 - c. Cabling routed under paved roadway areas shall be installed in rigid galvanized steel conduits.
 - d. Track circuit connection cables shall be protected by heavy duty, two-ply, fiber reinforced rubber hose or Schedule 80 PVC conduit. The top end of each hose or conduit shall be filled with sealing compound where the cable emerges.

1.07 Support Systems

A. TC Power Distribution Systems

1. Description

A Train Control Power Distribution System shall be provided inside each Train Control Room. Each of these Power Distribution Systems shall include all transfer and bypass equipment, power supplies, transformers, buses, feeders and mains necessary to accept electrical energy from the power sources furnished by others, modify it as necessary, and distribute it at proper voltages to the various pieces of Yard Signal Control and Interlocking System equipment mounted in the TCR in compliance with Authority standards.

2. Load Balance and Power Factor

Each TC Power Distribution System shall be designed to achieve the best load balance and power factor practicable.

3. Power Failure Alarm

Each TC Power Distribution System shall include a power failure and over current alarm system circuited in compliance with Authority standards.

4. Protective Devices

Each TC Power Distribution System shall include an array of monitoring, isolation and protective facilities in compliance with Authority standards.

5. Voltage and Capacity

All TC Power Distribution Systems, regardless of rated system voltage, current or frequency, shall deliver the system voltage to the modules, devices, or appliances connected to that system at not less than 95 percent, or more than 105 percent of the nominal voltage rating of the modules, devices, or appliances, and with sufficient capacity for continuous operation of the applicable equipment.

6. Configuration

Each TC Power Distribution System shall be configured in compliance with all applicable Authority standards and practices, and shall be compatible with the commercial power sources furnished by others.

7. Supplementary Power Sources

For any TCR not furnished with commercial power sources by others, the TC Power Distribution System shall also include provision of necessary power sources from the nearest TCR having one or more commercial power sources.

8. Lightning/Surge Protection and Grounding Systems

a. Lightning/Surge Protection

A complete, coordinated system to protect the Train Control circuits and equipment from lightning and other electrical surges shall be included in the Train Control system. This lightning/surge protection system shall include:

Segregation of high voltage wiring from low voltage wiring;

Segregation of Train control wiring from power/operating wiring and communications wiring;

Provision of short, direct, low resistance conductor paths for the grounding of equipment and protective devices;

Provision of initial lightning protection and surge protection by means of low resistance (15 ohms) earth grounds for outside Train Control equipment, and at the point where TC cables and wiring first enter the buildings housing the Train Control Rooms;

Provision of primary, high-current-capacity, properly grounded arresters of characteristics and type(s) appropriate to the application(s);

Provision of three-stage secondary surge protection, which shall consist of:

- Stage 1 - Dual overvoltage devices, each containing a gas-filled surge arrester, a varistor-type overvoltage protection module, and zener-type suppression diodes;

- Stage 2 - Fast-blow fuses rated at the maximum current capable of being delivered by the device(s) being protected,

and;

- Stage 3 - a duplication of Stage 1, circuited as shown on Criteria Diagram TC-23.

b. Grounding

- (1) Low resistance grounding shall be provided for all TC circuits and metallic equipment and racks in Train Control Rooms, and for all metallic outdoor TC equipment.
- (2) Ground connection to the track rails or use of the neutral conductors of the power company or any signal power supply system will not be permitted.
- (3) All ground connections in each TCR shall be made to a room prime ground bus bar in the manner prescribed by the latest applicable WMATA METRORAIL Train Control Specifications.
- (4) The grounding of each piece of metallic outdoor TC equipment shall be provided by means of an individual connection to a driven copper ground rod, or rods driven in series, one on top of the other. The resistance of the connection from each piece of equipment to earth ground shall not exceed 15 ohms.

B. TC Maintenance Telephone System

1. Hardware

All telephone jacks and plugs, terminals, jack boxes, rotary selector switches, interconnecting twisted pair wiring and speaker phones of the types prescribed in the latest applicable WMATA METRORAIL Train Control Specifications shall be provided to extend the existing METRORAIL Train Control (TC) Maintenance Telephone System throughout each new METRORAIL TC Contract area in the WMATA prescribed manner.

2. Location of Jacks

TC Maintenance Telephone jacks shall be provided in each of the following pieces of equipment, as applicable to the given contract work:

- a. Power, Entrance, and Equipment Racks (2 per rack)
- b. Large Junction Boxes and Wayside Interface Junction Boxes furnished by the Contractor.
- c. Signal Junction Boxes
- d. Trailable Switch Mechanisms
- e. Yard Control Machine

1.08 Yard Monitoring Facilities

A. Event Recording System

1. Description:

Each Yard Train Control System shall be equipped with a complete, properly operating, microprocessor controlled Event Recording System which shall monitor, record, store, and print or display, in various prescribed formats, the status of various prescribed Yard Train Control functions over a period of time. The Event Recording System shall be accurate, user friendly, versatile in output formats, easily expandable, easy to troubleshoot and maintain, and shall meet all of the following basic minimum requirements:

- a. The system shall be equipped to monitor 250 points. Modular construction shall be utilized such that the initial system can be easily expandable in the field to monitor up to 500 points.
- b. All data points shall be monitored continually including during viewing and/or printing.
- c. All detected changes of state shall be recorded with the device identification, new status, and the time and date of occurrence.
- d. Event printouts and/or displays shall be accurate to one second.
- e. Displays and printouts shall be menu driven and manually initiated from a local or remote keyboard or other interrogating device.
- f. Displayed and/or printed data shall include the following information in a format easily readable and understandable by Train Control maintenance personnel:
 - type of event,
 - julian date,
 - time of occurrence,
 - point identification, and
 - new state.
- g. Standby battery shall be provided as an integral part of the Event Recording System to prevent loss of the time base during external power failures or shut-down periods up to seven days in duration.
- h. Controls shall be provided for setting the date and the time; for initiating the viewing and/or printing of stored data in the desired format, and for adding new devices to be monitored.
- i. The printer shall be capable of printing one event per line, two lines per

second.

- j. The system shall include a standard RS232C interface wired to one or more plug couplers.
- k. Input wiring to the system shall be easily removable to facilitate testing.
- l. Detection of an error in the Event Recording System (by the internal diagnostic subsystem) shall cause a change in status of the externally wired error detection contact closure.
- m. The system shall include automatic and manually-initiated screen saving.

2. Input Storage

- a. The minimum storage capability of the hard disk drive provided shall be 100 megabytes or greater. Sufficient storage media for 32 days of events shall be furnished initially.
- b. The program which controls the hard disk drive storage shall store the yard events in a file format labeled on a daily basis (0000-2400 hours) by date and year, with one separate file for each day. These files shall be further subdivided by the type of event, i.e., switch machines, controlled signals, track occupancy, auxiliary devices, alarms, etc.
- c. The event storage program shall automatically rotate through the storage area, erasing the oldest of the 32 daily files at the start of each new day's recording.

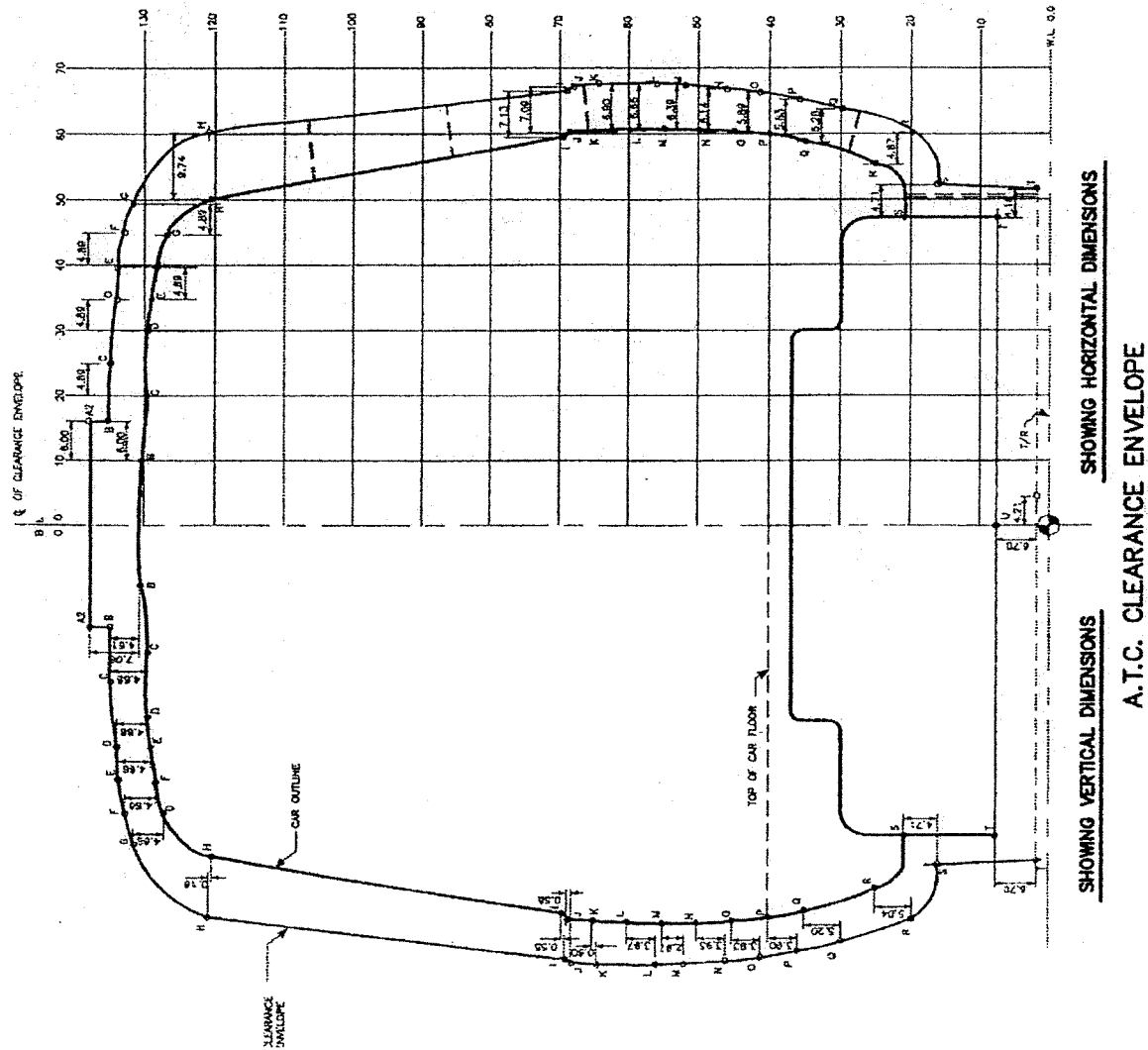
3. Outputs

The processor shall have the capability of outputting information to a local or remote monitor, printing device or floppy disc in various menu-driven, operator-selectable formats.

4. Equipment and Installation

- a. The major computer components of the Event Recording System shall be installed on a rack in the Yard (main) Train Control Room in a manner previously approved by the Engineer.
- b. Indication contacts shall be provided on appropriate equipment for use by the Event Recording System.
- c. Plug connector receptacles shall be provided for the Event Recording System wiring on the racks containing equipment to be monitored in the various Yard TCRs.
- d. Interconnecting cables shall be provided between the event recording equipment and test contact receptacles on the various racks, and between the rack test contact receptacles and the appropriate test contacts on the equipment mounted on the racks.

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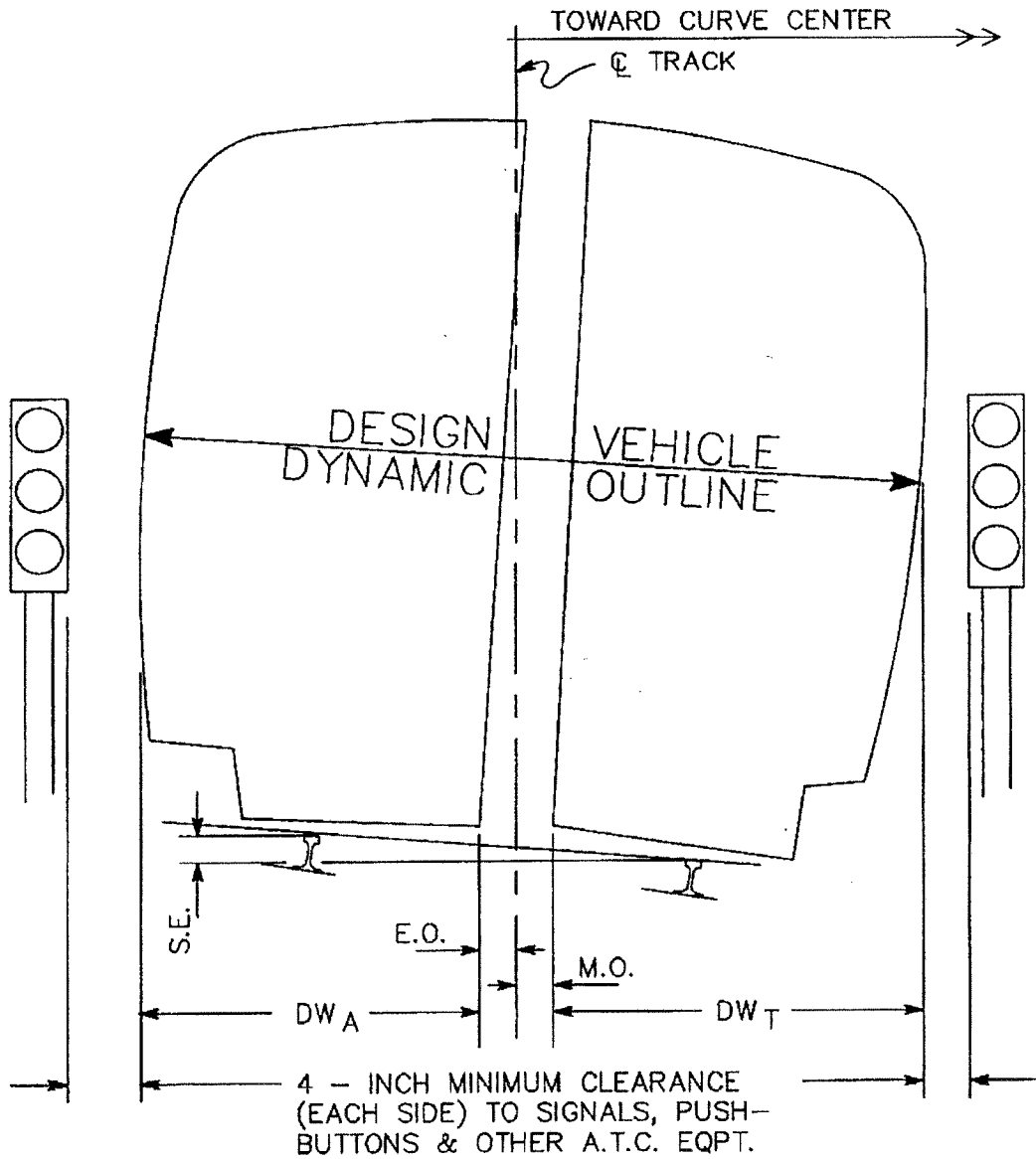


STATIC OUTLINE (CAR OUTLINE)	
PT. B.L.	W.L.
B	10.00
C	20.00
D	30.00
E	35.00
F	40.00
G	45.00
H	50.72
I	59.63
J	60.31
K	60.63
L	60.84
M	60.88
N	60.69
O	60.44
P	60.00
Q	59.16
R	55.50
S	47.50
T	47.50
U	0.00

A.T.C. CLEARANCE ENVELOPE	
PT. B.L.	W.L.
A2	16.00
B	16.00
C	24.89
D	34.89
E	39.89
F	44.89
G	49.89
H	60.46
I	66.76
J	67.40
K	67.53
L	67.49
M	67.27
N	66.83
O	66.33
P	65.63
Q	64.44
R	60.37
S	52.21
T	51.68
U	4.21

- NOTES:**
1. ALL MEASUREMENTS ARE IN INCHES
 2. MEASUREMENTS ARE BASED ON TANGENT LEVEL TRACK.
 3. A.T.C. CLEARANCE ENVELOPE REPRESENTS THE VEHICLE DYNAMIC OUTLINE PLUS TWO INCHES (ABSOLUTE MINIMUM CLEARANCE).

A.T.C. CLEARANCE DIAGRAM TC-1

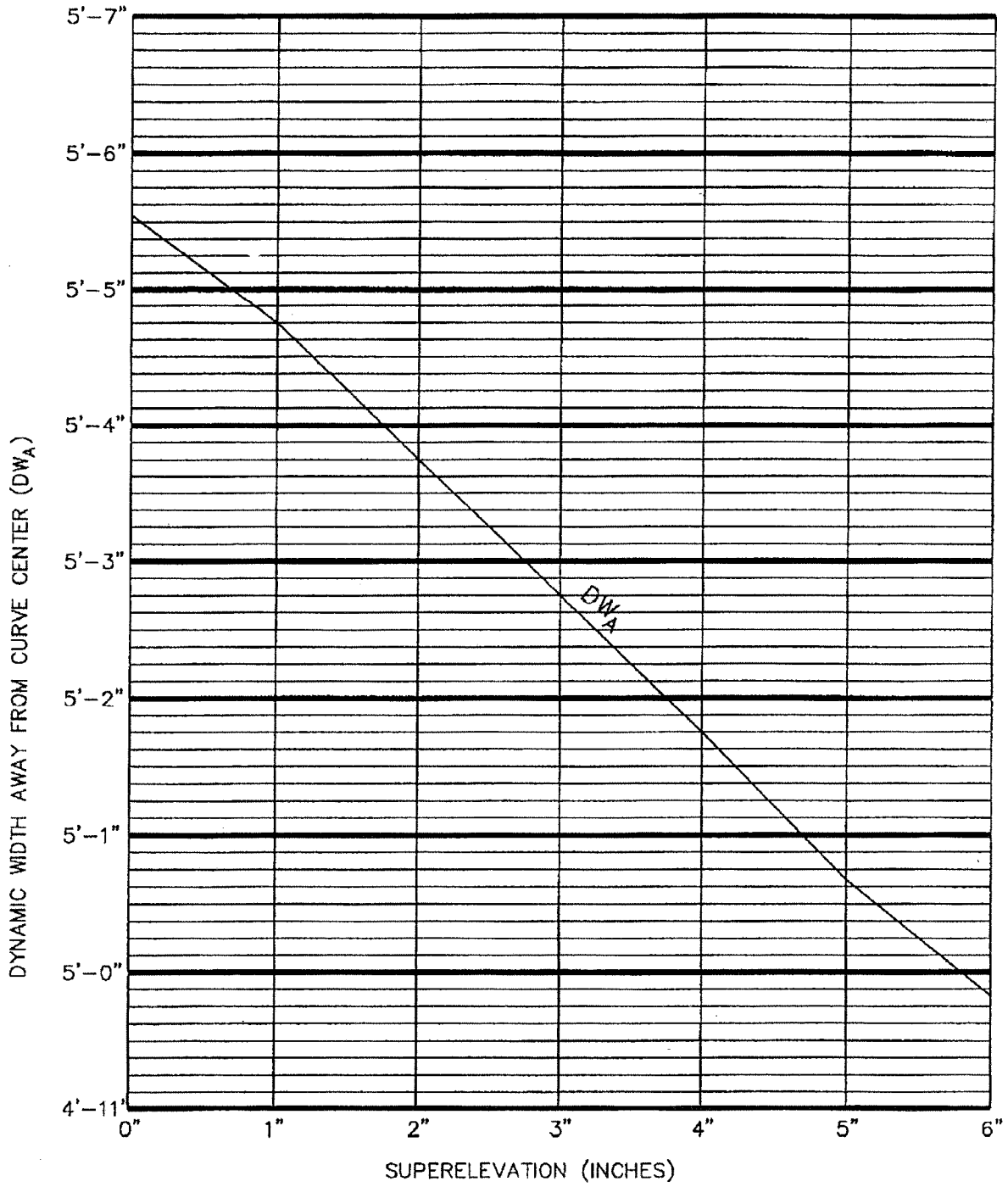


NOTES:

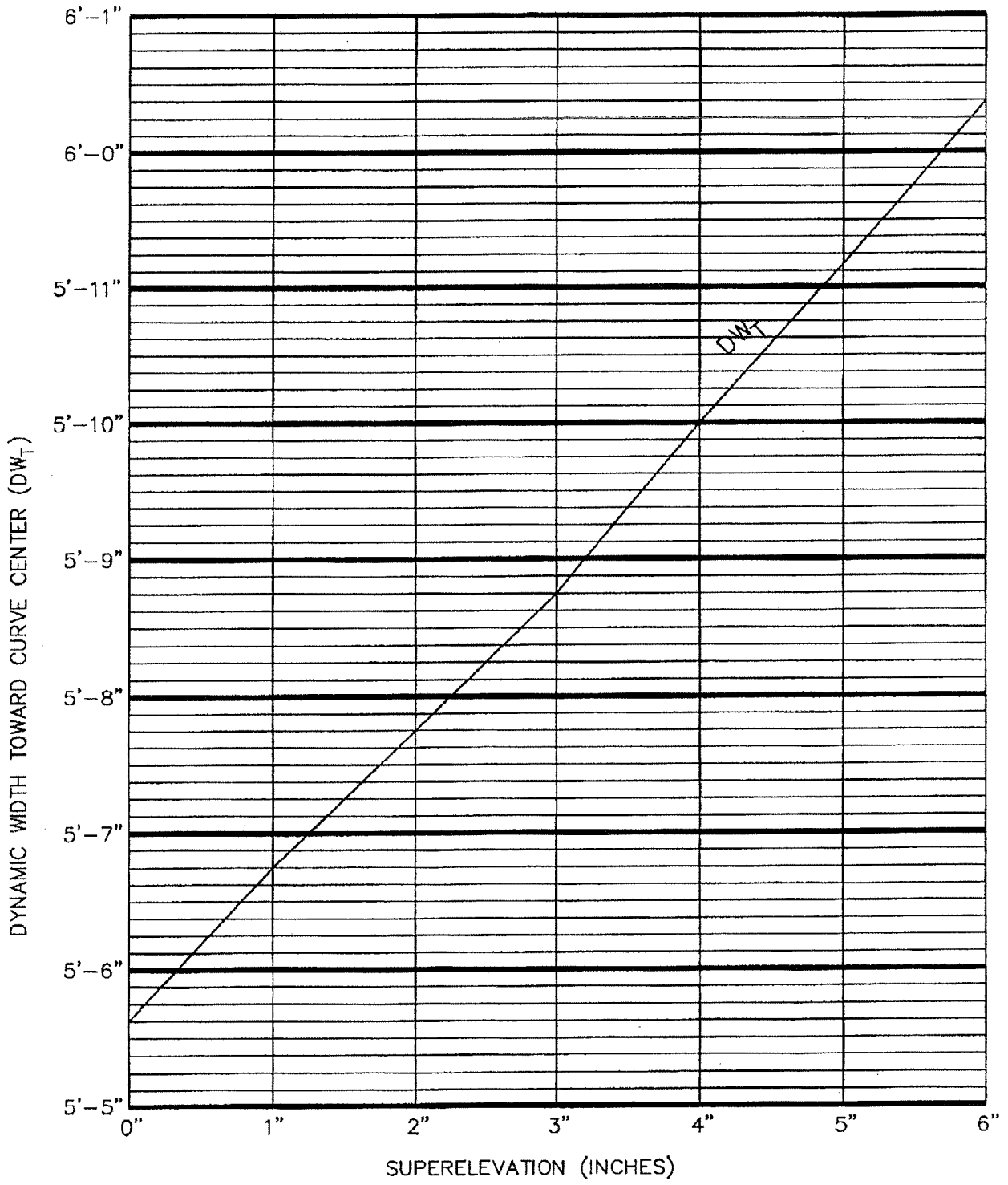
1. FOR DESIGN VEHICLE CLEARANCES, CONSIDER THE END OVERHANG, E.O., EQUAL TO THE MIDDLE ORDINATE, M.O.
2. $M.O. \text{ (IN FT.)} = R - \sqrt{R^2 - 676}$
 WHERE R = CURVE RADIUS (IN FT.).
3. FOR VALUES OF DW_A AND DW_T, SEE PAGES TC-3 & TC-4

TC-2 - A.T.C. CLEARANCE DIAGRAM

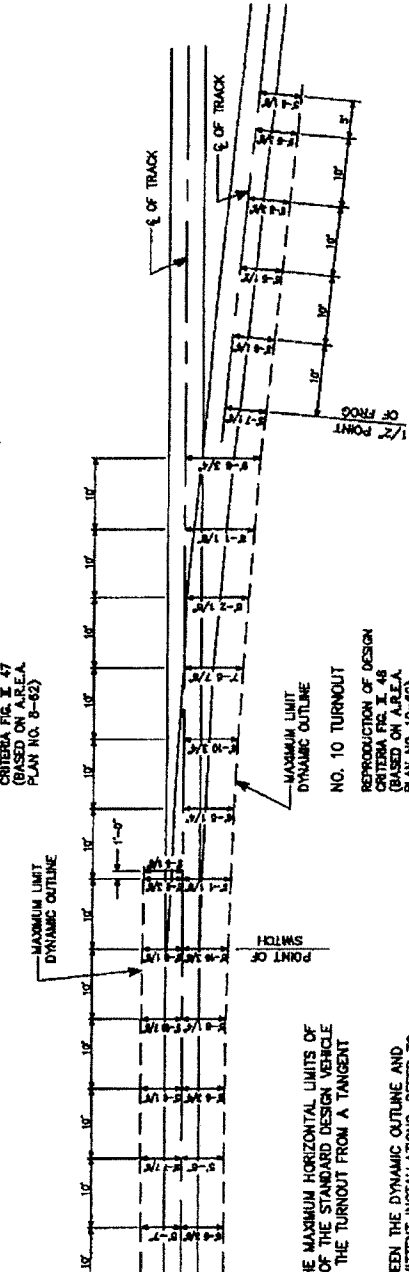
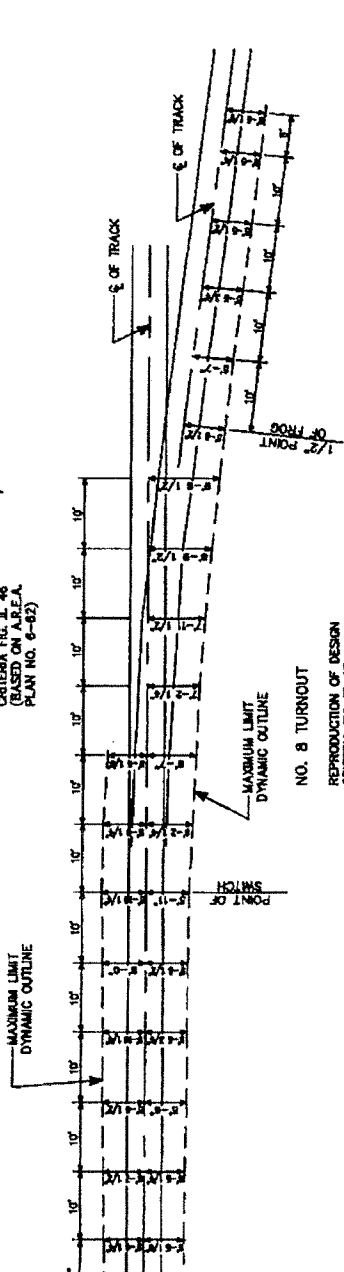
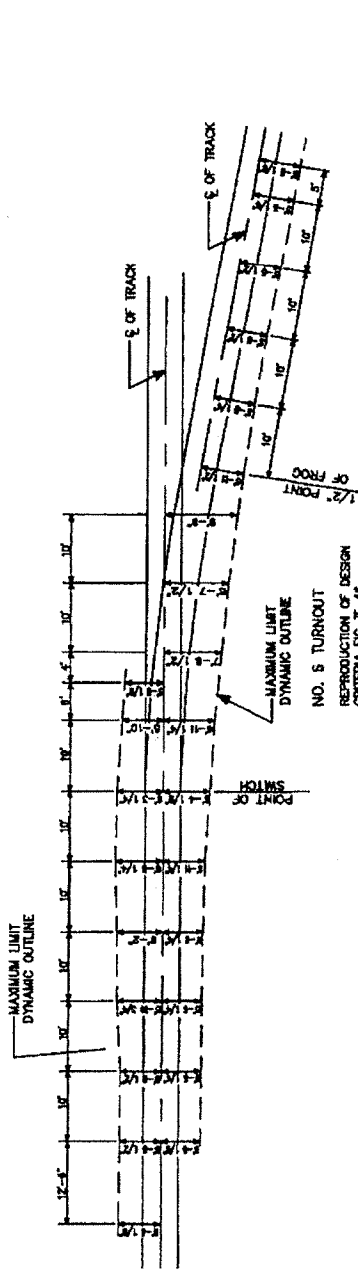
TC-3



DYNAMIC WIDTH
AWAY FROM CURVE CENTER

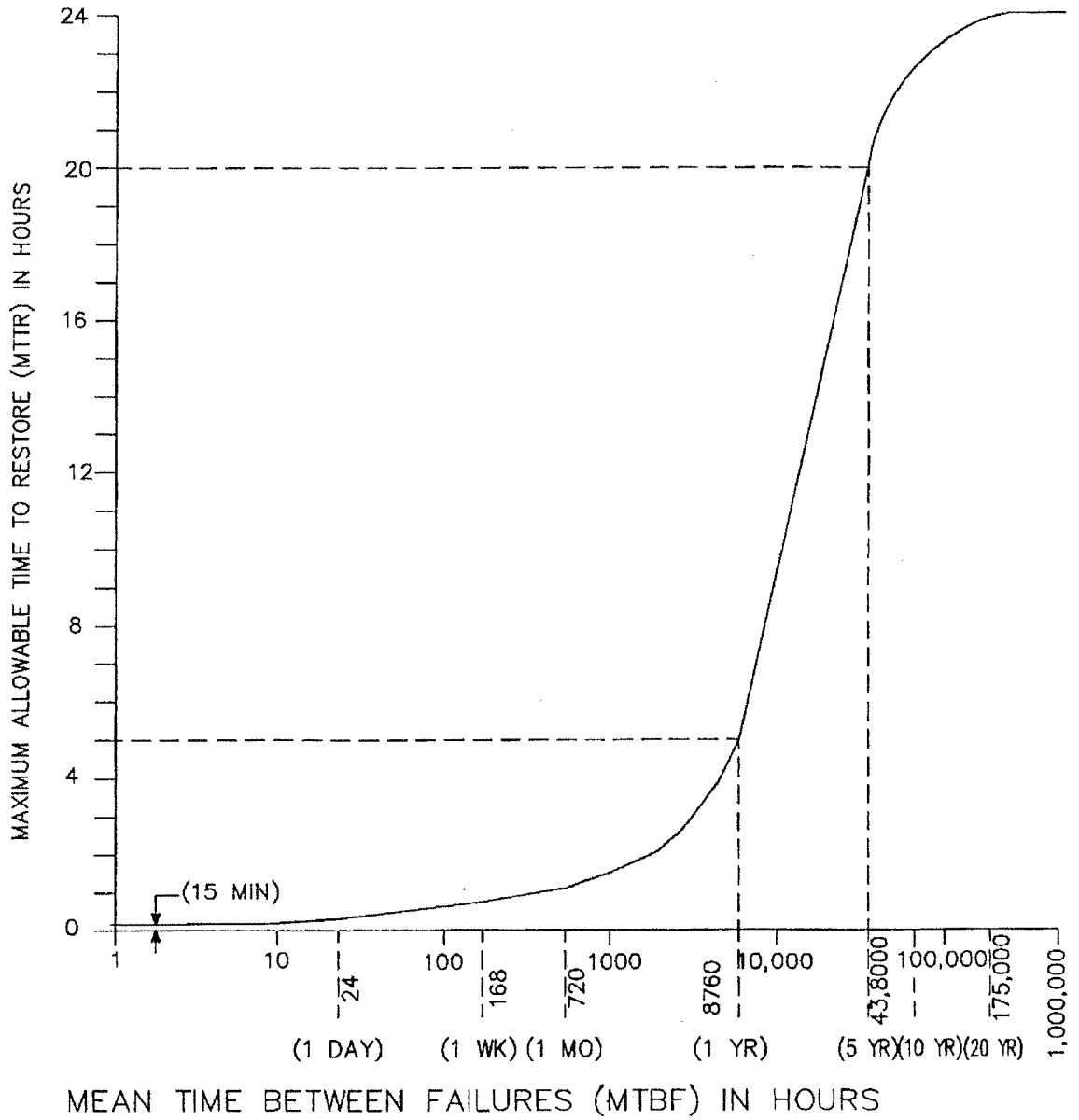


DYNAMIC WIDTH
TOWARD CURVE CENTER



- NOTES:
1. THIS DIAGRAM GIVES THE MAXIMUM HORIZONTAL LIMITS OF THE DYNAMIC OUTLINE OF THE STANDARD DESIGN VEHICLE AS IT MOVES THROUGH THE TURNOUT FROM A TANGENT RUNNING TRACK.
 2. FOR CLEARANCES BETWEEN THE DYNAMIC OUTLINE AND STRUCTURES OR INTERMITTENT INSTALLATIONS, REFER TO THE CLEARANCE DIAGRAMS IN THE MANUAL OF DESIGN CRITERIA FOR THE PARTICULAR TYPE OF CONSTRUCTION INVOLVED.
 3. IF THE TURNOUT IS MADE FROM A CURVED OR SUPERELEVATED TRACK, THE VALUES SHOWN ON THIS STANDARD MUST BE CORRECTED FOR THAT SUPERELEVATION AND CURVATURE.

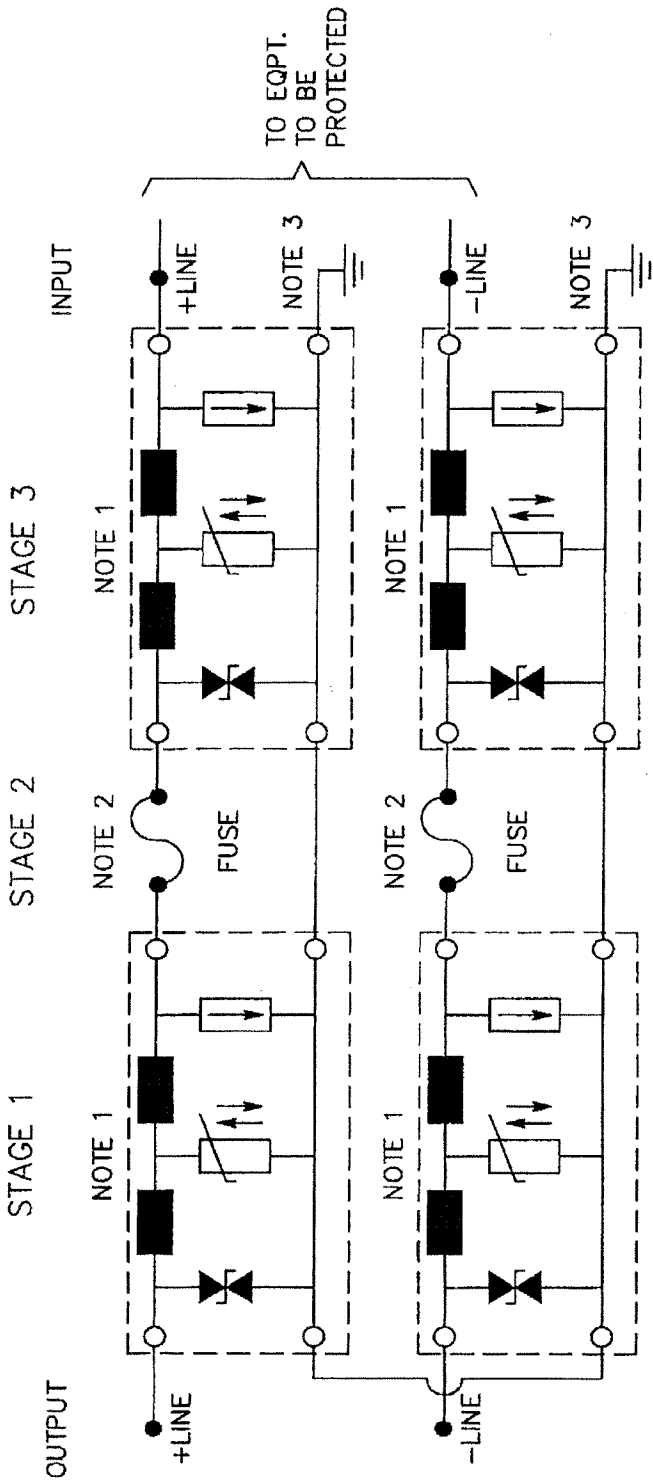
TC-5 HORIZONTAL CLEARANCE THROUGH TURNOUTS



TC-7 - MICROPROCESSOR SYSTEM MTR
GRAPH SHOWING THE MAXIMUM ALLOWABLE TIME TO RESTORE A
 MICROPROCESSOR SYSTEM FOR ANY MEAN TIME BETWEEN ITS FAILURES

THREE-STAGE SECONDARY SURGE PROTECTION

TC-23



NOTES:

1. OVERVOLTAGE DEVICES SHALL BE WEIDMULLER DKU-24DC.
2. FUSES SHALL BE RATED AT MAXIMUM CURRENT LINE DRIVER DEVICES CAN DELIVER.
3. ALL CONNECTIONS TO GROUND SHALL BE AS SHORT AS POSSIBLE. THE GROUND OF THE SURGE PROTECTION SHALL BE THE GROUND OF THE SURROUNDING STRUCTURE. THE SURROUNDING STRUCTURE SHALL BE GROUNDED DIRECTLY TO EARTH GROUND BY A METHOD APPROVED BY THE ENGINEER.

END OF SECTION

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PROGRAM CRITERIA

YARD COMMUNICATIONS

1 GENERAL

1.01 Criteria Coverage

A. Scope

These Criteria include design and functional criteria for the Washington Metropolitan Area Transit Authority (WMATA) METRORAIL Yard Communications Systems changes and additions being implemented under the Metro Matters Project.

B. Intent

The intent of these Criteria is to establish acceptable standards for Yard Communications Systems and equipment which must be specified, designed, properly implemented, tested, and documented, to result in systems which shall serve the voice and data communications requirements within the project yards and comply with compatibility requirements for the Communications Systems in use on the WMATA METRORAIL System.

1.02 GENERAL DESCRIPTIONS

- A. The Yard Communications System provide state-of-the-art, efficient, reliable communications between all yard facilities and include an interconnection to the systemwide communications network.
- B. The Yard Communications System is more localized than the Mainline System. Yards consist of somewhat independent functioning elements such as rail vehicle maintenance, the vehicle cleaning and wash operations, vehicle storage, make-up and dispatch of trains, wayside maintenance, security and administration functions. Selected functions are centralized at the Gatehouse and at the Yard Control Room. The communications systems are designed to serve the specific functions.
- C. The Yard Communications Network consists of communications systems with common equipment located in the yard main Communications Equipment Room. These systems are extended to the various yard facilities through a cable system that radiates from the Communications Equipment Room. The cable is installed in cable duct except for a small amount buried at trackside.
- D. A yard radio system provides service to trains and to maintenance and security personnel within the yard area.
- E. Control of various yard communications systems is centralized at the Yard Control Room and at the Gatehouse.
- F. The Yard Communications System includes the following elements:

1. Public Address System
2. Talkback System
3. Telephone System
4. Data Communications System
5. Radio System
6. Closed Circuit Television System
7. Fire and Intrusion Alarm System
8. Communications Consoles
9. Communications Power Distribution System

1.03 System Criteria

A. Public Address System:

1. Basic System Configurations:

- (a) The Yard Public Address System enables announcements to be made throughout the yard buildings (typically including: Yard Operations Building; Traction Power Building(s); Car Wash Building; Communications and Train Control Rooms; and, where applicable, the Shop building(s)). The announcements originate from telephones within the yard buildings, gatehouse and Yard Control Room..
- (b) The Public Address System consists of loudspeakers, including enclosures and baffles, and paging horns installed in selected rooms and locations within each yard building. A Telephone Access Paging System, power amplifiers, distribution panels and jackfield panels is provided in the main Communications Equipment Room.
- (c) The loudspeakers of the Public Address System are grouped into individual zones throughout the yard buildings. The Public Address System is configured to permit announcements to be made to the speakers in an individual zone, or simultaneously to a combination of any and all zones (ALL PAGE) by dialing the appropriate zone code(s).
- (d) The Telephone Access Paging System accepts an audio input from the Telephone System via the appropriate Channel Bank Terminal, provides the appropriate dialed zone decoding and audio routing of the announcements to the desired zone amplifiers, which provide audio amplification for announcements to each zone circuit. The audio inputs and outputs of the Telephone Access Paging System are connected to a

distribution panel.

- (e) Jackfield panels provide audio test points for the Public Address System. Each Public Address Loudspeaker circuit is wired through a jackfield panel to a loudspeaker distribution panel. In addition, the loudspeaker distribution panels provide single point ground connections for the Public Address System cabling.

2. Operations and Administration Building Requirements:

- (a) The Yard Public Address System includes loudspeakers grouped into zones. The zones are addressable from telephones in the Operations and Administration Buildings through the Telephone Access Paging System. The zones are designed with consideration given to the functional requirements of the space within the buildings. As a minimum, each building and functional area is considered a separate zone. Loudspeakers are recessed in areas with suspended ceiling and surface mounted in other areas.

3. Shop Traction Power, and Car Wash Building Requirements:

- (a) The Yard Public Address System includes Paging Horns (loudspeakers) in Traction Power Buildings, Car Wash Buildings, and, where applicable, in Shop Buildings. The Telephone Access Paging System and loudspeakers grouped into zones are designed with consideration given to the functional requirements of the space within the buildings. As a minimum, each building and functional area is considered a separate zone.

4. Yard Control Room and Gatehouse Requirements:

- (a) The Yard Public Address System for the Yard Control Room and the Gatehouse is addressed under separate headings.

5. Telephone Access Paging System

- (a) The system provides a Telephone Access Paging function which includes decoding circuitry to provide selection of any zone or combination of zones including all zones during an "ALL PAGE."
- (b) The Telephone Access Paging System is a part of the Yard Telephone System. A dedicated telephone extension number from the Rolm PABX via a dedicated channel card in the Channel Bank Terminal provides access to the paging system.

6. Power Amplifier

- (a) The system includes a power amplifier for each loudspeaker zone. As a minimum the power amplifiers have the following characteristics:
 - (1) Power Output: At least 375 watts continuous rms (50-10,000 Hz)

@ 70.7 volts.

- (2) Total Harmonic Distortion: Less than 1% (50-10,000 Hz) @ 70.7 volts.
- (3) Frequency Response: ± 1 dB (30-15,000 Hz)
- (4) Input Impedance: 600 ohms and 10K ohms balanced.

7. Loudspeakers

- (a) The system includes loudspeakers with the following characteristics (as a minimum):
 - (1) 8-inch diameter, 8 ohm with a frequency response of ± 2 dB (30-19,000 Hz).
 - (2) Power Rating: 7 watts.
 - (3) High efficiency, low distortion, permanent magnet type with moisture resistant seamless cone.
 - (4) Each loudspeaker has a 70.7 volt matching transformer providing selectable power levels of $\frac{1}{2}$, 1, 2, and 5 watts to the loudspeaker.

8. Paging Horns

- (a) Horns (loudspeakers) have the following characteristics as a minimum:
 - (1) Weatherproof design consisting of a water-sealed all-metal construction with baked epoxy finish suitable for both indoor and outdoor installation.
 - (2) Contain built-in 70.7 volt line transformer with selectable audio power levels of 3.7, 7.5, 15, and 30 watts.

9. System Performance:

- (a) The following performance requirements are met or exceeded:
 - (1) Frequency Response: ± 5 dB (@ 200 Hz - 8 kHz).
 - (2) Noise Level: 60 dB less than 5% (@ 250 Hz - 6.6 KHz).
 - (3) Loudspeaker Sound Pressure:
 - (i) At least 100 dB measured 1 meter in front of loudspeaker for areas with ceiling heights 25 feet or greater.
 - (ii) At least 70 dB measured 1 meter in front of loudspeaker for

areas with ceiling heights less than 25 feet.

B. Yard Talkback System

1. Basic Talkback System Configurations:

- (a) Provides voice paging from a master control panel located on the Yard Communications Console in the Yard Control Room, to personnel located trackside (via nearby loudspeaker/ talkback stations) and/or to the Gatehouse Building console as set by selector switch position;
- (b) Provides the ability for trackside personnel, in the vicinity of track switching points and other locations within the yard, or Gatehouse personnel to verbally answer a page or signal the Yard Communications console that they want to talk to the Yard dispatcher;
- (c) The system broadcasts an emergency tone, originating from the Communications Console, to the loudspeaker/talkback stations located trackside;
- (d) Broadcasts an "All Call" verbal message, originating from the Communications Console, to all of the loudspeaker/talkback stations located trackside.
- (e) The Yard Talkback System includes:
 - (1) Talkback Stations
 - (2) Master Talkback Control Panel
 - (3) Gatehouse Talkback Control Panel
 - (4) Talkback Control Unit
- (f) Talkback Stations
 - (1) The Talkback Stations are located along the trackside in the vicinity of track switching points and at other locations considered appropriate. The final locations of the talkback speakers must take into consideration train clearances and clearances of people when using the talkback system. Safety of personnel is of primary importance in determining the final locations.
 - (2) The Talkback Stations include:
 - A metal stanchion mounted on a concrete base.
 - An amplifier and "CALL" button mounted in a waterproof enclosure mounted on the stanchion.
 - A control relay or equivalent circuitry for talk/listen function

mounted in the weatherproof enclosure.

- Two weatherproof speaker horns mounted on the stanchion.

(g) Talkback Amplifier

(1) The amplifier has the following characteristics, as a minimum:

- Input Power - 24Vdc, 1.0 Amp
- Output - Push-pull, Class B, 12 watts min,@24Vdc
- Sensitivity - 0.5 Volts at rated output
- Frequency Response - 250-4000 Hz \pm 1.5 dB
- Distortion - 1% max. total harmonic distortion @1,000 Hz, 12 watts
- Input Impedance - 50,000 ohms
- Temperature Range - -30°C to +70°C

(h) Call Buttons

(1) The "CALL" button is a weather-proof, momentary, normally-open contact pushbutton switch sealed against oil and water.

(i) Talkback Speaker Horns

(1) Weatherproof speaker horns have the following characteristics:

- Corrosion resistant finish
- Integral 8 ohm, 30 watt driver
- Low frequency cutoff - 250 Hz
- Dispersion angle -90°
- Sound pressure level – 116 dB @ 12 watts, 119 dB @ 30 watts
- Frequency range 450-6000 Hz

(j) Master Talkback Control Panel

(1) The Master Talkback Control Panel located in the Yard Communications Console provides the capability to call, receive calls, and talk with yard personnel in the vicinity of the trackside Talkback Stations. From this panel a specific Talkback Station can be called or all Talkback Stations can be called.

(2) The Master Talkback Control Panel includes the following features:

- Illuminated pushbutton switches associated with each Talkback Station and the Gatehouse.
- A spring loaded "Talk/Listen" switch normally in the "Listen" position.
- A loudspeaker, with volume control to serve as speaker and microphone.
- An illuminated "All Call" switch to provide for simultaneous paging to all Talkback Stations and the Gatehouse.
- An illuminated "Emergency Call" switch to provide for an emergency tone to be transmitted to all Talkback Stations and the Gatehouse.

(k) Gatehouse Talkback Panel

(1) A Gatehouse Talkback Panel is located in the Gatehouse Console which provides the Gatehouse with the equivalent capability of a Talkback Station. The panel includes, the following features:

- A Talkback loudspeaker with volume control.
- An illuminated pushbutton switch to provide an indication for an incoming call and to initiate an outgoing call.
- A spring-loaded "Talk/Listen" switch, normally in the "Listen" position.
- The console includes a station amplifier, located outside the panel with a control relay or circuitry to provide for the talk/listen function.

(l) Talkback Control Unit:

(1) The Talkback Control Unit is located in the Yard Communications Equipment Room.

(2) The Talkback Control Unit includes the following:

- Circuitry for the control functions of the Talkback System.
- Circuitry to distribute primary power to the Talkback Stations.
- An Amplifier
- DC Power Supply with 120 Vac, 60 Hz input.

- Multitone generator.

2. Talkback System Performance Criteria

(a) At Talkback Stations with speakers configured as loudspeakers:

- Speaker power: >103 dB at 4 feet
- Distortion: <1.5% total harmonic distortion 300-3000 Hz
- Audio dispersion: -90 degrees each speaker
- Frequency Response: ± 1.5 dB between 300-3000 Hz

(b) At Talkback Stations with speakers configured as microphones (measured at console panel):

- Frequency Response: ± 1.5 dB @ 300-3000 Hz
- Harmonic distortion: <1.5% 300-3000 Hz

3. Environmental Criteria

(a) All equipment fully operational without damage or functional degradation under any combination of the following:

- Ambient temperature: -30°C to +60°C
- Relative humidity: 0% to 95%
- Effects of rain, salt, dust, oil and other pollutants.
- Effects of wind up to 90 mph
- Effects of train related vibrations

C. Yard Telephone System

1. General

(a) The Yard Telephone System is part of the WMATA Systemwide Telephone Network. Its purpose is to provide telephone service to WMATA personnel working within the Yard limits. Telephone instruments associated with the Yard Telephone System are used to access the Yard Public Address System.

(b) The Yard Telephone System provides automatic Dual Tone Multiple Frequency (DTMF) tone telephone service in Yard buildings at selected locations. All telephone instruments are wired to the Yard Communications Equipment Room using dedicated cable pairs.

(c) All telephone instruments are cross connected to the appropriate telephone sub-system which provides the functionality required for each individual instrument. The configuration of the Yard Telephone System may include one or more of the following subsystems.

- The Carrier Transmission System provides the transmission facility to connect the telephone circuits to the existing ROLM 9000 PABX in the WMATA Jackson Graham Building.
- A ROLM 8000 Satellite PABX provides local yard telephone service and connectivity to the ROLM 9000 in Jackson Graham Building.
- A digital key system provides local telephone service and includes an interface to the ROLM 9000 PABX in the Jackson Graham Building.

(2) Telephone Instrument Locations:

(a) The Yard Telephone System includes, as a minimum, telephone instruments installed in offices, administrative spaces, and service areas as follows:

- Yard Operations Room(s)
- Gatehouse
- Train Control Building
- Traction Power Substation
- Car Wash Building
- Shop Building
- Elevators
- Emergency Trip Stations
- Tiebreaker Station(s)

telephone jacks are provided at appropriate locations.

(3) Types of Telephones

(a) The Yard Telephone System includes, as a minimum, the following types of telephone instruments:

- Analog telephone instruments - multi-line and single line.
- Emergency Trip Station telephone instruments.
- Automatic dialing intercom telephone instruments.

- Elevator telephone instruments.
 - Digital PABX or Key System telephone instruments.
- (4) Yard Operations Building Telephones:
- (a) The system includes telephone jacks installed in locations convenient to proposed work stations and yard consoles. In offices and administrative spaces locations are selected with consideration given to the function to be performed in that space. Analog or digital telephone instruments both multi-line and single line are provided. In general, desk type instruments are provided in office areas and wall type instruments are provided in the Communications Equipment Room and service areas.
- (5) Gatehouse Telephones:
- (a) The system includes a desk type multi-line analog or digital telephone instrument in the Gatehouse located adjacent to the Gatehouse console.
- (6) Yard Control Room and Train Control Room(s)
- (a) The system includes a single line, wall mounted, analog telephone instrument for the Yard Control Room and for each Train Control Room and other service room in the Yard.
- (7) Traction Power Building(s)
- (a) The system includes a single line, wall mounted, analog telephone instrument for the Yard Traction Power Substation and/or Tiebreaker Station.
- (8) Car Wash Building Telephones:
- (a) Ruggedized single line, analog telephone instrument mounted in weatherproof enclosure are provided in the exposed areas of the Car Wash Building.
- (9) Shop Building(s)
- (a) The system includes analog or digital telephone instruments in Shop Buildings. In general maintenance and service areas are provided with ruggedized single line analog telephone instrument mounted in weatherproof enclosures. In protected areas with desks or similar work areas (parts storage, electronic supply, etc.) desk type single line analog or digital telephone instruments are provided. Multi-line instruments are provided in work spaces assigned to supervising personnel.
- (10) Elevators and Elevator Machine Room:
- (a) The system includes single line analog telephone instruments in elevators and elevator machine rooms.
- Telephone instruments in elevator cars are equipped with auto-

dialing feature to provide automatic dialing to the Gatehouse, yard control console, and/or other selected locations. The telephone instrument is installed in the telephone cabinet integral to the elevator car.

- A single line, wall mounted, analog telephone instrument is provided in the Elevator Machine Room.

(11) Emergency Trip Stations

- (a) The system includes Emergency Trip Station telephone instruments installed in Emergency Trip Station enclosures located in the Shop Area, Car Wash Area and throughout the yard.

(12) Digital Telephone Instrument (Single and Multi-line) Criteria.

- (a) The digital telephone instruments are compatible with the central distribution system provided (i.e. PABX or Key System) and are programmed for features appropriate to the specific station applications.

(13) Analog Telephone Instrument (Multi-line) Criteria:

- (a) Multi-line with hold and conference features.
- (b) Hands free operation with LED indication.
- (c) DTMF Keypad.
- (d) 18 single-touch memory capability.
- (e) Battery back-up for memory.
- (f) Desk and Wall Mountable.

(14) Analog Telephone Instrument (Single Line) Criteria:

- (a) Single Line.
- (b) Desk and Wall Mountable.
- (c) DTMF Keypad.

(15) Ruggedized Analog Telephone Instrument Criteria:

- (a) Single line, analog.
- (b) High-impact, anti-corrosive enclosure, resistant to chemicals and solvents.
- (c) Sealed DTMF keypads.
- (d) Sealed electronic ringer with loud ringer broadcast.

- (e) 15 foot extra strength cord.
 - (f) Noise canceling microphone.
 - (g) Connects to standard RJ11C jack.
 - (h) Mountable in weatherproof enclosure.
- (16) Weatherproof Enclosure Criteria:
- (a) For outdoor applications.
 - (b) High-impact, anti-corrosive enclosure, resistant to chemicals and solvents.
 - (c) Spring Door Return.
 - (d) Compatible with Ruggedized Telephone Instrument.
- (17) Emergency Trip Station Telephone Instrument Criteria:
- (a) Single Line, Analog Telephone Instrument with electronic ringer, DTMF keypad covered with protective seal.
 - (b) Face plate of heavy gauge steel, corrosion resistant, dustproof.
 - (c) Handset: Cradle of cast aluminum with nylon coating with heavy duty handset cord of appropriate length to fit into enclosure.
- (18) Elevator Telephone Instrument Criteria
- (a) Single Line Analog Telephone Instrument.
 - (b) Equipped with automatic dial feature.
 - (c) Equipped with ringer option.
 - (d) Compatible with the fully enclosed elevator car telephone cabinet provided by others.
 - (e) Equipped with Braille instruction plate.
- (19) System Performance Criteria:
- (a) Frequency response from end-to-end: 300 Hz to 3000 Hz, maximum 6 dB loss.
 - (b) Maximum Actual Measured Loss (AML) shall not exceed 8.5 dB at 1000 Hz when measured from the Communications Equipment Room to telephone instrument location - terminated into 900 ohms impedance.
 - (c) Noise objective of 20 dBrnC with 30 dBrnC maximum measured noise terminated into 900 ohm impedance.

- (d) The DC loop resistance shall not exceed 1300 ohms being terminated into a short circuit.
 - (e) Loop DC current not less than 23 mA.
 - (f) Balance ratio not less than -50 dB.
- (20) Telephone Equipment installed in Communications Equipment Room
- (a) Centralized and ancillary equipment required for the proper functioning of the Yard Telephone System is installed in the Yard Communications Equipment Room. Equipment includes ringing generator, power supplies, cable terminals, protection blocks and all items required to properly interface the yard Telephone System with other systems and Networks.

D. Data Communications

1. General

- (a) The Yard Data Communications System is part of the WMATA computer network. Its purpose is to accommodate present and long term requirements of WMATA Information Technology and Services (ITSV) for the transmission of digital data between WMATA facilities. Initially ITSV requires the transmission of data through an interface to the existing LAN/WAN and computer systems from Terminals and Personal Computers to be installed by others in the various Yard Facilities and Buildings.

2. Data Equipment Room

- (a) The Data Equipment Room contains all the equipment necessary to support the Yard interface with the WMATA LAN/WAN system. This includes at a minimum 19-inch equipment racks, switchers, routers, servers, data patch/distribution panels, and fiber optic interfaces as required. Data Equipment Rooms are generally located in the Yard Shop and Operations Buildings.

3. Data Distribution

- (a) Data distribution throughout the Yard facilities is accomplished by fiber optic interface between major buildings and the use of dedicated Category 5 Cable (CAT-5) for local distribution. In general CAT-5 cable should be run to all locations that require an administrative telephone and other locations as designated by the Authority Representative. All CAT-5 cable must be terminated in a data jack at the user end and the distribution patch panel in the Data Equipment Room.

E. Yard Radio System

1. General

- (a) The Yard Radio System consists of two subsystems; the Yard Dispatcher's Radio Subsystem and the Yard Gatehouse Radio Subsystem.
- (b) The Yard Dispatcher's Radio Subsystem provides two-way voice communications between a base station and Yard personnel (with portables), and between the base station and transit trains within the confines of the yard and lead track areas.
- (c) The Yard Gatehouse Radio Subsystem provides communications with the Transit Police and Security network (TPAS) within the yard area on the primary TPAS frequency.

2. Yard Dispatcher Radio Subsystem:

- (a) The Yard Dispatcher's Radio Subsystem includes voice frequency modulated, high band (150-174 MHz), two-way simplex radio communications. It provides RF coverage within the WMATA rail yards, lead tracks and associated areas.
- (b) The Yard Dispatcher's radio base station equipment is located in the Yard Control Building. An outside omnidirectional rooftop antenna coupled with a Radio Antenna System provides RF coverage to the desired areas.
 - The control of the base station is by dispatcher interface through a remote control unit which is capable of making the base station perform all of the functions required in these Criteria. The remote control unit is located adjacent to the Yard Communications Console.

3. Gatehouse Radio Subsystem

- (a) The Yard Gatehouse Radio Subsystem includes a voice frequency modulated, high band (150-174 MHz), two-way radio subsystem, operating on the Transit Police and Security (TPAS) Network radio frequency. It provides RF coverage of the WMATA rail yard and associated areas patrolled by Transit Police personnel using the TPAS Network.
- (b) The Yard Gatehouse Radio Subsystem portable radio equipment is located in the Gatehouse. An outside omnidirectional unity gain antenna provides coverage of the desired areas.

4. Yard Dispatcher Radio Equipment Criteria:

- (a) Radio Base Station
 - 40 Watt output - 16 Channels.
 - Field programmable without opening the Radio.
 - Frequency Range 150-174 MHz; RF input impedance 50 ohms.

- Equipped with Desk Mounting Microphone.
- Equipped with Remote Controller; Tone Frequency Control.
- AC Power Supply (120 Vac, 60 Hz).

(b) Unity Gain Antenna Criteria:

- Omnidirectional, roof mount, VHF Antenna.
- Impedance: 50 ohms.
- Power capability: 40 watts, minimum.
- Frequency Range: 150-170 MHz.

5. Yard Gatehouse Radio Equipment Criteria:

(a) Portable Radio

- Single frequency simplex operation.
- Frequency range: 150-170 MHz.
- Equipped with microphone, speaker and battery.
- Battery Charging Rack manufactured by the same manufacturer as the Gatehouse Portable Radio and capable of charging a single nickel cadmium battery and portable radio.

(b) Unity Gain Antenna Criteria

- Omnidirectional Pole mount VHF Antenna.
- Impedance: 50 ohms.
- Complete with mounting hardware.
- Power capability: at least 5 watts.
- Frequency Range: 150-170 MHz.

6. Yard Radio System Coverage Criteria

(a) The Yard Radio Systems signal strength and antenna radiation patterns provide the following coverage as a minimum:

(1) The Yard Dispatcher's Radio Subsystem Coverage:

- Lead Tracks - 100%

- Exposed Yard Area - 100%
- Rail Vehicles in Yard Area - 100%
- Yard Boundary Areas - 100%

(2) The Yard Gatehouse Radio Subsystem Coverage:

- Lead Tracks - 100%
- Exposed Yard Area - 100%
- Rail Vehicles in Yard Area - 98%
- Yard Boundary Areas - 100%

7. Frequency Assignments

- (a) Frequency assignments within the allocated frequency bands will be furnished by the Authority.

8. System Performance Requirements

- (a) The Yard Radio System criteria ensures that the following performance requirements are met or exceeded:

<u>CHARACTERISTIC</u>	<u>REQUIREMENTS</u>
Frequency Stability	±.0005% of the assigned carrier frequency
Receiver Sensitivity	.35 microvolt (12 dB SINAD)
Audio Distortion 1 kHz	Equal to or less than 3%
Audio Response	+1, -3 dB, from 6 dB per octave pre-emphasis 300 Hz to 3 kHz referenced to 1000 Hz
Modulation	16F3, ±5 Khz for 100% Deviation at 1 kHz
FM Hum & Noise	-45 dB, 300-3 kHz, BW, 1 kHz TONE @ 3 kHz Deviation
Spurious & Harmonic	70 dB

RF Impedance	50 ohms
Temperature Range	-30 to 60 degrees C
Humidity	90% @ 50 degrees C
Spurious & Image	-80 dB
Selectivity	-80 dB
Intermodulation	-78 dB

F. Closed Circuit Television System

1. General

- (a) The Yard Closed Circuit Television (CCTV) System consists of two independent CCTV Systems: the Gatehouse CCTV System and the Yard Control CCTV System. The Yard CCTV System provides security, general surveillance, and surveillance of yard operations.

2. Gatehouse CCTV System

- (a) The Gatehouse CCTV System provides the Gatehouse attendants with surveillance of major parking bays and the yard perimeter.

- (1) The Gatehouse CCTV System includes but is not limited to the following equipment:

- CCTV Cameras.
- Pan and Tilt Units.
- 9-inch CCTV Monitors.
- PT&Z Control Panel.

- (2) Each CCTV camera is be equipped with a pan and tilt unit and with a zoom lens.

- (3) CCTV Monitors are located in the Gatehouse to monitor the video output from each CCTV camera in the Gatehouse CCTV System. Two 9-inch CCTV monitors are mounted in the Gatehouse Console. Each of the 9-inch CCTV monitors are used to view a sequence from all Gatehouse CCTV System cameras. The two cameras provide continuous surveillance and adjust to Pan, Tilt and Zoom (PT&Z) settings. One camera is dedicated for each 9-inch monitor.

3. Yard Control CCTV System

- (a) The Yard Control CCTV System provides the Yard Control Room attendants

with surveillance of interlocking switching track areas

- (1) The Yard Control CCTV System includes the following components:
 - CCTV Cameras.
 - Pan and Tilt Units.
 - PT&Z Control Panels.
 - 9-inch CCTV Monitors.
 - PT&Z Terminal Panel.
- (2) CCTV Monitors are located in the Yard Control Room to monitor the video output from each CCTV camera in the Yard Control CCTV System. Two 9-inch CCTV monitors are located in the Yard Communications Console located in the Yard Control Room. Each 9-inch CCTV monitor is assigned to a unique Yard-Control camera.
- (3) Fiber Optic Video Links provide the means of transmitting CCTV Camera Video signals over a multimode fiber optic facility.
 - Fiber Optic Video Links are used when the inter-building conduit path between a camera and its control point exceeds 800 feet.

4. CCTV Cameras and Associated Equipment

- (a) The cameras are provided in two configurations - with fixed lens and with zoom lens.
 - (1) The cameras with fixed lens meet or exceed the following requirements:
 - High performance monochrome camera.
 - 2/3-inch f/1.4 Auto-Iris Lens with IR filter.
 - EIA RS-170 Compatible, Automatic Gain Control, and Automatic Black Clamping.
 - Low Temperature Operation.
 - Environmental Resistant Sealed Housing.
 - Television camera housing and all mounting hardware are finished in Metro Bronze, Federal Standard 595A, Color No. 20040.
 - (2) The cameras equipped with zoom lens meet or exceed the following requirements:

- High performance monochrome camera.
 - 2/3-inch Format CCD Image Sensor.
 - Zoom Range: 11.5-69mm (6x), f/1.4, Auto Iris lens with IR filter.
 - EIA RS-170 Compatible, Automatic Gain Control, and Automatic Black Clamping.
 - Low Temperature Operation.
 - Environmental Resistant Sealed Housing.
 - CCTV camera housing and all mounting hardware is finished in Metro Bronze, Federal Standard 595A, Color No. 20040.
- (3) The zoom lens controller meets or exceeds the following requirements:
- Provides zoom, focus, and iris controls.
 - Output voltage: ± 2 to ± 9.5 Vdc (adjustable).
 - 110 Vac operation.
 - With 19-inch Rack Mounting Kit.
- (4) Cameras equipped with zoom lens are also equipped with Pan and Tilt Units. The Pan Tilt Units and Pan Tilt Controllers meet or exceed the following requirements:
- (i) Pan Tilt Unit
- Spot heater in base; blanket heater in cover.
 - 110 Vac operation.
 - Weatherproof.
 - The exterior of the Pan & Tilt Unit and all mounting hardware are finished in Metro Bronze, Federal Standard 595A, Color No. 20040.
- (ii) Pan Tilt Controller
- Operates 110 Vac Pan & Tilt Units.
 - Joystick control.
 - 19-inch rack mount/adapter.

(b) CCTV Monitors

(1) The 9-inch TV monitors meet or exceed the following requirements:

- 9-inch Monochrome CCTV Monitor.
- Resolution: 700 TV lines minimum.
- Sweep linearity: 2% or better.
- Video input: EIA RS-170 compatible composite video, 75 Ohms (BNC).

(c) Fiber Optic Link

(1) A Fiber Optic Link between a camera and its control point is provided when distances exceed 800 feet or to eliminate EMI. The Fiber Optic Video Link consists of a Fiber Optic Video Transmitter, a Fiber Optic Facility, and a Fiber Optic Video Receiver.

(2) The Fiber Optic Link meets or exceeds the following requirements:

- Accommodates standard NTSC video signal.
- Video Input/Output signal 1V p-p.
- ASMA Optical Connectors.
- 15 MHz Video Bandwidth.
- Video Input/Output impedance 75 Ohms unbalanced.
- Differential phase <5 deg type Differential gain <8%.
- Optical Wavelength 850nm.
- Compatible with 62.5/125 um multi-mode fiber.
- Operating environment -20 deg C to +65 deg C, 0 to 95% relative humidity (non condensing).

(d) CCTV Control Consoles

(1) A CCTV Control Panel and 9-inch Monitors are installed in the Gatehouse Console.

(2) A CCTV Control Panel is installed in the Yard Control Console and 9-inch Monitors are installed on a table adjacent to the Yard Control Console.

5. CCTV System Coverage Criteria

- (a) The Yard CCTV System ensures that the following viewing coverage requirements are met or exceeded:
 - (1) The Gatehouse CCTV System provides coverage of at least 90 percent of the parking areas and the Yard perimeter.
 - (2) The Yard Control CCTV System provides coverage of at least 90 percent of the interlocking switching track area.

6. System Performance Criteria

- (a) The Yard CCTV System meets or exceeds the following performance requirements:
 - (1) Gray Scale Reproduction
 - Ten shades of gray are distinguishable when viewing a standard EIA Resolution Chart on each CCTV camera.
 - A faceplate illumination of 0.2 foot-candles (or less) with IR filter and AGC off causes a full video output from the CCTV camera.
 - (2) Minimum Scene Illumination
 - Each CCTV camera provides a usable video output with IR filter and AGC on with a faceplate illumination of 0.04 foot-candles (or less).
 - (3) Resolution
 - The center limiting vertical resolution as determined by viewing on any CCTV monitor, as produced by a signal originating from each associated CCTV camera and passing through the installed cable and distribution equipment for each CCTV system, is not less than 350 lines in the center when all system equipment is operated to any combination of values within those specified. The horizontal resolution measured under these conditions is not less than 550 TV lines in the center of the picture when viewing on any CCTV monitor.
 - (4) Video Signal Level
 - Video signal levels conform to level requirements of EIA Standard RS-170 when measured at the input of the installed CCTV monitors.
 - (5) Scanning Lines

- 525 lines per frame, interlaced 2:1 Standard RS-170 with no discernible interlace jitter or pairing on the monitor.

(6) Frame Frequency

- 30 frames per second

(7) Aspect Ratio

- Height to width ratio of 3 to 4.

(8) Noise

- Operating of any aspect of the system, including the pan & tilt unit or zoom lens function controls, does not produce any discernible noise on the CCTV monitor. The signal-to-noise ratio under all transit system operating conditions is degraded by no more than 3 dB.

7. Environmental Requirements

- (a) All equipment mounted outdoors remains fully operational without damage or functional degradation under any combination of the following environmental/ working conditions:

- (1) Ambient temperature -40 degrees C to +55 degrees C.
- (2) Relative humidity 0 percent to 100 percent.
- (3) Operation to +60 degrees C shall be fully satisfactory with less than 100 lines reduction in camera horizontal resolution.
- (4) Rain, salt, dust, oil, and other pollutants.
- (5) Winds up to and including 90 MPH with rime icing.
- (6) Vigorous and normal use.
- (7) Train related vibrations.

8. Equipment, Material and Installation

- (a) The Yard CCTV System employs the latest, state-of-the-art equipment and material. Installation and workmanship complies with the latest codes and standards.

- (1) The system meets or exceeds the the following "grounding" requirements:
 - All CCTV Equipment installed in Communications Equipment Rooms is connected to Communications ground.

- Shields of all copper coaxial cables are grounded only to the Communications ground in a Communications Equipment Room.
- The grounds of CCTV equipment installed in CCTV equipment cabinets are electrically isolated from power building ground.
- All CCTV cameras are isolated from ground through structures and wiring, except for a single ground path via the shield of the video coaxial cable to the communications ground from a Communication Equipment Room and except for a single ground path via the shield of the video coaxial to the Fiber Optic video transmitter or to the ground from an insulated CCTV equipment cabinet.
- All installed video connectors and adapters are covered with shrink sleeving to electrically isolate the connectors from power and building ground.

G. Fire and Intrusion Alarm System:

1. General:

- (a) The Yard Fire and Intrusion Alarm (FIA) System is to provide alarm warnings to assist Washington Metropolitan Area Transit Authority (WMATA) employees in protecting the public, employees, and property.

2. Fire Detection System Description:

- (a) The Yard Fire and Intrusion Alarm System provides an electrically supervised, closed circuit fire detection system for the Rapid Transit System. Automatic devices, such as fixed temperature fire detectors, combination rate of rise and fixed temperature fire detectors, combination smoke and fixed temperature detectors, products of combustion detectors, and water flow switches, shall be included. Manual pull stations are provided as required. Audible and visual alarms and indications shall be provided in the Yard Gatehouse and an alarm, via DTS, at the Control Center.
- (b) Provisions are made for automatic shut down of air handling systems, closing of fire doors and the performance of other functions as required in the area of an alarm.
- (c) The system is installed in accordance with the NFPA and all local fire codes. In cases of conflict local codes will prevail.
- (d) The system includes the automatic permanent recording of a fire alarm, including date, time, and location at the JGB Control Center.

3. Intrusion Detection System Description:

- (a) The system provides an electrically supervised, closed circuit intrusion detection system for the designated Yard Shop Building Rooms and Facilities. Automatic devices, tape, and switches shall be provided on doors, windows, louvers, and other points as required in the shop building, gatehouse, substations, tie-breaker stations, train control and communications rooms requiring protection against unauthorized entry. Audible and visual alarms and indications are provided in the Yard Gatehouse and an alarm, via DTS, at the JGB Control Center. Automatic recording of an intrusion indication, including a permanent record of date, time, and location, is provided at the Control Center.

4. FIA System Configuration:

- (a) Fire Detectors and Intrusion Detectors are grouped into zones. Fire Zones and Intrusion Zones shall be independent of each other. Fire Zones and Intrusion Zones shall each be connected to a Common Control Unit.
- (b) The FIA System includes the following major components:
 - (1) Common Control Unit
 - (2) Gatehouse FIA Annunciator
 - (3) Graphic Annunciator Panels
 - (4) Fire Detection system
 - (5) Intrusion Detection System

5. Fire Detection System Criteria:

- (a) A Fire Detection System consisting of fire detectors and manual pull stations and audiovisual alarm devices is provided in the Yard Shop Building and in ancillary buildings located within the yard.
- (b) All fire detector Zone Alarms and Trouble Indications shall be reported directly to the Common Control Unit, which shall display the alarms on building Graphic Annunciator Panels and the Gatehouse FIA Annunciator Panel.
- (c) Detectors:
 - (1) The system incorporates state-of-the-art fire detectors. The latest improvements to the following types of detectors are used:
 - Combination Detectors (Rate-of-Rise and Fixed Temperature) to monitor room and area ambient temperature and temperature change.
 - Fixed Temperature Detectors to monitor room and area temperature.

- Combustion Product (Ionization) Detectors to detect the presence of smoke.
 - Duct Detectors to detect the presence of smoke in ventilation duct work.
- (d) Manual Pull Stations with local audible/ visual alarms (typically a horn/strobe-light) are located in hallways and work areas. Activation of a Manual Pull Station initiates a Fire Alarm in the Fire Zone associated with the area.
- (e) Audio/Visual Alarm Devices are located throughout the shop building and ancillary buildings. These audio/visual devices shall be activated by any fire alarm within the respective building. When the triggering alarm is acknowledged, the horn is silenced but the light remains flashing until the associated control unit is reset.
- (d) Fire Zone Layout
- (1) The following criteria is used in the layout of fire zones:
- No Fire Zone shall contain more than 10,000 square feet. The 10,000 square feet zone shall be contiguous.
 - No Fire Zone shall contain more than four rooms plus a connecting passageway.
 - No Fire Zone shall contain more than ten Ionization Detectors.
 - The maximum distance between any two points of a Fire Zone shall not exceed 300 feet.
 - A separate Fire Zone shall be assigned to each remote ancillary building within the yard. Some yard buildings may have multiple zones and/or an independent Control Panel. In this instance, these alarms are summarized and reported to the Master Control Panel as a single zone.
 - Each Tie Breaker Station shall be assigned a separate Fire Zone.
 - Each Traction Power Substation shall be assigned a separate Fire Zone.
 - A separate fire zone shall be assigned to each elevator.
- (e) Fire Detection System Interfaces:
- (1) The Fire Detection System provides controls to and/or interfaces with the following systems and equipment:

- Selected ventilation fans within the yard facilities are remotely controlled by the Common Control Unit. Upon receipt of a Fire Alarm associated with an area being serviced by a ventilation fan, the Common Control Unit cause the fan to shut down.
- Selected ventilation fans within the yard facilities are locally controlled by detectors serving the area. The local control is provided by ancillary contacts on the fire and smoke detectors.
- All Chemical and Wet Fire Suppression (Sprinkler) Systems are monitored by the Common Control Unit. Tamper switches detect any movement of the Fire Main manual shut-off valves and provide a "Trouble" condition in the Fire Zone associated with that Sprinkler System.
- The Fire Detection System provides an interface so that upon detection of smoke within an Elevator Machine Room, all elevators associated with the Elevator Machine Room that travel more than 25 feet, immediately return to a designated level. The elevator(s) remain at this designated level and elevator cab controls (except for emergency controls) are rendered inoperative as long as smoke is detected within the associated Elevator Machine Room.
- The Yard Fire Detection System provides an interface with the DTS System to indicate a summary Fire Alarm condition at the yard which is transmitted to the JGB Rail Operations Control Center. Some yards include an interface with a digital communicator unit for transmission of alarms to the WMATA Rail Maintenance Operations Center.

- (2) Interface of the FIA System and other systems is accomplished in interface boxes located near the fan controller or other system. The interface boxes are painted red and appropriately labeled.

6. Intrusion Detection System Criteria:

- (a) An Intrusion Detection System consisting of intrusion detectors is provided in the yard buildings.
- (1) Intrusion Detectors provide alarms indicating unauthorized entry for each of the following conditions:
- A broken or opened window connected to a public or outside area.

- A broken or opened air duct cover, louver or grating connected to a public or outside area, if the shortest side is greater than six inches.
 - A protected door when opened.
- (2) All intrusion detector zone alarms and trouble indicators are reported directly to the Common Control Unit which shall display the alarms on the Gatehouse FIA Annunciator Panel.

(b) Intrusion Detectors

- (1) The design incorporates state-of-the-art intrusion detectors. The latest improvements to the following types of detectors are used:
- Trip wire and window tape are provided across louver openings and windows. When the wire is broken or disturbed, a relay associated with the wire shall place +24 Vdc on the "Alarm" lead.
 - Magnetic Switches are used on grates and doors to detect when they are opened. Each magnetic switch is weathertight or installed in a weathertight enclosure.
 - Tamperproof detectors especially designed to provide alarm for unauthorized access to devices such as flow valves and TV cameras.

(c) Intrusion Zone Criteria

- (1) The following criteria is used in the layout of Intrusion Zones:
- A separate zone is assigned for protected doors within the Shop Building. Protected doors include doors for Train Control, Communications and Electrical equipment and the Yard Control Room.
 - No zone shall contain more than three rooms with protected doors.
 - No zone shall contain more than 10,000 square feet. Zone areas shall be contiguous.
 - A separate zone is assigned to each remote Train Control Room.
 - A separate zone is assigned for each Tie Breaker Station.
 - A separate zone is assigned for each Traction Power Substation.

- A separate zone is assigned for each Chemical Suppression System.

(2) Special Protection Areas

The Intrusion Detection system design shall include provisions for the following special protection areas and interfaces:

- Doors leading from an outside or public area into a protected zone, including roll-up doors, shall be furnished with additional features. At these locations, a key-operated access control switch, a non-locking pushbutton switch, and a magnetic switch shall be provided. Roll-up doors shall be equipped with only a key-operated access control switch and a magnetic switch.
- The system includes, in the Common Control Unit, a single alarm output (contact closure) to the DTS for a summary yard intrusion alarm.

H. Yard Consoles

1. General

- (a) The Yard Consoles include a Yard Communications Console located in the Yard Control Room and a Gatehouse Console located in the Gatehouse.

2. Yard Communications Console

- (a) The Yard Communications Console includes a self-contained, table top console housing, a Talkback Control panel, a CCTV Pan, Tilt and Zoom panel, a cable terminating facility and ac power receptacles.

- The console is of steel construction equipped for mounting standard 19-inch console panels. The console is equipped for attachment to a conference table top.
- The two 9 inch CCTV Monitors are mounted on the conference table top.

3. Yard Gatehouse Console

- (a) The Yard Gatehouse Console includes a self-contained console housing; a Talkback Station Panel (with remote amplifier); a Fire Alarm Subsystem Annunciator Panel; a dual 9-inch Television Monitor Assembly; a CCTV Control Panel; a coax Video Receiver Panel; a PT&Z Star-Distribution Panel; a Gate Intercom Panel when required; wire and cable termination facilities, and; ac power receptacles.

4. Yard Console Configuration

- (a) The console configuration includes a self-contained, single bay table top cabinet. The cabinet is constructed of 19 gauge steel and provides for the mounting of 19-inch wide equipment panels in the front section of the cabinet. The cabinet is constructed so that equipment panels can be installed or removed without disassembly.
- (b) The cabinet frame is reinforced to provide rigidity required to maintain alignment. Accurately machined surfaces are provided to assure proper positioning. Steel is accurately rolled and has a smooth finish. Joints are formed to a tight fit with abutting edges flush and securely welded. Joints are welded their full length and dressed flush on exposed surfaces. Spot welding is used when practicable in preference to screws or rivet fasteners.
- (c) The cabinet has appropriately sized and shaped top panel, side panels and back panel to fully enclose the cabinet. The back panel is perforated to provide ventilation for the equipment mounted in the console.
- (d) Appropriate protected passageways are provided at the rear portion of the bottom panel for the installation of cables to the various equipment within the console and for the installation of the power conductors to the ac duplex receptacles. In addition, an appropriate protected passageway is provided at the bottom rear portion of the right side panel for the installation of the cables to the MRS radio base station microphone and telephones that are installed on the conference table adjacent to the Yard Communications Console.

5. Gatehouse Console Configuration

- (a) The Gatehouse Console includes a self-contained, double bay floor mounted cabinet. The cabinet is constructed of 16 gauge steel and provides for the mounting of 19-inch wide equipment panels in the front section of the cabinet (both bays).
- (b) Each cabinet bay is comprised of a Turret Frame and a vertical Instrument Frame. The Turret Frame consists of 20-degree sloped front that provides 21-inches of sloped panel space. The vertical Instrument Frame provides 12 1/4-inches of vertical panel space in the front section. The cabinet bays are constructed so that equipment panels can be installed or removed without disassembly.
- (c) The cabinet frames are reinforced to provide rigidity required to maintain alignment. Accurately machined surfaces are provided to assure proper positioning. Steel is accurately rolled and has a smooth finish. Joints are welded their full length and dressed flush on exposed surfaces. Spot welding is used when practicable in preference to screws or rivet fasteners.
- (d) The cabinet bays have the appropriately sized and shaped top panels, side panels, and back panels to fully enclose the assembled cabinet (two bays). The cabinet has appropriately sized and shaped louvered panels in the side section of the Instrument Frame of each cabinet bay.

6. Yard Communications Console Panels and Equipment

- (a) The following panels and equipment are located in or adjacent to the Yard Communications Console:
 - (1) Talkback Control Panel.
 - (2) CCTV Control Panel with PT&Z Panel.
 - (3) 9-inch CCTV Monitors mounted on conference table adjacent to console.
 - (4) Telephone Instruments mounted on conference table adjacent to console.
 - (5) Radio base station microphone mounted on conference table adjacent to console.

7. Yard Gatehouse Console Panels and Equipment

- (a) The Gatehouse console provides for the following panels and equipment:
 - (1) Talkback Station panel with associated amplifier.
 - (2) Fire and Intrusion Alarm Annunciator panel.
 - (3) CCTV Control Panel.
 - (4) PT&Z Control Panel.
 - (5) 9-inch CCTV Monitors.

8. Equipment, Material and Installation

- (a) The Yard Consoles incorporate the latest state-of-the-art equipment and material. Installation and workmanship complies with the latest codes and standards.

I. Yard Electrical Power Distribution System Criteria

1. General

- (a) The Electrical Power Distribution System provides power distribution from the 3-phase, 4-wire, 120/208 Vac, primary power feed, to the communication systems.
- (b) The Electrical Power Distribution System includes the following facilities:
 - (1) 120 Vac Emergency Power (from existing UPS) for communications equipment in the Yard Communications Equipment Room.
 - (2) -48 Vdc power for communications equipment in the Yard Communications Equipment Room.

2. The 120 VAC Emergency Power Distribution System includes, but not limited to, the following components in the Yard Communications Equipment Room:
 - (a) Power Distribution Panelboard
 - (1) 3-phase, 4 wire, 120/208 Vac, main lugs only with isolated solid neutral bus and a ground bus.
 - (2) Capacity: 20 single-pole branch circuit breakers.
 - (3) Panel Amperage: Main Lugs, 100 Amps.
 - (4) Enclosure: NEMA Type 12 surface mounting and surface screw front cover with hinged door and flush lock.
 - (5) Circuit Breakers-16 single-pole NEMA Standard AB-1.
 - (b) AC Power Receptacles:
 - (1) Required conduits and fittings, junction boxes, feeder wires, and branch circuit wiring and cabling to apportion the 120 Vac power to the communications systems and facilities equipment.
3. The -48 Vdc Power Distribution System includes, but not limited to, the following components in the Yard Communications Equipment Room:
 - (a) -48 Vdc Power Supply
 - (b) -48 Vdc Power Distribution System Status Panel.
4. The -48 Vdc Power Distribution System provides fail safe service by load-sharing several power supplies. It is possible to remove power supplies from the active -48 VDC Power Distribution System to repair, or add power supplies for increased capacity without disrupting communications services. The power distribution system has the following additional features:
 - (a) Input: 95-130 Vac, 60 Hz (nominal), Power Factor: PF>90%.
 - (b) -48Vdc, 24 AMP Load sharing output.
 - (c) Rectifier Output Failure indicator with Form "C" alarm contacts.
 - (d) High DC Voltage shutdown.
 - (e) 19-inch Rack mount complete with 23-inch rack mount adapters and hardware.
 - (f) Fuse, alarm and distribution panels are provided on equipment racks to provide distribution to specific equipment.
5. Status Panel

- (a) The Status Panel provides voltage and current metering for the -48 Vdc Power Distribution System. The Status Panel also distributes -48 Vdc power to the Telephone (TEL), Carrier Transmission (CTS), Fiber Optic (FOS) Systems equipment racks and, as needed, to any other communications equipment racks requiring a source of -48 Vdc power. The Status Panel has the following additional features:
 - (1) Voltage and current metering (2% accuracy).
 - (2) High/Low DC Voltage Alarm Form-C Contacts.
 - (3) 6-position alarm breaker power distribution panel.
 - (4) 19-inch Rack Mount complete with 23-inch rack mount adapters and hardware.

6. Grounding

- (a) All conduit is electrically insulated from equipment racks and equipment cabinets; power ground is separated and isolated from the communications ground. Conduit containing branch circuit conductors are insulated from the equipment racks and cabinets by means of short lengths of non-conducting conduits.
- (b) Short lengths of flexible metallic conduit are provided in the equipment cabinets and on the equipment racks between the non-conducting conduit and the AC power receptacle strips. Each branch circuit contains a separate neutral conductor to the Communications Equipment Room Power Distribution Panelboard.

END OF SECTION

PROGRAM CRITERIA

STRAY CURRENT AND CATHODIC PROTECTION DESIGN

1.01 GENERAL

1.02 PURPOSE

This criteria describes design requirements necessary to accomplish stray current and corrosion control measures for WMATA owned and maintained structures. Stray current and corrosion control requirements shall be coordinated with all other engineering disciplines to minimize stray current and galvanic corrosion effects on WMATA and other underground structures, prevent premature failures and be installed, operated and maintained in a cost effective manner.

1.03 SCOPE

- A. Soil and Water Corrosion Control: Soil and ground water corrosive characteristics shall be determined, documented and analyzed from supplemental on-site measurements. The results of these measurements shall be the basis for corrosion control designs. Structures shall be protected against the environmental conditions by use of coatings, insulation, cathodic protection and electrical isolation and/or electrical continuity as appropriate.
- B. Grounding: Due to the natural difference between personnel safety grounding and stray current and corrosion control requirements, the guidelines provided in this criteria shall be followed. Designs shall be reviewed by WMATA corrosion control personnel to assure stray current and corrosion control designs are not compromised while still providing a safe system.

1.04 APPLICABILITY OF CRITERIA

The stray current and corrosion control criteria shall be applicable throughout the design, installation, and start-up process of the upgrade.

1.05 EXPANSION CAPABILITY

Stray current and corrosion control systems shall be easily expandable to the entire system without major reconfiguration, reconstruction, redundancy and duplication of equipment. Experimental designs, equipment and prototypes of a research nature are discouraged and must be reviewed and approved by WMATA prior to their implementation and prior to incurring any costs.

1.06 STANDARDS AND CODES

- A. Standards, codes, and recommended practices for stray current and corrosion control and grounding systems include the following publications and/or codes by:
 - 1. NACE International,
 - 2. SSPC, The Society for Protective Coatings,
 - 3. National Fire Protection Association,
 - 4. American National Standards Institute,
 - 5. National Electrical Manufacturers Association,
 - 6. American Standards for Testing Materials,

7. International Electrical and Electronic Engineers,
8. The Occupational Safety and Health Act,
9. National Electrical Code,
10. National Electrical Safety Code,
11. Life Safety Code,
12. Grounding Bonding & Shielding MIL-STD-188-124, and
13. Codes and regulations of the jurisdictional authorities.

1.07 SOIL AND WATER CORROSION PREVENTION

A. Purpose

The designs shall conform to structure life objectives for buried structures. Stray current and corrosion control provisions shall be required for all facilities, regardless of location or material of construction when corrosion failure of such facilities will affect safety or interrupt continuity of operations.

B. Scope

The structures which may be affected by soil and water corrosion shall be identified. Typically, these include, but are not limited to:

1. Ferrous pressurized piping (water, fire water, sewage ejectors, etc.),
2. Hydraulic elevator cylinders,
3. Underground storage tanks, and
4. Other underground structures.

C. Stray current and corrosion control measures provided by others for structures owned by others shall be coordinated with the design/builder and WMATA. This coordination shall be required to resolve design conflicts and to minimize impact of other designs, such as interference of cathodic protection. All contacts with owners of other structures shall be coordinated through the WMATA.

1.08 DESIGN OF SOIL AND WATER CORROSION PREVENTION SYSTEMS

A. General

Protection of metal structures, shall include, but shall not be limited to, corrosion control techniques, such as coating, electrical isolation, electrical continuity, and cathodic protection.

B. Materials and Structures

1. Ferrous Pressure Piping: All designs using buried cast iron, ductile iron and steel pressure piping shall be cathodically protected. Designs shall be provided to WMATA and will include the following:
 - a. Application of a protective coating to the external surfaces of the pipe (see Section 1.08 D.),
 - b. Electrical insulation from interconnecting piping, other structures, and segregation into discrete electrically insulated sections depending upon the total length of the piping (see Section 1.08 E.),
 - c. Electrical continuity through installation of insulated copper wires, across all mechanical joints other than intended insulators (see Section 1.08 F.),

- d. The number of sacrificial anodes shall be determined on an individual structure basis (see Section 1.08 G.), and
 - e. Permanent test/access facilities, to allow for verification of continuity, effectiveness of insulators and coating, and evaluation of protection levels; shall be installed at all insulated connections and at intervals convenient to local conditions and to the engineer's guidance (see Section 1.08 H.).
2. Reinforced/Prestressed Concrete Pressure Pipe: Design and fabrication of reinforced concrete pipe and steel cylinder prestressed concrete pipe shall include the following:
- a. Establish a low permeability concrete by controlling the water/cement ratio, ratios of 0.3 for core concrete and 0.25 for mortar are preferred, industry practices may result in significant increases and wide variations to these levels,
 - b. Maximum of 200 ppm chloride concentration in mixing water for concrete, and
 - c. Use of Type V cement.
3. Concrete/Reinforced Concrete: Design shall be based on the following for concrete in contact with soils:
- a. Use of Type V cement,
 - b. Maximum 200 ppm chloride concentration in mixing water and admixtures combined, and
 - c. Minimum 2-inches concrete cover on the soil side of all steel reinforcement when the concrete is poured within a form or a minimum 3-inches cover when the concrete is poured directly against soils.
4. Non-Metallic Materials: Plastics, fiberglass, and other non-metallic materials for pressurized piping may be appropriate to aid in corrosion control. The corrosion control design shall consider the following characteristics of proposed materials:
- a. Manufacturer's recommendations,
 - b. Mechanical strength and internal pressure limitations,
 - c. Elasticity/expansion characteristics,
 - d. Comparative costs,
 - e. Expected life,
 - f. Failure modes,
 - g. Local codes, and
 - h. Prior experiences with the proposed non-metallic material in similar applications.

C. Hydraulic Elevators

- 1. Hydraulic elevator steel cylinder plunger casings shall be coated on the exterior surface with a coal tar epoxy or coal tar tape. The plunger casing shall be electrically insulated from support brackets, hydraulic feed lines, and any other metallic connections. The plunger shall be electrically isolated from the elevator car body and any other metallic connections.
- 2. An outer construction casing of fiberglass-reinforced plastic (FRP) will require the space between the casings be filled with high resistivity sand, with a sacrificial anode system installed in the sand fill for cathodic protection of the hydraulic elevator plunger casing.
- 3. Test facilities shall be installed to activate and monitor the cathodic protection installation. The end cap at the bottom of the construction casing (FRP) and joints

in the length(s) of casing pipe used shall be installed and sealed in such a manner that there is no water infiltration into the casing.

4. A removable water tight lid shall be installed on the outer construction casing until installation of the cylinder. The construction casing shall be free of water prior to installation of the cylinder. The top of the casing shall have a permanent moisture seal after the cylinder is installed.

D. Coatings

Buried metal structures requiring coating shall be provided with coal tar, coal tar tape or coal tar epoxy coating systems having high electrical resistance. Mill applied coatings shall be specified whenever possible with use of compatible tape coatings for joints and field touch-up. The corrosion control design shall specify surface preparation, application procedure, primer, number of coats, minimum dry film thickness and inspection methods for each coating system.

E. Electrical Insulation

The corrosion control design shall establish the need for and location of insulated flanges, spacers, couplings, and unions. Insulated fittings shall have a minimum resistance of ten (10) megohms prior to installation and be designed for compatibility with material carried, including pressure and temperature restrictions. No more than 2% of the test current applied across the insulating device shall flow through the insulator. All insulated fittings, buried or exposed, shall be provided with monitoring cables. Wherever possible, a minimum clearance of twelve inches shall be provided between new and existing structures. When field conditions prohibit a six inch clearance, the design shall include special provisions, such as insulating spacers, to prevent electrical contact with the existing structure(s).

F. Electrical Continuity

1. Electrical continuity bonds of insulated copper wires shall be used to provide a low resistance path for cathodic protection current on systems with mechanical joints. Any threaded or slip-on connections will be exothermically welded at the connection point to provide low resistance paths. Welded and soldered joints do not require bonding. Continuity testing requirements shall not exceed 10% of the theoretical resistance.
2. Continuity bonds shall be made with high molecular weight polyethylene insulated copper cables and thermite welds. All thermite welds shall be coated.

G. Cathodic Protection

1. Cathodic protection installations shall be designed consistent with structure life objectives. Sacrificial galvanic anodes shall be used wherever possible to avoid corrosive interference efforts with underground utilities.
2. All new, replaced, or relocated pressurized utility piping associated with construction shall be afforded corrosion protection in accordance with requirements of each utility. At a minimum, test wires shall be installed for future testing.
3. The cathodic protection design shall consider the following:
 - a. Soil Environment,
 - b. Mutual protection or interference configurations,

- c. Limitations of protection potentials, and
 - d. Test monitoring facilities.
4. Cathodic protection designs shall be based on theoretical calculations using site environmental soil data collected during design surveys and boring operations for each system. Designs shall include the following minimal factors:
- a. Minimum assumed bare surface area shall be 1%,
 - b. Minimum protection current density for bare surface area shall be 2.0 ma/sq. ft.,
 - c. Calculated anode bed resistance,
 - d. Anode size, spacing and quantity, and
 - e. Calculated anode life.
5. The anticipated anode life shall not be less than life objectives.

H. Test Facilities

Types and locations of test facilities shall be specified in the corrosion control designs. Test facilities shall be designated according to type of installation, and shall include structure cable(s) reference electrode(s), anode lead cable(s), and continuity bonds. Conduit shall be as specified.

I. Casings

Casings, if required, shall be installed bare, unless coating and a sacrificial anode system is required by the owner. Casing insulators must be installed on the carrier pipe to avoid electrical contact between the casing and carrier pipe. Test leads are required on the casing and the carrier pipe.

J. Electrical Bonding

1. Concrete Structures: Structural reinforcing steel for at-grade and underground concrete structures shall be electrically bonded or welded to provide electrical continuity as shown on the design and standard drawings. Reinforcing steel in concrete walls, abutments and other similar structures shall be made electrically continuous. To allow for stray current tests, one No. 2 AWG insulated wire shall be exothermic welded to the reinforcing steel and terminated in a flush mounted junction box at the beginning and the end of each structure run for periodic monitoring and/or testing.
2. Traction Power Substations: At each traction power substation associated with WMATA structures, provisions shall be made to connect the electrically continuous reinforcing via cable to the traction power substation negative bus through diodes. These diodes and associated drainage equipment will be furnished as part of the traction power equipment. Termination connections will be incorporated to the reinforcing steel, as well as all embedded conduits and cables in the substation as required on the standard drawings.
3. Utility Structures: WMATA owned utility structures such as buried metallic pipe shall be, at a minimum, provided with electrical continuity. Pressure piping that penetrates structural walls shall be electrically insulated from the outside service piping and from watertight wall sleeves. Dielectric insulation shall be made on the interior of the structural wall and at all dissimilar metal connections. If an electrical

ground connection is made to the utility, the connection must be made on the building side of the insulator.

4. Replaced, relocated, and maintained in place utility structures owned by others shall be provided with corrosion control measures required by individual master agreements. These structures in the vicinity of traction power substations may require provisions for future connection to substation negative buses. These connections will be based upon results and agreements after cooperative testing performed by the utility and WMATA. To permit future connections, at least four 3-inch conduits shall be stubbed-out and capped, approximately 30 inches below grade, and at a distance of 3 feet outside of each traction power substation. The conduits shall be brought into the substation and turned up at a wall adjacent to the negative switchboard.

K. Storage tanks

Buried storage tanks shall be cathodically protected to prevent corrosion and avoid environmental impacts.

L. Piling

Permanent ferrous metal foundation piling shall be bonded and provided with stray current drain cables to a traction power substation, when adjacent to a substation. Metal piling remote from a traction power substation shall be provided with stray current drain cables for test purposes and future connection to substation negative switchboard. To assist in shielding stray currents, soldier piles to be left in place shall be bonded for continuity and provided with drainage connections. Bonding of soldier piles shall be accomplished by using No. 4/0 AWG insulated cable, thermite welded between piles. Soldier piles so bonded and drained to traction power substations shall not be used for alternating current grounding purposes.

M. Test Facilities

Test facilities shall be required on all WMATA owned electrically bonded structures to measure and monitor protection/stray current. The corrosion control design shall provide test facilities for individual protected structures. Junction box spacing shall not exceed 100 feet in continuous structures.

N. Quality Control

Stray current and corrosion control designs shall be coordinated with all other engineering disciplines to insure they do not conflict with other installations. Shop drawings, material catalog cuts, and additional information related to the stray current and corrosion control designs will be submitted for review and approval. Testing of materials prior to their delivery from a manufacturer, or during construction, shall be conducted, as required, to ensure compliance to corrosion control designs.

O. Testing

Testing shall be conducted in the presence of the Engineer to insure that installations are functioning in the proper manner and that they comply with engineering designs. Testing

will include, but not be limited to:

1. Electrical continuity bonding
2. Electrical insulation
3. Coating effectiveness
4. Test station installations
5. Cathodic protection installations

Test results indicating deficiencies in the corrosion control measures will be examined to determine the cause and what type of corrective action is required.

P. Test Results

Baseline values shall be established at the time of completion of the installation. The results shall include the following:

1. Galvanic anode system tests
2. Resistance tests
3. Test locations
4. Test criteria
5. System troubleshooting, if performed.

1.09 SPECIAL DESIGN PROVISIONS

A. Facility Identification

During the pre-design and design phases of the project, the design/builder shall identify unique and special design cases such as paralleling lines, and unusual soil conditions. In these cases, the design/builder shall evaluate and recommend special design measures as appropriate.

END OF SECTION

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PROGRAM CRITERIA

SIGNAL CONTROL AND INTERLOCKING SYSTEM

PART 1: GENERAL

1.01 DESCRIPTION: The Washington Metropolitan Area Transit Authority (WMATA) plans to expand and improve current operations at Alexandria Yard as part of the Metro Matters Program. Work to be accomplished under this project is diverse and includes various tasks such as the installation of new turnouts and shop lead tracks, track realignment, installation of new wayside signaling equipment and train control room signaling equipment, yard control machine revisions and building of civil infrastructure to support signaling. This Section describes the general scope, functional design and other requirements for the Yard Signal Control and Interlocking (YSCI) system work to be accomplished in Alexandria Yard.

1.02 PROGRAM CRITERIA

- A. Program Criteria applicable to the work described in this Scope of Work shall be the same as that provided in Project Manual, Book 2.

1.03 GENERAL FEATURES ALEXANDRIA YARD

- A. The changes and additions to the yard signaling system control and indication logic shall either be relay or microprocessor based and meet the design requirements provided under this Contract. The Design-Builder shall use Entrance-Exit type philosophy for routing train movements throughout the turnouts. The yard signaling system logic shall be designed using traditional vital and non-vital signaling philosophy consistent with the existing in-service signaling system at Alexandria Yard.
- B. A Yard Control Machine located in the Yard Tower shall be used to control routing throughout the yard by utilization of pushbuttons and switches located on the Yard Control Machine.
- C. Single rail power frequency track circuits shall be provided to ensure train detection throughout the yard turnouts and shop lead tracks.
- D. Trailable switch machine layouts with external switch circuit controllers shall be installed on all new and relocated turnouts.
- E. Switch rail heaters and crib heaters shall be installed on all new and relocated power operated yard switch machine turnouts. Control of the heaters shall be from the Yard Control Machine.
- F. Transit style wayside signals shall be installed at the limits of all interlockings to provide the train operator with a proceed or stop aspect.

- G. Interconnecting signal cables between the wayside equipment and Yard train control room shall be routed through new ductbanks, surface trench and conduit systems designed, furnished and installed by the Design-Builder under this contract. Where existing ductbank and conduit systems can accommodate the additional cabling without exceeding fill limitations, they may be used subject to Authority approval.

1.04 SCOPE OF WORK

- A. The work to be performed for the YSCI system under this Contract shall comply with the requirements of the Program Criteria and the Specifications. The Design-Builder may propose alternatives to the existing facilities, the criteria and the specifications within the parameters established for the project. It shall be the Design-Builder's responsibility to provide conclusive evidence that acceptance of an alternative is in the best interests of the Authority. WMATA Typical Layout Drawings and selected Yard As-Built Drawings to demonstrate the existing circuit and equipment configurations are provided as Information or Reference Drawings to enable the Design-Builder to better understand existing conditions and the expected installation methods and functional requirements. The Design-Builder's design shall be based on the existing conditions within the yard. Complete sets of Yard As-Built Drawings will be furnished by the Authority upon request by the Design-Builder. The Design-Builder shall be responsible to incorporate any changes marked on the TCR Room Book of Plans that have not been incorporated in the permanent drawings.

- B. The Design-Builder shall furnish the design, manufacture, documentation, delivery, storage, installation, demonstration, testing, interface requirements, placing into service and preparation of as-built drawings for the new YSCI system in the Alexandria Yard. This work shall include, but not limited the following components:

- 1. Train Control Room Equipment Space:

- a. The Design-Builder shall provide adequate space in the Alexandria Yard Train Control Rooms for the installation of new signaling equipment. This work shall include the removal of obsolete, "out of service", or disconnected equipment to create vacant space and the rearrangement of existing equipment, if necessary, to maintain the grouping of similar devices.

- 2. Trailable Switch Machine Layouts:

- a. Provide new switch layout on Bypass Track for new turnout for new Shop Track 3AW at the West end of the Shop Building. #
- b. Provide new switch layout on Bypass Track for new turnout for realigned existing Shop Track 6 at the West end of the Shop Building. #

- 3. Snowmelter Cases:

- a. Provide two new Snowmelter Control Cases at new turnouts on the West end of the Shop Building. #

- 4. Snowmelter Rods and Crib Heaters:

- a. Provide new Snowmelter rods and crib heaters for two new turnouts. #
- 5. Single Rail Power Frequency Track Circuits
 - a. Provide new and reconfigured track circuits for the new interlockings and shop lead tracks on both the East and West ends of the Shop Building.
- 6. Wayside Signals:
 - a. Provide new signal layouts to replace existing Signals 214, 216 and 218 and provide a new signal layout at the clearance point for new Track 3AW at the West end of the Shop Building. #
- 7. Yard Signal Control Logic:
 - a. Provide vital and non-vital equipment and circuits to implement changes and additions to accommodate the program track changes. Non-vital circuit requirements may be satisfied with the use of microprocessors or non-vital relay logic.
- 8. Yard Control Panel:
 - a. Replace existing panels of the yard control machine with new panels equipped with new switches, pushbuttons, indicator lamps and other panel control and indication components for the existing and new tracks. Replacement panels may be engraved phenolic panels or mosaic tile compositions and shall be wired to plug connectors to expedite panel replacement. Replacement panels shall match any panels not replaced in regard to materials, color, engraving, lettering size and weight, and overall appearance.
- 9. Signal Bonding:
 - a. Provide signal bonding as required for new and modified turnouts.
 - b. Provide signal bonding around any existing insulated joints which are not required in the new track circuit configurations.
- 10. Power Bonding:
 - a. Provide power bonding as required for new and modified turnouts.
 - b. Provide power cross bonding on shop and yard tracks to connect new tracks to existing negative return system and replace existing cross bonding displaced by new shop construction on both the East and West end of the Shop Building.
 - c. Provide power bonding around any existing insulated joints which are not required in the new track circuit and negative return rail configurations.

11. Cabling:

- a. Provide replacement cables for cables which are included in the existing ductbank TC/C-4 between Manhole TC/C-B and the mainline ductbank that interferes with construction of the inspection pits at the East end of the Shop Building.
- b. Provide new replacement cables for any existing cabling which is damaged during the course of the work.
- c. Provide new cabling between the Train Control Room and the new and relocated wayside equipment.
- c. Provide all necessary temporary and permanent wiring within the Train Control Room.
- d. Provide all necessary cabling between the Train Control Room and the Yard Control Room.

12. Ductbank, Conduit and Surface Trench:

- a. Provide replacement facilities for existing Ductbank TC/C-4 between Manhole TC/C-B and the mainline Ductbank that interferes with construction of the new Shop Extension at the East end of the existing Shop Building.
- b. Provide replacement facilities for any other existing underground conduit, ductbank or surface trench that is impacted by track and shop construction as determined in the final design.
- c. Provide new ductbank, conduit and surface trench to expand or supplement the existing facilities to accommodate the new cabling requirements.

13. Revisions and additions to the existing power distribution system:

- a. Provide new power distribution equipment as necessary to accommodate the additional electrical loads for the new signal equipment.

14. Event recording:

- a. Replace the existing Event Recording System with a new system incorporating all existing and new functions.

15. Power supplies, associated subsystems, equipment, materials, cables, hardware, and appurtenances, to provide a complete operating signal system as described

- C. The Design-Builder shall furnish the management, labor, data, design, relay logic, testing services, training, manuals, parts, materials, tools, equipment, appurtenance, and incidentals necessary to complete the work in accordance with the Contract requirements.

SECTION 02205

REMOVAL AND RESTORATION OF EXISTING FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies removing, restoring and reinstalling miscellaneous facilities on WMATA property which are removed during construction.
- B. Related Work Specified Elsewhere
- | | |
|---------------|-------------------------------------|
| Section 02220 | Demolition |
| Section 02320 | Grading, excavating and backfilling |
| Section 02515 | Water Distribution System |
| Section 02554 | Storage Tank Systems |
| Section 02725 | Base for pavements |
| Section 02740 | Bituminous pavement |
| Section 02750 | Concrete pavement |
| Section 02772 | Curbs, gutters and walks |
| Section 02820 | Fencing |
| Section 02920 | Topsoil, seeding and sodding |
| Section 02930 | Landscaping |
| Section 02935 | Salt Dome |
| Section 03100 | Concrete formwork |
| Section 03200 | Concrete reinforcement |
| Section 03300 | Cast-in-place structural concrete |
- C. Definitions
1. Miscellaneous facilities include, but are not limited to, the following: Alarm and sprinkler systems, signs, awnings, security grilles, heating, cooling and electrical facilities, vaults, entrance walkways, steps, sidewalks, curbs, walls, railings, fences, shrubs, lawns, trees, and salt dome.
 2. Definitions pertaining to trees, shrubs and other plants - ANSI Z60.1.
 3. .Salvage - To remove and store material and equipment for reuse in this or other Authority contracts.
- D. Salvage:
1. Clean salvaged items of foreign material and store in accordance with the General Requirements at accessible points within right-of-way unless otherwise shown, approved or directed.
 2. Repair or replace salvaged items which are damaged or destroyed.
 3. Unless otherwise specified items removed but not to be salvaged will become the property of the Contractor.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Working Drawings: Complete details of temporary signs including method of reinstalling existing permanent signs. Submit prior to removing signs.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ANSI: Z60.1.
 - 3. ASTM: C4.
 - 4. ICNCP (International Commission for the Nomenclature of Cultivated Plants): International Code of Nomenclature for Cultivated Plants.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Materials for Restoration: New materials, unless otherwise approved, conforming to existing undisturbed materials in quality, color and finish.
- B. Topsoil: Section 02920.
- C. Seeding and Sodding: Section 02920.
- D. Trees, Shrubs and Other Plants: Same species as that removed, unless otherwise specified, and identified in accordance with the International Code of Nomenclature for Cultivated Plants.
- E. Clay Drain Tile: ASTM C4.

PART 3 - EXECUTION

3.01 REMOVALS: Remove work to extent shown minimizing damage to work which is to remain in place.

3.02 TRACKWORK AND SPECIAL TRACKWORK: All reuseable trackwork and special trackwork material shall be salvaged and delivered to a facility located within a 50 mile radius as directed by the WMATA Project Manager.

3.03 ALARM AND SPRINKLER SYSTEMS:

- A. Alarm Systems:
 - 1. Maintain existing alarm systems in operating condition. On completion of construction, reinstall components to provide same degree of protection as original system.
- B. Sprinkler Systems:
 - 1. Maintain existing sprinkler systems fully operative in areas temporarily occupied for construction purposes.
 - 2. Protect system from freezing where exposed to open-air conditions.
 - 3. Restore sprinkler system to provide same degree of protection as original system.
- C. Fire Hydrants: Install new fire hydrants and water valves prior to removal of existing fire hydrants and valves due to shop expansion construction.

3.04 GRILLES: Remove and reinstall security grilles concurrently with building modifications.

3.05 VAULTS: Perform work on vaults as specified in Section 02320.

3.06 HEATING, COOLING AND ELECTRICAL FACILITIES

- A. Heating and Cooling Facilities - Shady Grove Shop Building underground heating oil fuel tank: Remove fuel tank under existing parking area. Restore with adequately sized fuel tank including access manholes and service lines - locate under future parking area.
- B. Electrical Facilities - Remove and reconstruct electrical facilities to extent necessary to provide electrical service inside building line.
- C. Gasoline and Diesel Fueling Facilities - Remove and restore Shady Grove fueling facility to new location adjacent to M/W Storage Track 7 and to relocated Access Road

3.07 SIGNS, FLAGPOLES, RAILINGS AND FENCES:

- A. Salvage usable signs, flagpoles, railings and fences where removal is required by shop expansion construction.
- B. Provide temporary sign for each permanent sign removed in accordance with approved working drawings. Remove on completion of construction.
- C. Reinstall items in their original locations or in alternate locations required by shop expansion construction. Reinstall or replace chain-link fences in accordance with Section 02820.
- D. Repair existing surfaces, damaged during the work, by cleaning and restoration to match existing.

3.08 STEPS, WALLS AND COPINGS:

- A. Salvage steps and copings of wall components where shown and rebuild them to match existing.
- B. Where new reinforcing steel and concrete construction is necessary, provide such items in accordance with Sections 03100, 03200 and 03300 so as to maintain continuity of quality and appearance between existing and new construction.

3.09 SIDEWALKS AND CURBS:

- A. Restore sidewalks and curbs to line and grades which existed originally or new lines and grades required by shop expansion construction using new asphalt and concrete of equal quality to existing.
- B. Restore asphalt and concrete sidewalks and curbs using new asphalt and concrete of equal quality to existing and to match lines, grades, thicknesses and construction, or new lines and grades as required by shop expansion. Perform work in accordance with Sections 02725, 02740, 02750 and 02772.

3.10 PARKING AREAS AND ACCESS ROADWAY PAVEMENTS: Restore parking area and access roadway pavements to lines, grades, thickness and construction as existed prior to removal at locations required by shop expansion. Perform work in accordance with Section 02725, 02740 and 02750.

3.11 LANDSCAPING:

- A. Tree Preservation:
 - 1. Repair injuries, abrasions or other damage to planting by cleanly removing broken members, loose or torn bark and shape edges in order to permit drainage of rain water from wounds. Perform pruning in accordance with Section 02930.
 - a. Where depth of soil over root system of existing plantings is to be modified by final grading, provide the following:

- (1) Where increase of one foot or more in elevation is shown, spread continuous layer of rock aggregate, graded 1/4 inch to two inches, six inches deep from trunk to drip line of branches prior to installation of fill.
- (2) Provide proper aeration by installing, within perimeter of spread, system of four-inch clay drain tile, vertically from soil surface into aggregate fill.
- (3) Construct stone wells around trunks as approved. Extend stone work from rock fill layer to final grade, allowing sufficient space for trunk growth.
- (4) Protect trees, shrubs, groundcovers and features such as landforms, walls, wells, coping and similar items that are to remain. Exercise special precautions and provide treatment for retention and protection of such landscape items in preference to removal.

B. Tree Removal and Replacement:

1. Where existing trees are to be removed and replaced by others at present locations, use replacement trees of comparable species and size up to four inches maximum caliper, except that the jurisdictional authorities have the right to specify alternate tree species or varieties of comparable size and cost, if such are readily available. Do not replant or relocate trees over 12 inches in caliper, except in cases of historical significance, rarity of type, excellence of form or other special considerations.
2. Replace trees of minimum three-inch caliper, removed by construction, on the basis of diameter inch for diameter inch, up to four-inch maximum caliper, and on total diameter inches removed, so that planting can be complete and uniform throughout.
3. Use replacement trees of prime specimen quality, field selected and seal-tagged. Measure, grade, install and maintain plants in accordance with ANSI Z60.1, except for National Park Service lands where trees are to be measured for diameter by taking the average of two trunk caliper measurements at right angles, six inches above the root crown.
4. Replace shrubs removed with same species and varieties and of same size in height or width or substitute at locations designated by the Engineer a number of plants of same species and variety whose total measurements equal measurement of plant or plants to be replaced

C. Plant maintenance and replacements:

1. For 18 months after completion of plant installation, maintain planting and incidental work by replacing plants, watering, weeding, cultivating, fertilizing, remulching, pruning, controlling insects and diseases, reguying, rewrapping and by performing other maintenance operations for promotion of root growth and plant life so that work is in satisfactory condition at completion of Contract and throughout maintenance period.
2. Water and weed root system of plants at regular intervals and keep surrounding soil in condition for promotion of root growth and plant life.
3. Provide planting and planting materials that will be in a condition acceptable to the Engineer at end of maintenance period.
4. During next planting season, replace trees, ground cover, vines and shrubs which are discovered during and at end of maintenance period to be dead or in unhealthy, unsightly or badly impaired condition. Replace with healthy plants of same kinds and sizes as originally specified.
5. The Contractor will not be held responsible or liable for damages to plants and planting materials by animals, malicious or careless damage by human agencies over which he has no control, or by fire and storm damage following completion and acceptance of original planting.

- D. Topsoil:
 - 1. Provide and place topsoil in tree spaces and areas to be seeded in accordance with Section 02920.
- E. Grassed Areas:
 - 1. Unless otherwise shown, provide seed in accordance with Section 02920. If sodding is required, provide in accordance with Section 02920.
- F. Replace landscaping, trees and grassed areas, inside and outside limits of work, if removed or damaged.

3.12 JOINTS BETWEEN EXISTING AND RESTORED WORK:

- A. Make joints between existing and restored work as inconspicuous as practicable.
- B. Use saw to cut straight line at joint between existing and new concrete surfaces.
- C. Make joints between existing and restored work at least equal structurally to original undisturbed items.

END OF SECTION

THIS PAGE NOT USED

SECTION 02220

DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies demolition work.
- B. Related Work Specified Elsewhere:
 - Section 02230 Clearing, grubbing, removal and protection of trees and shrubs
 - Section 02320 Removal of concrete and masonry walls and foundations 12 inches below existing grade
 - Section 02205 Removal and restoration of miscellaneous facilities and salvage
- C. Definitions:
 - 1. Demolition: Complete removal and disposal of existing facilities from areas to be cleared and grubbed and from other areas shown.
 - 2. Existing facilities include, but are not restricted to, buildings, sheds, streetcar tracks, pavements, sidewalks, curbs and gutters, signs, posts, fences, drainage, sewage and other utility facilities located in the area to be cleared and grubbed.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Certification:
 - 1. Submit copy of request to utility companies owning or agency controlling services and appurtenances affected by demolition work for discontinuance of services along with certificates of severance.
 - 2. Documentation:
 - a. Demolition permit from the jurisdictional agency or owner.
 - b. Permits and releases from each owner of property where demolition debris will be deposited absolving the Authority of responsibility in connection with such disposal.
 - c. District of Columbia: Disposal of soils from Brentwood Yard can require special handling and disposal. Meet the requirements of the Department of Health, Environmental Health Administration, including required soils testing, prior to demolition and disposal of soils.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.

1.04 JOB CONDITIONS:

- A. Buildings:
 - 1. Demolish buildings in place.
- B. Maintenance of Traffic:
 - 1. Furnish and maintain temporary signs, barricades, flashing lights and flag persons necessitated by the work and remove same upon completion of work.
 - 2. Bridge cuts in traffic areas with steel plates or by other approved means.
 - 3. Keep traffic areas free from debris and spillage of materials.
- C. Protection and Restoration:
 - 1. Prevent damage to pipes, conduits, wires, cables and structures above and below ground which are not designated for removal. Repair or replace damaged items.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 PRESERVATION OF REFERENCES:

- A. Prior to removal, record location and designation of survey markers and monuments located within demolition area. Store markers and monuments during period of work. Restore survey markers and monuments upon completion of work.

3.02 BUILDING DEMOLITION:

- A. Undertake rodent control and extermination program in demolition areas.
 - 1. District of Columbia: Rodent control shall be initiated with the Department of Health, Environmental Health Administration two weeks before start of construction. The Contractor shall take the necessary steps to insure that the project site, including all project related facilities within the site, is free of rodent infestation at all times. Work includes, but is not limited to the following:
 - a. Daily removal of and proper disposal of all refuse. In the event that refuse cannot be removed from the project site the same day, the refuse shall be stored in containers designed to prevent infiltration by rodents.
 - b. Inspections at least once a week throughout the project site for possible rodent infestations. If such infestations are found, the Contractor shall engage the services of a certified pest control contractor and retain such service until infestation is no longer apparent.
- B. Take possession of building materials, fixtures and equipment in, attached to or belonging to, buildings and structures.
- C. Proceed with demolition of building or structure and appurtenances.
- D. Party Walls:

1. Where building wall being demolished is a party wall with another building not to be demolished, prevent damage to other building and avoid interference with its occupants.
 2. Restore and waterproof exposed party walls in accordance with applicable building code for exterior walls of particular type of construction involved.
 3. Should party wall become unsafe or dangerous because of demolition, effect remedial measures for anchoring, bracing or buttressing. If such work does not correct unsafe or dangerous conditions, remove and replace wall and perform necessary work to properly enclose structure that is to remain standing, at no cost to the owner of such property.
- E. Cellars, Foundation Walls, Truck Ramps, and Retaining Walls:
1. Break concrete and masonry cellar and truck ramp floors into pieces not exceeding four cubic feet in volume or, where approved, punch holes of not less than one-square-foot area through full thickness of floor approximately at 10-foot centers.
 2. Remove foundation and cellar 12 inches minimum below final grade, and remove retaining walls 12 inches below subgrade or subballast.
 3. After breaking or removing cellar floors and truck ramps, fill spaces with durable free-draining fill material, consisting of particles no one of which exceeds eight inches in its greatest dimension. Use masonry rubble obtained from demolition work if it meets this requirement. Place fill material in layers each of 12-inch maximum thickness, compact each layer and fill voids in each lift with approved coarse sand.
 4. Correct subsidence in filled areas by placing and compacting additional fill.

3.03 REMOVAL OF PAVEMENTS, SIDEWALK, CURBS AND GUTTERS:

- A. Demolish pavement, sidewalks, curbs and gutters within demolition area shown to underside of pavement and dispose of resulting debris.
- B. Fill resulting excavations, holes and depressions to existing grade or alternative grade as shown, using fill material conforming to requirements of Section 02320.
- C. Adequately drain resulting surfaces.

3.04 DISPOSAL:

- A. Remove debris resulting from demolition work to locations outside Authority's right-of-way.
- B. Dispose of debris off site only with permission of property owner where such debris is to be deposited and in accordance with codes and regulations of the jurisdictional authorities.
 1. District of Columbia: Meet the requirements of the Department of Health, Environmental Health Administration, for disposal of debris off the Brentwood Yard site
- C. Do not burn debris at demolition site.

END OF SECTION

THIS PAGE NOT USED

SECTION 02230

SITE CLEARING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This Section includes the following:
1. Protecting existing trees and vegetation to remain.
 2. Removing trees and other vegetation.
 3. Clearing and grubbing.
 4. Topsoil stripping.
 5. Removing above-grade site improvements.
 6. Disconnecting, capping or sealing, and abandoning site facilities in place.
 7. Disconnecting, capping or sealing, and removing site facilities.
- B. Related Sections include the following:
- | | |
|---------------|--|
| Section 02220 | Demolition |
| Section 02920 | Topsoil, seeding and sodding |
| Section 02930 | Landscaping |
| Division 1 | Construction Facilities and Temporary Controls |
- C. Definitions
1. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of weeds, roots, and other deleterious materials.
 2. Facility: Utility structures and system components belonging to utility company including service lines which are used to provide service to utility's customers and product which these facilities convey.
 3. Utility: Company, agency, owner or operator of facility concerned.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Documentation:
1. Permits and releases from each owner of property where debris will be deposited absolving the Authority of responsibility in connection with such disposal.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Requirements for satisfactory soil materials are specified in Division 2 Section "Earthwork."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.
- B. Standard Wood Tree Guards: As shown on W.M.A.T.A. Standard Drawing ST-C-16, consisting of the following:
 - 1. Wood posts: Two inches square.
 - 2. Wood stringers: Two inches by four inches.
- C. Standard Chain-Link Tree Guards: As shown on W.M.A.T.A. Standard Drawing ST-C-16, consisting of the following:
 - 1. Chain-link fencing: Nine gauge, two-inch mesh.
 - 2. Posts: 2.7 lbs. per foot "H" or 1-1/2 inches inside diameter.
 - 3. Brace rails: 1-5/8 inches outside diameter.
 - 4. Stretcher bars: 1/4-inch by 3/4-inch.
- D. Temporary Enclosures and Wrapping: Design-Builder's option.
- E. Tree Wound Paint: Standard bituminous product.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TREE PROTECTION

- A. Erect and maintain temporary enclosures or wrappings around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove enclosures or wrapping when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
 - 2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
- B. Protect trees shown on the drawing with standard wood or chain link tree guards.
- C. Nurture protected and replaced trees, shrubs and plants during the period of this Contract.

- D. Do not excavate within drip line of trees, unless otherwise indicated.
- E. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.
 - 3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 - 4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.
- F. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.
 - 1. Employ a qualified arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 - 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.03 UTILITY FACILITIES

- A. Locate, identify, disconnect, and seal or cap off facilities indicated to be removed.
 - 1. Owner will arrange to shut off indicated facilities when requested by Design-Builder.
- B. Existing Facilities: Do not interrupt facility service to building connections occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Authority Representative not less than two days in advance of proposed facility interruptions.
 - 2. Do not proceed with facilities interruptions without Authority Representative's written permission.
- C. Excavate for and remove underground facilities indicated to be removed.

3.04 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
 - 4. Use only hand methods for grubbing within drip line of remaining trees.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated

1. Place fill material in horizontal layers not exceeding 8-inch loose depth, and compact each layer to a density equal to adjacent original ground.

3.05 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 1. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Limit height of topsoil stockpiles to 72 inches.
 2. Do not stockpile topsoil within drip line of remaining trees.
 3. Stockpile surplus topsoil and allow for respreading deeper topsoil.

3.06 REMOVAL OF TREE BRANCHES:

- A. Remove tree branches which extend over structure neat lines and are less than 20 feet above top of rail or existing surface whichever is higher.
- B. Remove tree branches which create a hazardous condition.
- C. Remove branches so as to present balanced appearance of tree.
- D. Treat scars resulting from removal of tree branches with heavy coat of tree wound paint

3.07 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.08 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.
- B. Dispose of debris off site only with permission of property owner where such debris is to be deposited and in accordance with codes and regulations of the jurisdictional authorities.
- C. Burning and burying debris on site is prohibited.

END OF SECTION

SECTION 02240

DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies general dewatering systems for control of groundwater and removal of surface water during construction.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM:
 - a. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
 - b. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
 - c. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
- B. Design Criteria:
 - 1. Provide dewatering system which will reduce hydrostatic pressure and lower groundwater levels below excavation levels as necessary for safe and proper prosecution of the work and which will result in obtaining stable, substantially dry subgrade for prosecution of subsequent operations.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Working Drawings:
 - 1. Type of dewatering system proposed, showing arrangement, location and depths of proposed system, complete description of equipment and materials to be used, installation procedure, well and piezometer development procedures, maintenance plan for dewatering system and piezometers, standby equipment and standby power supply (if required), and proposed location of points of discharge of water and settlement measuring procedure.
 - 2. Obtain approval of jurisdictional agencies prior to installation of system.
 - a. District of Columbia: The Contractor shall obtain a temporary discharge permit from the Department of Health, Environmental Health Administration, prior to any dewatering at the construction site.
- B. Documentation:
 - 1. Observe and record average flow rate and time of operation of each pump used in dewatering system. Provide appropriate devices, such as totalizing flow meters for observing flow rates. Provide interior dewatering well drop tube and exterior filter

- piezometer to observe and record operating levels and filter levels. Submit data on approved form and in approved format during period dewatering system is in operation.
2. Observe and record elevation of groundwater in the piezometers, including those previously installed, on approved form and in approved format, during the period that dewatering system is in operation. Sound depth to bottom of each piezometer monthly to ensure that soil particles are not building up in standpipe. Submit observation records promptly, regularly and as directed.
 3. During dewatering, make observations daily. After dewatering levels have stabilized, observations frequency may be reduced as approved.
 4. Submit maintenance schedule for piezometers and dewatering system. Record and submit maintenance records for each piezometer and dewatering well or dewatering system component weekly or as approved
 5. Provide drill logs and installation details of all dewatering system components, and piezometers, 24-hours after installation.

1.04 JOB CONDITIONS:

- A. Subsurface Conditions:
 1. Reports of subsurface investigations are available as listed in the General Requirements.
- B. Permits:
 1. Prior to discharging water, obtain permit from jurisdictional agency.
 - a. District of Columbia: The Contractor shall obtain a temporary discharge permit from the Department of Health, Environmental Health Administration, prior to any dewatering at the construction site.
 2. Control discharge of water in accordance with the General Requirements, if specified.
- C. Responsibilities:
 1. Design and install dewatering system to accomplish groundwater control as specified.
 2. Monitor, and report as required, discharge from dewatering system to determine if water quality meets the requirements of jurisdictional agency. Modify dewatering system as necessary to meet the requirements of jurisdictional agency.
 3. Measure to determine if movement occurs in adjacent areas by dewatering operations; take approved measures to minimize movement and prevent damage to affected properties, buildings, structures, utilities or facilities. Establish criteria for acceptable tolerances.
 4. Take measures to prevent damage to properties, buildings, structures, utilities and facilities resulting from groundwater pumping.
 5. Modify system if it causes, or threatens to cause, damage to properties, buildings, structures, utilities or facilities.
 6. Repair as approved, damage, disruption or interference to properties, buildings, structures, utilities or facilities resulting from dewatering operations.
 7. Information Drawings may designate locations where lowering of groundwater will not be permitted.
 8. Locations of dewatering system elements and piezometers may be adjusted in field to suit job conditions, as approved.
 9. Operate dewatering system without interruption until directed otherwise.

PART 2- PRODUCTS

2.01 PIEZOMETERS:

- A. See Soil & Geological Standard Drawing Piezometer Details as shown.
- B. Piezometer construction shall use ASTM-specified materials and procedures (D2466, D1785, and D2564) .

PART 3 - EXECUTION

3.01 SURFACE DRAINAGE:

- A. Intercept and divert surface drainage away from excavations, piezometers and dewatering wells by use of dikes, curb walls, ditches, pipes, sumps or other means.
- B. Design surface drainage systems to prevent erosion.
- C. Remove surface drainage system when no longer required.
- D. Remove debris and restore site to original conditions.

3.02 DRAINAGE OF EXCAVATED AREAS:

- A. Provide and maintain ditches of adequate size to collect surface and subsurface water and divert it into sump for draining or pumping into channels or storm sewers, as approved.
- B. Install settling basins, tanks or other approved apparatus as necessary to bring the discharge into compliance with permit requirements.
- C. When no longer necessary, backfill and seal drainage ditches, sumps and settling basins with approved material.

3.03 DEWATERING:

- A. Coordinate dewatering installation to prevent conflict with other construction activities.
- B. Install dewatering system in accordance with approved drawings and procedures. If site conditions require modification of the dewatering system, implement modifications to achieve specified design criteria prior to excavation.
- C. Demonstrate by approved methods that discharged sand content from each well meets the design criteria specified above under Quality Assurance.
- D. Discharge subsurface water clear of the work area.
- E. Maintain continuous and complete effectiveness of the installation through regularly scheduled maintenance of well screens, pumps, piezometers, electrical and piping systems.
- F. Maintain water level so that no damage to structure can occur.

- G. During backfill operations, the extent of dewatering may be reduced when approved, provided water level does not result in uplift pressure in excess of 80 percent of downward pressure produced by weight of structure and backfill in place.

3.04 PIEZOMETERS:

- A. Prior to dewatering operations, install piezometers at locations shown or as approved and to the depths shown or approved.
- B. Verify installed piezometer tip elevation. Reinstall piezometers which do not comply with requirements at no additional cost to the Authority.
- C. 48 hours after completion of each piezometer installation, prove proper functioning of piezometer by performing Falling Head Tests. Submit test records within 24 hours of test completion.
- D. While dewatering system is in operation, prove continued proper functioning of each piezometer by performing rising head tests. Submit test records within 24 hours of test completion.
- E. Take static water level readings prior to energizing dewatering system. Submit water level readings within 24 hours of observation.
- F. Operate dewatering system so that groundwater level in piezometers is maintained continuously within prescribed limits.
- G. Protect and maintain piezometers in good operating condition until completion of Contract.
- H. Replace promptly any piezometer or dewatering well that is damaged or destroyed.
- I. Terminate piezometer readings when approved.

3.05 Not Used

3.06 SYSTEM TO BE REMOVED:

- A. Upon completion of Contract, remove piezometers and well casings, unless otherwise specified, to a depth of two feet minimum below ground surface.
- B. Backfill voids, well and piezometer casings with bentonite-cement grout.
- C. Backfill remaining space with compacted earth and restore ground surface to its original condition.

END OF SECTION

SECTION 02260

SUPPORT OF EXCAVATION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies support for cut-and-cover, open-cut excavation, trench excavation and shafts.
- B. Related Work Specified Elsewhere:
 - 1. Grading, excavating and backfilling: Section 02320.
 - 2. Maintenance, support and restoration of utility facilities: Section 02270.
 - 3. Concrete reinforcement: Section 03200.
 - 4. Cast-in-place structural concrete: Section 03300.
 - 5. Steel bars, steel strand, anchorages, couplings for ground anchors, grout: Section 03415.
 - 6. Structural steel: Section 05120.
 - 7. Grounding and bonding of soldier piles: Section 16060.
- C. Contractor's Options:
 - 1. System of support to consist of soldier piles and lagging, sheet-piling or slurry-trench concrete walls, secured in place by means of bracing members such as wales, struts, shores and ground anchors. Other methods of support permitted only when approved.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standard and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. API: 13A, 13B-1.
 - 3. ASTM: A36, A709, A722.
 - 4. EPA.
- B. Design Criteria:
 - 1. Design support of excavation in accordance with design criteria shown and specified. Criteria are the minimum acceptable.
 - 2. Design component members of system to support temporary decking system, earth and rock pressures, unrelieved hydrostatic pressures, utility loads, applicable traffic and construction loads and other surcharge loads. Use loading combinations shown. Prepare design for staged removal of bracing to suit sequence of concrete placement.
 - 3. Design support system for nonpenetration of station and entrance surfaces visible to public. Temporary penetration permitted only where location of penetration is eventually to be hidden by elements such as acoustical panels or similar items.
 - 4. Design sheeting and bracing for sides of excavations for underground structures in a manner permitting safe and expeditious construction of permanent structures, minimizing movement or settlement of the ground and preventing damage to adjacent buildings, structures and utility facilities. Locate and design the bracing system such that it will not interfere with the reinforcement and construction of the permanent structure.
 - 5. For support systems in which struts are installed between opposite sides of the excavation, design and construct support of both sides to obtain comparable rigidity.

6. Choose location of soldier piles to allow for expected deviations from true line during driving procedure without encroaching on future permanent structures.
7. Approval of Contractor's plans and methods of construction does not relieve the Contractor of the responsibility for adequacy of support.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Working Drawings:

1. Details, arrangement and method of assembly of proposed system, including construction sequence.
2. Method of preloading and bracing.
3. Elevations and sections showing full excavation depth from top grade to bottom of soldier piles or subgrade, whichever is deeper.
4. Loads for various stages of bracing removal and concrete placement.
5. Anticipated equipment load.
6. Maximum design load to be carried by various members of support system and preloads.
7. Depths below main excavation to which support system will be installed.
8. Methods of resolving difficulties arising from misalignment of soldier piles exposed during excavation and criteria for implementation of those procedures.
9. Methods of controlling and monitoring vibrations caused by driving of soldier piles to prevent damage to structures and utility facilities.
10. If proposed support system includes tieback anchors, show geologic profile or section for which each anchor is intended, design load for full depth of the excavation, maximum design and proof load and criteria proposed for deformations under proof loads.
11. Ground anchors and rock bolts:
 - a. Prior to starting work, submit support system tieback and rock bolt details including design calculations, installation and load test procedures, grouting materials, grouting methods and detailed working drawings of the proposed rock bolt system.
 - b. Show geologic profile or section for which each ground anchor or rock bolt is intended and design load of ground anchor and rock bolt for full excavation condition.
12. Include design calculations and maximum theoretical deflections of support members.
 - a. The maximum allowable deflections of support members are as follows:

Soldier beams	1/2-inch
Walers	1/4-inch

This does not include the movement of support due to creep in tieback.
13. Include existing utility facilities. After checking their locations by field investigations, revise drawings to show actual locations of facilities, location of excavation supports, interference with proposed work and measures proposed to overcome such interferences.

B. Documentation:

1. Where proposed system of tieback anchors or rock bolts projects beyond vertical projection of property lines shown onto adjoining property, obtain permission of owner in writing.
2. Submit copies of permits with drawings.
3. Calculations:
 - a. Design calculations as applicable.

- b. Do not proceed with work prior to approval.

1.04 JOB CONDITIONS:

- A. Provision for Contingencies:
 - 1. Monitor performance of components of support system, both vertical and horizontal movement in accordance with Section 02291, at regular intervals not to exceed three days.
 - 2. Provide contingency plan or alternative procedures to be implemented if unfavorable performance is evidenced.
 - 3. Keep on hand materials and equipment necessary to implement contingency plan.
- B. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to utility owner.
- C. If existing utility facilities interfere with proposed method of support, modify or relocate such facilities with the approval of the appropriate utility owner. If relocation of the utility is not possible, obtain Engineer's approval for field changes to the approved support scheme of the excavation.
- D. Do not splice elements of support system unless approved.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Steel Sheet Piles: Continuous interlocking type with cross section selected for intended use.
- B. Cast-In-Place Structural Concrete: Section 03300, Class 3500 unless otherwise shown.
- C. Timber Lagging: Structural grade, minimum allowable flexural stress of 1,100 psi.
- D. Concrete Reinforcement: Section 03200.
- E. Structural Steel: Section 05120; ASTM A36 or ASTM A709, Grade 36, minimum.
- F. Rock Bolts: Section 02420.
- G. Ground Anchors:
 - 1. Steel bars: ASTM A722 and Section 03415.
 - 2. Steel strand: Section 03415.
- H. Anchorages and Couplings for Ground Anchors: Section 03415.
- I. Grout: Section 03415.
- J. Bentonite Powder: API 13A.
- K. Other Materials: Those best suited for intended use, and as approved.

2.02 MIXES:

- A. Lean Concrete: Portland cement and mineral or soil aggregate proportioned so that concrete retains its shape during excavation operations.

- B. Concrete for Slurry Trench Walls:
 - 1. Tremie concrete of 3500 psi strength or higher if necessitated by design, with the following additional requirements:
 - a. Minimum cement factor: Seven bags per cubic yard.
 - b. Water-cement ratio: As necessary for strength and durability.
 - c. Sand proportion: As necessary to produce optimum results.
 - d. Rounded gravel aggregate: 1-1/2 inch maximum.
 - e. Slump: Six inches plus-or-minus one inch.
 - f. With water-reducing or fluidizing agents as necessary.
 - 2. Submit mix design for approval.
- C. Bentonite Slurry:
 - 1. Stable suspension of powdered bentonite, or equal, and natural silts and clays in water.
 - 2. Density: 64 pcf minimum, 85 pcf maximum.
 - 3. Marsh funnel flow rate: 40 seconds minimum, 80 seconds maximum viscosity.
 - 4. Fluid loss: 25-cc maximum in 30 minutes.
 - 5. pH: 7.0 to 11.0
 - 6. Shear strength:
 - a. By shearometer: 1.4 to 10 N/M.
 - b. By fan viscometer: 4.0 to 400 N/M.

PART 3 - EXECUTION

3.01 SHEETING, SHORING AND PILING:

- A. Install soldier piles by driving, preboring or other pre-excitation methods. Drive soldier piles only in those areas where shown or approved. Install piles vertically within tolerance of one foot per each 100 feet for full depth of each pile.
- B. Where piles are installed by preboring or other pre-excitation methods, take appropriate measures to stabilize excavation to preclude loss of ground.
- C. Provide prebored holes for soldier piles adequate to accommodate pile section shown on approved working drawings. Extend hole to necessary depth below top of subgrade.
- D. Carry bottom of support system to depth below main excavation, adequate to prevent lateral movement. In areas where additional excavation is required below main excavation subgrade, make provisions to prevent movement of main excavation supports.
- E. Multiple-Layered Horizontal Bracing:
 - 1. At locations where top of weathered bedrock is above the subgrade of main excavation, install soldier piles so that tips are at least two feet below top of subgrade.
 - 2. At locations where top of weathered bedrock is five feet or more below subgrade of main excavation, install soldier piles so that lower tip is at least five feet below bottom of excavation.
 - 3. If weathered bedrock is encountered at elevation between subgrade elevation and five feet below subgrade, install soldier piles so that lower tip is five feet below subgrade or two feet into rock, whichever is higher.
- F. After seating soldier piles in pre-excavated holes, encase piles with Class 3500 concrete up to lowest point of excavation adjacent to pile location. Fill remainder of hole with lean concrete, completely encasing pile.

- G. Use timber lagging, steel sheeting or precast reinforced concrete members secured in place for sheeting of excavations.
- H. Follow excavation closely with placement of sheeting and lagging. Do not allow maximum height of unsheeted or unlagged face of excavation to exceed five feet in rock or predominantly clayey soils and three feet in sandy soils.
- I. Do not permit height of unlagged face to exceed 15 inches if water flows from face of excavation or if soil in face moves toward excavation area.
- J. Carefully perform excavation for installation of sheeting to minimize formation of voids. Separate sheeting members only to extent necessary to permit packing behind them.
- K. Pack behind sheeting as installation progresses to establish tight contact between excavation face and sheeting. Pack openings between sheeting members with straw or other suitable material to allow free drainage of water without loss of soil or sand packing.
- L. If unstable material is encountered during excavation, take suitable measures to contain it in place and prevent ground displacement which may cause damage.
- M. Maintain sufficient quantity of material on hand for sheeting, shoring, bracing and other operations for protection of work and for use in case of accident or emergency.
- N. Support System For Vertical Shafts Which Penetrate Soil/Rock Interface:
 - 1. Soldier piles:
 - a. If shaft excavation is supported by soldier piles, locate piling at least five feet in a horizontal direction from outer face of shaft wall. Install lower tip of piling at least ten feet below top of unweathered bedrock.
 - b. Procedure for establishing tip elevations:
 - 1) Make three pilot core borings at equal spacing along soldier pile line. Borings may be washed through overburden, but must be cored through bedrock to a depth of 20 feet into unweathered rock as determined by the Engineer. Advance holes in rock by rotary drilling methods and recover 2-1/8 inch diameter (NX) size rock cores using Series M double-tube core barrel. Drill in conformance to applicable portions of Section 02431. Place cores in wooden boxes as specified in Section 02431 and deliver to storage site as directed.
 - 2) Install soldier piles to obtain tip elevations established by the Engineer's examination of coring results.
 - 3) For shafts where pilot core borings indicate top of unweathered bedrock varies by more than three feet in elevation, set tips of soldier piles at least ten feet below lowest point of top of unweathered bedrock.
 - 4) In drilling soldier pile holes; use equipment capable of penetrating hard igneous and metamorphic rock that has an average unconfined compressive strength of six to eight kips per square inch and that may reach even greater values in some locations.
 - 2. Ring beams and lagging or liner plate:
 - a. If shaft excavation is supported by ring beams or liner plates, install rings or liner plate to at least ten feet below average elevation of top of unweathered bedrock, which will be determined by the Engineer from examination of the rock in the advancing excavation.

3.02 SLURRY WALLS:

- A. Slurry Trench Equipment:
1. Use equipment capable of removing from trench foreign materials embedded in soil as well as natural materials, including boulders, where necessary. Arrange equipment to permit free vertical passage of slurry within trench and to prevent development of suction or pressure.
 2. Furnish trench inspection tools adequate to ensure that trench has been excavated to dimensions shown on approved working drawings and that cuttings and foreign material have been removed.
 3. Use slurry mixing equipment capable of producing, with mechanical agitation, a stable suspension of bentonite and water. Transport slurry to panels by temporary pipe line or other approved methods.
 4. Furnish slurry circulation equipment to provide circulation and agitation of the slurry throughout full depth of excavated panels. Do not agitate slurry by air
 5. Use slurry reclaiming equipment which will remove detrimental quantities of excavated material from slurry to ensure use of clean slurry in trenches. Recirculate reclaimed slurry to trenches in a continuous operation regardless of slurry density. Monitor slurry and control its capability of retaining solid particles in suspension.
- B. Field Quality Control:
1. Make tests on samples of in-place slurry to determine density, viscosity, filtration and sand content in accordance with API 13B-1.
 2. Maintain quality of bentonite slurry compatible with soil characteristics of trench walls.
- C. Construction:
1. Perform preparatory work to discover, protect, maintain, relocate and restore utility facilities and other obstructions in vicinity of slurry walls.
 2. Construct slurry trench walls by displacement of bentonite slurry with tremie concrete.
 3. Construct walls of reinforced concrete or plain concrete embedded with structural steel. Where soldier piles are used in construction of walls, it is permissible to consider piles as reinforcement.
 4. Provide sufficient embedment of walls below subgrade of excavation to prevent loss of ground due to piping under wall or lateral movement of wall.
 5. Use construction methods ensuring that slurry materials employed during trench excavation and placing of tremie concrete are contained and controlled to prevent leakage and spillage of slurry and excavated materials into basements, vaults, utilities and other facilities.
 6. Excavate slurry wall trenches in panels of width and depth shown on approved working drawings with maximum panel length of 18 feet. Reduce panel length when excavating adjacent to facilities sensitive to settlement.
 7. Maintain level of slurry in panels no more than five feet below top of trench during excavation operations and until tremie placement is essentially completed.
 8. Progress construction with no less than one unexcavated panel and one tremie-filled panel with concrete cured at least 72 hours, between two slurry panels under active excavation.
 9. Keep slurry circulated or agitated during drilling and excavating and immediately prior to concreting. Continuously maintain slurry requirements even during nonworking periods and stoppages. If stoppage occurs in the operation causing slurry in panel to remain uncirculated and unagitated for more than 24 hours, backfill panel until operation can be resumed.
 10. Place concrete by tremie methods either by gravity flow or by pumping. As soon as possible after placement of concrete is commenced, position bottom of pipe not less than five feet below upper surface of concrete being placed and maintain it in this position throughout operation. Equip tremie pipe with bottom valve or other device

to prevent mixing of slurry with concrete inside tremie pipe. Aluminum pipe is prohibited.

11. Inspect trenching in the presence of the Engineer prior to concreting. Ensure that settled cuttings and excavated material have been removed.
12. Start placement of concrete in panels within 12 hours after completion of panel excavation and proceed continuously until concreting is completed.
13. When wales are used, obtain tight bearing between wales and wall and ample bearing area with wedges and dry pack for load transfer.
14. Preload braces at each level to computed maximum compressive force to be encountered at that level. Base calculations of this computed force upon pressure diagrams shown. Take into consideration increased strut loads that may develop because of removal of bracing as structure is built.
15. Accomplish preloading by approved procedures. Transfer load by jacking applied symmetrically to braces without introducing eccentricity.
16. Introduce jacking load into braces immediately after each tier of braces has been installed and before excavation has progressed more than two feet below bottom of bracing tier. Make provision to fix preload into each brace by shim plates, wedges, blocking or other approved device.
17. After concrete invert slab has been placed and attains sufficient strength to receive loads from slurry walls, remove tiers of bracing above invert level, provided the following conditions exist:
 - a. Remaining tiers are capable of resisting total load calculated from trapezoidal pressure diagrams shown.
 - b. Calculated deflection of the walls between tiers of bracing, assuming forces indicated by the trapezoidal pressure diagrams, does not exceed 1/2 inch.
18. Construct tight joints between adjacent pours of concrete in slurry wall to minimize loss of fines from retained earth. Take necessary care to accomplish this in terms of properly excavating trench and cleaning abutting face of hardened concrete or surfaces of structural members if used. Provide approved method of water stopping.
19. Seal leaks encountered in walls as excavation progresses, if leaks are of sufficient size to permit penetration of fines and loss of ground. Procedures may include grouting outside or through wall.
20. Dispose of unsuitable excavated material and debris in accordance with Section 02320.
21. Dispose of slurry waste offsite by means of sealed tanks and in accordance with EPA regulations.

3.03 PRIMARY SUPPORT:

- A. Use wales, struts, tieback anchors and rock anchors as necessary to provide primary support of excavation faces retained by soldier piles, sheeting, sheet piles or concrete slurry walls. For excavation depths greater than eight feet, primary support or supports are required.
- B. Provide struts with intermediate bracing as needed to enable them to carry maximum design load without distortion or buckling.
- C. Provide diagonal bracing as needed to maintain stability of system.
- D. Include web stiffeners, plates or angles as needed to prevent rotation, crippling or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.
- E. Install and maintain primary support members in tight contact with each other and with surface being supported.

- F. Design primary support members to support maximum loads occurring during excavation or removal stages.
- G. Preloading:
 - 1. Except for ground anchors and slurry wall bracing, preload primary bracing members including struts, shores, wales carrying axial load, and similar members at installation to 50 percent of design load, which for this purpose is maximum load that bracing member will have to carry. Preload tiebacks and slurry walls as specified for those installations.
 - 2. Use procedures that produce uniform loading of bracing member without appreciable eccentricities or overstressing and distortion of members of wall system.
 - 3. Make provisions for permanently fixing load in each member using steel shims or wedges welded into place.
 - 4. Accomplish preloading by jacking support in place against soldier piles or wales.
 - 5. Do not use wooden wedges to preload bracing member.
 - 6. Include in preloading system means to determine within five percent amount of preload induced into bracing members.
- H. If decking beams are not required or if decking beams are not designed for support of excavation loads, install uppermost tier of bracing at vertical distance of not more than six feet below top of excavation.
- I. Install tiers of primary support with no greater vertical distance between them than 16 feet
- J. Reduce maximum vertical distance to 12 feet at locations where ground movement and settlement must be minimized to prevent damage, where shown and as directed.
- K. Excavate to no more than two feet below point of support about to be placed. Install support and preload immediately after installation and prior to continuing excavation.

3.04 SUPPORT SYSTEM WITH TIEBACKS:

- A. Install tieback system in accordance with approved working drawings. Install anchorage in soil no closer than a plane extending upward at an angle of 45 degrees to the horizontal from outer limit of lowest depth of excavation.
- B. Stress tiebacks to proof loads equal to 140 percent of maximum design load and maintain proof load for 30 minutes prior to reducing to design load. Reject tiebacks which lose more than five percent of proof load during 30-minute period.
- C. Apply proof loads in increments of five tons at one-minute intervals and provide means to measure load application within accuracy of plus-or-minus five percent.
- D. After reducing tieback load to design load, encase anchors in grout maintaining design load until anchors are fixed in place.
- E. In transfer of loads from jacks to support system, use fixation method which will limit load loss to no more than five percent of design load.
- F. Provide and maintain convenient access and appropriate means to accomplish these observations.
- G. Preliminary And Creep Tests On Tiebacks:
 - 1. Reapply proof loads equal to 140 percent of design load at each level of support in excavation on first installation on each side of excavation at horizontal intervals not

- exceeding 500 feet and wherever there is significant difference in soil in which tiebacks are installed.
2. As specified for proof loading, apply proof loads in increments of five tons at one-minute intervals. Provide means to measure load applications with an accuracy of plus-or-minus five percent of design load. Maintain proof load for 24 hours prior to reducing it to design load.
 3. Make records of axial movement with incremental applications of load as well as amount and time of load fall-off with no pumping of jack or axial movement during 24-hour period that proof load on tieback is maintained. If during 24-hour period axial deformation of tieback system exceeds 0.02 inch or decrease in jack pressure without pumping is more than five percent after correcting for temperature changes during the test period, redesign tieback system to satisfy requirements.
- H. Rock Bolts:
1. Tension rock bolts to their design load as approved to permit checking of each loading by the Engineer.
 2. If grouted rock bolts are used, after loading has been approved, pressure-grout each permanent rock bolt in place using methods and equipment which will ensure elimination of air from bolt hole.
 3. If fully resin-encapsulated bolts are used, use slow-setting resin to allow Engineer sufficient time to approve loading prior to gelation.
- I. Vertical Support System With Tiebacks:
1. Install piles or other vertical support system members incorporated in a system utilizing tiebacks so that they are capable of resisting vertical components of tieback loads without significant settlement during excavation and construction.
 2. Install vertical support members so that settlements will not be caused by construction. In general, install members to be end bearing in stratum below maximum depth of excavation and capable of carrying total vertical loads without assistance of skin friction at depth of excavation.

3.05 LAGGING:

- A. Unless otherwise shown or specified, provide timber lagging of three inches minimum thickness where it spans soldier piles placed at distances five to seven feet on centers and for excavation depths up to 25 feet. Increase minimum lagging thickness to four inches for excavation below 25 feet in depth.
- B. For other conditions and types of lagging, submit design details for approval.

3.06 TRENCH EXCAVATION:

- A. Perform sheeting, shoring and bracing for trench excavation for utility facilities and other purposes in accordance with specified safety requirements.
- B. Provide sheeting, shoring and bracing for trench excavation in subgrade of subway excavation to prevent movement of main excavation support system.

3.07 SUPPORT OF EXCAVATION AT INTERFACES:

- A. Design, construct, maintain and remove all or parts of support system at limits of the Contract at interface with the Authority's adjacent contracts, as may be necessitated by construction schedules and sequence of operations of respective contracts.

- B. In the event excavation is commenced at an interface prior to the commencement of excavation on adjacent contract, design, construct and maintain end support system making provisions as follows:
 - 1. Install near face of cofferdam on line separating contracts. Allow no part of support system to project into the next contract except thickness of supporting wall, e.g. soldier piles and lagging, and tiebacks if approved.
 - 2. Provide support system adequate to support backfill and restoration loads with installation of a reasonable bracing system by adjacent contractor during excavation for his contract.
 - 3. Design and construct support system so that it will be supported against vertical settlement when adjacent contractor removes lower portion of the cofferdam to effect connection of structures at juncture of two contracts.

- C. If excavation has commenced on adjacent contract at interface prior to excavation on this Contract, make provisions as follows:
 - 1. Coordinate removal of such portions of cofferdam which have been installed in adjacent contract and support and maintain remainder as necessary to effect juncture of contracts.

3.08 FIELD QUALITY CONTROL:

- A. Tests:
 - 1. Where system of tiebacks or rock bolts is proposed in conjunction with or in lieu of struts, bracing and shores, undertake approved number of on-site tests to demonstrate adequacy of tiebacks or rock bolts for typical subsurface conditions.
 - 2. Conduct tests and obtain approval prior to use of tieback system for excavation support.
 - 3. The Engineer may furnish and install certain instruments to monitor performance of tieback or rock-bolt system.

- B. Remove components of support system which inadvertently penetrate or encroach on permanent structure without endangering stability of support.

- C. Welding: In accordance with Section 05120.

3.09 REMOVAL OF SUPPORTING SYSTEM:

- A. When removing support of excavation system, wholly or in part, do not disturb or damage adjacent buildings, structures, construction or utility facilities. Fill voids immediately with lean concrete or with approved backfill compacted to density specified in Section 02320.

- B. During strut removal stages, design soldier piles or slurry walls for increased vertical spacing of supports. For the removal of the first level support immediately above the invert slab, the slab can be considered a support for the soldier piles or slurry walls if it is poured directly against the sheeting and shoring and the invert slab is in place for at least 48 hours and is adequate to safely support the support of excavation, adjacent structures and the works. Leave support immediately above top of intermediate structure element, such as walls, slabs, or other horizontal members, until they are placed and are in place for at least seven days and are adequate to carry the loads from the support of excavation and other loads imposed on them. Leave support immediately above top of roof slabs of structure in place for at least seven days after placement of roof slab concrete.

- C. Remove other supports above roof structure only after backfill has been placed and compacted to required density to within three feet of bottom of support.

- D. Except as specified below, remove supporting system to a depth of six feet below surface. Remove supporting systems of intersections of streets and at temporary access ramps to a depth of eight feet.
- E. Where top of Authority structure extends into six-foot or eight-foot limit, remove adjacent supporting systems to a depth flush with top of the Authority structure or one-foot below surface, whichever is greater. Increase removal depths where necessary to accomplish work in this Contract.
- F. Remove material of supporting system from site immediately.

END OF SECTION

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SECTION 02270

MAINTENANCE, SUPPORT AND RESTORATION OF UTILITY FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies protecting, supporting, maintaining and reconstructing existing utility facilities affected by construction, including but not limited to the following:
1. Storm, sanitary and combined sewer facilities.
 2. Water distribution and service
 3. Gas distribution and services.
 4. Electric light and power facilities and services.
 5. Telephone, telegraph and GSA communication facilities and services.
 6. Police and fire alarm systems.
- B. Related Work Specified Elsewhere:
- | | |
|---------------|--|
| Section 02220 | Demolition |
| Section 02320 | Grading, excavating and backfilling |
| Section 02240 | Dewatering |
| Section 02535 | Sanitary Sewer |
| Section 02635 | Storm Sewer |
| Section 02515 | Water distribution system |
| Section 02205 | Removal and restoration of existing facilities |
| Section 03100 | Concrete |
| Section 03200 | Concrete reinforcement |
| Section 03300 | Concrete: |
- C. Work by Others:
1. Gas distribution and services: Gas company will do its own work.
- D. Definitions:
1. Facility: Utility structures and system components belonging to utility company including service lines which are used to provide service to utility's customers and product which these facilities convey.
 2. Utility: Company, agency, owner or operator of facility concerned.
 3. Abandoned: Use of facilities shown as existing has been discontinued by the owners and operators. Demolish or remove such facilities to the extent they conflict with proposed work.
 4. To be abandoned: Particular facilities will be removed from operation and/or replaced by other facilities after written notice has been received that service is no longer required. Maintain service for as long as required, including temporary support, rerouting, substitution of temporary facilities or other measures, as directed by the Authority Representative. Demolish or remove such facilities to extent they conflict with proposed work.
 5. Maintenance: Ensuring continuous and satisfactory service during construction.
 6. Proposed facility:
 - a. New facility constructed and, if necessary, temporarily supported in place, by the Design-Builder.
 - b. Temporary facility constructed, supported in place and ultimately removed and new facility constructed, by the Design-Builder.
 - c. New facility constructed as part of rapid transit construction.

7. Temporary facility: Facility provided by the Design-Builder in lieu of existing or proposed facility, to ensure continuity of service.
8. Maintain complete-in-place: Support and maintenance in serviceable condition, of existing facilities during construction, which may include constructing permanent support, temporary support or other measures necessary to maintain continuous service of existing facility.
9. Expose and maintain existing cables and replace ducts and manholes: Remove existing duct and manhole structures, construct temporary manholes, place existing cables in split conduits and replace spare ducts with whole conduit. Maintain this system during construction. Reconstruct permanent concrete manholes and encase conduits in concrete as specified. Cables for electric power and telephone facilities shall be exposed, separated and supported under supervision of electric power and telephone companies.
10. Maintain service and replace:
 - a. Construct new facility in same location and support it in place.
 - b. Provide temporary facility and ultimately remove it, and construct permanent replacement facility in its original location.
 - c. Temporarily support original facility and ultimately replace it with new facility.
11. Remove and replace: Remove existing facility without providing temporary replacement and reconstruct new facility in same location during execution of contract.
12. Local Jurisdictional Authority: Agency responsible for acceptance and approval of work on storm, sanitary and water distribution facilities.
13. Salvage: Remove and store material and equipment for reuse in this or other Authority contracts.

1.02 SUBMITTALS

- A. Schedule of Work on Utility Facilities:
 1. Submit to the Utilities and the Authority Representative a detailed sequence of work, with starting and ending dates for each interruption of utility services, and method of coordination for shutoff, capping and continuation of utility services.
 2. Give notice at least two weeks prior to date of intended commencement of operations to parties having surface, subsurface or overhead structures in the construction area. Provide copies of notices to the Authority Representative.
 3. Do not commence work until written approval has been received from the Utility and the Authority Representative.
- B. Record Documents:
 1. Show actual location of existing facilities, interference which these facilities present to new work, proposed method of proceeding with actual construction and details of proposed support systems.
 2. Show actual location of settlement measurement points for facilities as indicated on the drawings. Submit copies of readings and measurements within 24 hours after such readings are taken.
 3. Prior to construction, submit two copies of records of inspection of sewers, one copy to local jurisdictional authority and one copy to the Authority Representative. On completion of tunneling and cut-and-cover and prior to paving or other construction over sewers, submit to local jurisdictional authority and the Authority Representative one copy each of the inspection records of sewers, including video-tape records of television inspections and coordinated logs, photographs and other records as specified by local jurisdictional authority for visual walk-through inspections. Obtain and submit a written approval and acceptance from local jurisdictional authority of the inspection records of preconstruction and post-construction conditions of affected storm and sanitary sewers.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, and Standards: Comply with codes and regulations of the jurisdictional authorities, published standards of owning utility agency, and ASTM: C136.
- B. Inspection Of Sewers:
 - 1. Employ a sewer inspection company which has been regularly engaged in television sewer inspections and which is acceptable to local jurisdictional authority to perform preconstruction and post-construction inspections of sewers 36 inches and smaller in diameter. Submit to Local jurisdictional authority for prior approval one sample of the cassettes to be used.
 - 2. Conduct preconstruction and post-construction inspections under conditions as nearly identical as practical and using the same company.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate with utilities who are furnishing materials for the work to determine availability, locations and required methods of storage and care of materials prior to incorporation into the work.
- B. Transport store and handle materials in accordance with the requirements of the utilities.

1.05 PROJECT CONDITIONS:

- A. Existing Facilities:
 - 1. Locations of existing facilities shown are plotted from available records; however, these locations are not guaranteed.
 - 2. Verify by field investigation and "Miss Utility" utility locating service, locations of facilities within and adjacent to limits of project which may be affected by construction operations. Avoid damage or disruption of facilities during operation.
 - 3. Upon encountering existing facility which is not shown or upon ascertaining that facility differs from that shown, determine ownership, use and disposition of such facility and proceed as follows:
 - a. If facility is abandoned or is to be abandoned, perform necessary work for either condition as specified.
 - b. If facility is to remain in service, perform support and restoration work in accordance with these Specifications and the CHANGES article of the General Provisions.
- B. Temporary Service:
 - 1. Do not interrupt facility service to building connections unless permitted in writing by Authority Representative, and then only after arranging to provide temporary service as required..
 - 2. Notify the Authority Representative and the Utility of damage to facilities caused by construction operations. Repair such damage, except that damaged cables will be repaired or replaced only by the Utility.
 - 3. Provide access for inspection of facilities and for emergencies involving utility services as specified in Section 01530.
 - 4. Permit free and clear access to utility personnel for purposes of inspection, maintenance, providing additional service and construction of new facilities.
 - 5. When approved working or shop drawings show temporary facility provided for the Design-Builder's benefit, supply necessary materials and perform necessary work.
 - 6. Pay utility directly if, as an aid to the Design-Builder's construction, the utility performs work not shown.
 - 7. Items supplied by the utility companies are as listed and as shown.

1.06 Coordination:

- A. Establish through the Authority Representative direct and continuous contact with respective utilities and cooperate with them in all phases of the work.
- B. Contact utility early enough to allow them sufficient time to accomplish the work. Give special consideration to lead times required for cable work. Provide schedule of utility relocation to the utility to permit coordination with Authority's construction sequence.
- C. To locate buried telephone cables, call the local telephone company's Buried Cable Location Service at least 48 hours prior to starting excavation.
- D. Comply with printed standards and practices of utilities available from the Authority Representative.
- E. Aerial facilities shown to be relocated by others will be relocated by facility owner. The Design-Builder is responsible for coordinating relocation work with utility owner as far as possible in advance of required time of relocation. A minimum three-month lead time is required by utility owner when facility serves only one utility. When facility to be relocated is shared by more than one utility agency or when a street light is included in the relocation, a minimum four-month lead time is required

PART - PRODUCTS

2.01 MATERIALS:

- A. Refer to individual Division 2 Storm, Combined And Sanitary Sewer, Water Distribution and Services, Ducts and Manholes Sections for pipe, tubing, fittings and appurtenances, and for joining and installation methods.
- B. Refer to individual Division 3 Concrete and Reinforcement Sections for materials and installation methods.
- C. Sand Backfill Around High Voltage Conduits And Pipes:
 - 1. Thermal Resistivity Value (RHO) of not more than 70 and the following sieve analysis when tested in accordance with ASTM C136:

Sieve Size	Percent Passing
4	94 - 100
8	80 - 90
16	60 - 80
30	35 - 60
50	31 - 35
100	3 - 13
200	1 - 5

- 2. The power company, through the Authority Representative, will inform the Design-Builder of approved sources for this material.

PART 3 - EXECUTION

3.01 Salvage:

- A. Salvage and clean material shown to be salvaged.
- B. Maintain adequate records and storage facilities for salvaged items as specified in the General Requirements. Make available for inspection a detailed record including signed vouchers and receipts.
- C. Reuse salvaged items after inspection and approval for reuse has been given by the Utility
- D. Return salvaged materials which are not reused to the Utility.

3.02 SETTLEMENT OR MOVEMENT:

- A. Where settlement or movement monitoring system is shown, comply with the following:
 - 1. Provide series of settlement measurement points along each facility and make regular readings to detect movements.
 - 2. Use approved painted marks, metal marker plugs or pins as settlement measurement points.
 - 3. Prior to subsurface work, make initial survey to establish elevations of installed settlement measurement points utilizing permanent, established bench marks outside 100-foot line.
 - 4. Take readings weekly on settlement points until completion of this Contract. Take readings daily during work which may affect facilities.
 - 5. Make readings to an accuracy of 0.01 foot.
 - 6. Take immediate remedial measures to correct conditions causing settlement or other movement and to repair damages thus caused.

3.03 EXCAVATION AND BACKFILLING OF UTILITY TRENCHES:

- A. Excavate and backfill utility facility trenches in accordance with Sections 02320 and 02240.
- B. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to facility owner.

3.04 SURFACE RESTORATION:

- A. Remove pavements, sidewalks, lawns, landscaping, curbs and gutters where necessitated by utility trenches in accordance with Section 02220.
- B. Replace pavements, sidewalks, curbs and gutters in accordance with Section 02205.
- C. Place temporary pavements where necessitated by sequence of operations.
- D. Replace lawns and landscaping in accordance with Sections 02920 and 02930.
- E. Provide erosion control measures to prevent erosion or displacement of soils and discharge of sediment bearing water or airborne dust from the site.

3.05 UNSAFE AND UNSUITABLE UTILITY STRUCTURES:

- A. General Requirements:

1. If upon exposure, condition or location of facility to be supported in place is found to be unsafe for maintenance or support, replace or reconstruct facility as required after receiving prior approval of the Authority Representative and Utility Owner.
 2. Maintain continuity of existing utility facilities. Protect, support, relocate and reconstruct such facilities, regardless of jurisdictional control.
- B. Electric, Communication and Similar Type Facilities:
1. If structures containing electrical, communication and similar types of cables shown to be maintained complete in place are found upon exposure to be incapable of being maintained in place because of condition, location or both, replace such structures with timber enclosures or split ducts after prior approval of the Authority Representative and the utility owner.
 2. When service box, manhole or conduit structure containing electrical or communication cables is broken away, replace it immediately with temporary structure having facilities for racking and supporting cables equivalent to existing facilities.
 3. Exercise care when working in vicinity of telephone structures containing coaxial cable which cannot withstand movement.
 4. Give timber enclosures one interior and one exterior coat of fire-retardant paint of type specified by owners and operators.
 5. Replace temporary timber enclosures with permanent structures in accordance with details shown and restore facilities to the satisfaction of the Authority Representative and utilities prior to completion of work. Remove materials of temporary nature after completion of permanent installation.
- C. Procedures for payment of costs of work on unsafe and unsuitable utility structures are governed by the CHANGES article of the General Provisions.

END OF SECTION

SECTION 02320

GRADING, EXCAVATING AND BACKFILLING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies grading, excavating and backfilling for structures and utility facilities.
- B. Related Work Specified Elsewhere:
- | | |
|---------------|--|
| Section 02220 | Removal of existing construction and facilities |
| Section 02230 | Clearing and grubbing |
| Section 02240 | Dewatering |
| Section 02270 | Maintenance, support and restoration of utility facilities |
- C. Definitions:
1. Grading: Shaping earth and rock through the removal or filling of earth and rock materials.
 2. Earth Excavation: Excavation of materials of whatever nature, except rock as defined below.
 3. Rock Excavation: Excavation of material in place which cannot be loosened or broken down by ripping using earth excavating equipment and which requires blasting or rock excavating equipment for its removal.
 4. Approved Material: Earth which meets specified measurable requirements for use as embankment, fill or backfill.
 5. Surplus Excavated Material: Approved excavated material which is not used in embankments or as fill on site.
 6. Unsuitable Material: Material which does not meet specified requirements for use in situ or as embankment, fill or backfill and is prohibited for use in the work.
 7. Authorized Excavation: Excavating to neat lines and limits shown and specified; excavating unsuitable material.
 8. Unauthorized Excavation: Excavating materials which would otherwise be left in place; excavation which is not specified as authorized excavation, such as excavation beyond neat lines and bottoms of footings as shown.
 9. Excess Excavation: Excavating materials beyond or below cross section shown, as well as unavoidable over breakage in rock.
 10. Controlled Low Strength Materials (CLSM): Fill.
- B. Salvage:
1. Materials shown to be salvaged in accordance with Section 02205 and the General Requirements.

1.01 1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and the additional requirements as specified for each:

- A. Samples:
1. Submit sample 21 days in advance of desired date of approval. Two one-cubic-foot samples are required of each material proposed for fill, backfill and embankments.

2. Obtain, identify and ship soil and aggregate samples in accordance with ASTM D75.
- B. Documentation:
1. Permits for disposal of excavated material:
 - a. Obtain written permits and releases from owners of property where material will be deposited.
 - b. Each permit and release from each property owner will absolve the Authority from responsibility in connection with such disposal of the material.
 2. Not Used
 3. Plan for tunneling or jacking of utility facilities:
 - a. Location: Under active yard tracks.
 - b. Prior to tunneling or jacking, submit a tunneling plan.
 - 1) Include in the plan the location of the facility, the method of construction, the types of equipment and the procedures proposed.
 - 2) Procedure for field determination of soil bearing capacity, including description of the equipment to be used, and any calibration curves for the various soil types to be encountered, details of field test procedures, forms for reporting of test data/results and details of minimum number of tests required for each footing/base area
- C. Certification:
1. With samples of materials proposed for fill, backfill and embankment, submit certified test reports of tests performed by an approved Independent Testing Agency for all tests required to demonstrate compliance with specified requirements.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. AASHTO: M147.
 3. ASTM: C33, D75 , D698, D2487, D2922, D3017, D4318.

1.04 JOB CONDITIONS:

- A. Existing Drainage:
1. Preserve, protect and maintain existing operable drains and sewers during grading operations.
 2. Keep excavations dry.
- B. Not Used
- C. Accident Prevention and Safety:
1. Perform work in accordance with specified safety requirements and PROTECTIVE DEVICES article of the General Requirements.
- D. Location of Underground Facilities and Structures:
1. Locations shown for utility facilities are approximate.
 2. Utility facility locations and site investigations are listed in the General Requirements.
 3. Contact Miss Utility to have utilities located before beginning excavation.
- E. Toxic and Combustible Substances:
1. During excavation, provide detection and testing equipment and carry out necessary tests to detect the presence of toxic and combustible substances.

2. Take action to safeguard persons and property in accordance with the rules and regulations of the jurisdictional agencies and utility owners.
3. Promptly notify utility owners when problems concerning their facilities become apparent.

F. Ramps:

1. Construct temporary ramps as necessary to provide access to work area.
2. Locate such access ramps in Design-Builder's storage, operations and access areas or within excavation for subway structure and maintain traffic as specified.
3. Support ramp excavation in accordance with Section 02260.
4. When ramps are in use, station flag persons equipped with red flags at ramp entrances to keep unauthorized vehicles or persons from entering work area.
5. When work necessitating entrance or exit of vehicles via ramps is not being performed, protect entrances and exits of ramps by warning signs, barricades and fences in accordance with the General Requirements.
6. Upon completion of the work needing ramps, remove the ramps and backfill excavated ramp areas, if necessary.

G. Excavation Near Buildings:

1. Control excavation in areas near buildings or structures to maintain stability of buildings or structures. If underpinning is necessary, perform excavation work so that condition of surrounding area remains unimpaired.

PART 2 - PRODUCTS:

2.01 MATERIALS:

A. Embankment, Fill or Backfill Materials:

1. Composition:
 - a. Well-graded soil-aggregate mixture, as defined by ASTM D2487, comprised of stone, gravel, sand, silt, clay or combinations of such materials.
 - b. Prohibited material: Organic matter, debris, cinders and frozen material.
2. Additional requirements:
 - a. Particle size: Four inches maximum, but not exceeding one inch within one foot of finished grade.
 - b. Liquid limit: Forty maximum, determined in accordance with ASTM D4318.
 - c. Plasticity index: Ten maximum, determined in accordance with ASTM D4318.
 - d. Maximum dry density: Not less than 100 pounds per cubic foot.

B. Select Material: AASHTO M147, with the following gradation requirements:

Sieve Designation	Percentage Passing By Weight
Two inch	100
One inch	70 - 95
3/8 inch	35 - 75
Size 4	25 - 60
Size 10	15 - 45
Size 40	10 - 30
Size 200	0 - 15

C. Pervious Material:

1. Natural, clean, free draining sand conforming to the requirements of ASTM C33 except the following:
 - a. Material passing Size 100 sieve not to exceed eight percent.
 - b. Material passing Size 200 sieve not to exceed five percent.
2. Drainage Material: Clean, crushed, rock, gravel, with 1-1/2 inch maximum particle size and maximum two percent by weight passing Size 4 sieve.
3. Below concrete walks and slabs: ASTM C33, Size No. 67, except maximum two percent by weight passing Size 4 sieve.

D. Impervious Material:

1. Silt-clay material minimum 35 percent by weight passing Size 200 sieve.
2. Plasticity index: 11 minimum, determined in accordance with ASTM D4318

2.02 SOURCE OF MATERIALS:

- A. Use materials for embankment, fill or backfill from this Contract if they meet specified requirements. If sufficient material meeting these requirements is not available from this Contract, obtain material meeting specified requirements.
- B. Use only material whose quality, source and zone of placement in the fill have been approved.
- C. Dress and shape borrow areas provided by the Authority to ensure positive drainage when borrow operations are completed.

PART 3 - EXECUTION

3.01 EQUIPMENT:

- A. Use appropriate equipment in sufficient quantity and sizes to perform the work as specified and shown.

3.02 EARTH EXCAVATION:

- A. Excavate in sequences and stages as specified, and in a manner which will not impair permanent or temporary structures, installations or surfaces.
- B. Excavate to neat lines or set back lines for mixed face conditions and grades shown. If approved, slopes may be flattened as a matter of expediency.
- C. Support sides of excavation.
- D. Protect, support and maintain utility facilities as specified in Section 02270.
- E. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to the facility owner.
- F. Control runoff so that water does not run through excavation area. Keep excavation free of water.
- G. Remove excavated materials to fill, embankment, stockpile or disposal locations. Keep haul routes clean in accordance with the General Requirements.
- H. Fill excess excavations with approved materials and compact as specified.
- I. Unauthorized excavation for the purpose of obtaining materials for resale or for use at another job site is prohibited unless otherwise approved by the Authority Representative.

3.03 ROCK EXCAVATION:

- A. Perform rock excavation to neat lines shown and so as to produce surfaces free of loose rock.
- B. Not Used
- C. Not Used
- D. Not Used
- E. Not Used
- F. Remove excavated rock to approved fill locations or disposal locations.
- G. Fill excess excavation with concrete or other approved material.
- H. Not Used

3.04 REMOVAL OF SUBSURFACE OBSTRUCTIONS:

- A. Permanent Closure walls:

- B. Prior to removal of parts of vaults or areaways which extend into Contract limits, build permanent closure walls where shown in such vaults or areaways to separate areas to be left intact from areas to be removed.
 - 1. Obtain the Authority Representative's approval of permanent closure wall design prior to its installation.
- C. Remove vaults, areaways and foundation walls as shown.

3.05 EMBANKMENT, FILL AND BACKFILL:

- A. Place embankment, fill and backfill in eight-inch loose layers, unless otherwise shown, for entire width so that each layer can be uniformly and properly compacted.
- B. Avoid accumulation of large pieces of material at one location. Fill voids and interstices with finer materials.
- C. In confined areas, use approved power-actuated compactors to achieve required density.
- D. Prior to compaction, adjust moisture content of material within required limits by drying or watering either at material source or on fill.
- E. Leave struts, braces, lagging and timber sheathing in place as long as needed to support excavation and adjacent facilities and structures.
- F. Where utility facilities and structures are supported in place, use special equipment and techniques as required to achieve specified compaction under and around them.
- G. Not Used
- H. When backfilling against structures, place material approximately simultaneously on both sides of structures to equalize opposing horizontal pressures.
- I. When backfilling on tops of structures, place material in six-inch lifts over full area.
- J. Under concrete floor and other slabs on grade, place drainage material directly on prepared subgrade which meets density and elevation requirements. Compact with hand-operated plate-type vibratory compactor.
- K. Prior to placing embankment against slope greater than one vertical to four horizontal, cut benches into existing slope. Height of bench not to exceed two feet unless otherwise approved.
- L. Maintain embankment, fill and backfill in stable, well-drained condition.
- M. Where approved, dispose of surplus excavated material by widening embankments and flattening slopes.
- N. Where pervious material will be exposed to erosion, cover it with 12-inch layer of approved impervious material compacted in place.

3.06 COMPACTION ADJACENT TO STRUCTURES:

- A. Compact embankment, fill or backfill materials within five feet of retaining walls, abutments or other structures using lightweight compactors.
- B. Do not overstress structures.
- C. Backfilling against new structures without approval is prohibited.

3.07 EXCAVATION OF UNSUITABLE MATERIALS:

- A. Remove unsuitable materials from the site.
- B. Replace unsuitable material with approved material and compact as specified.

3.08 PREPARATION OF GROUND AS SUBGRADE:

- A. Where the subgrade is on original ground or in cut or where embankment or fill is less than one foot, fulfill compaction requirement for 12 inches minimum below final subgrade.
- B. If necessary, scarify original ground and adjust moisture content prior to compacting.

3.09 FIELD QUALITY CONTROL:

- A. Allowable Tolerances:
 - 1. Construct finished subgrade to vary not more than 0.05-foot above or 0.10-foot below elevation shown.
 - 2. Complete embankment slopes to plus-or-minus 0.5 foot of slope line shown.
 - 3. Maintain moisture content of embankment, fill or backfill material within plus-or-minus three percent of optimum moisture content of material.
 - 4. Compact each layer of embankment, fill or backfill to 95 percent of maximum dry density as determined in accordance with ASTM D698, at moisture content within tolerance specified, except the following:
 - a. From upper surface of fill or backfill to a plane 12 inches below subbase level of vehicular pavement, sidewalks, trackbeds and structural foundations to 100 percent of maximum dry density at moisture content within tolerance specified.
 - b. In areas of 95-percent compaction where utility facilities are located in fill and are not supported on concrete cradles, compact material for a depth of one foot directly below bottom of facility to 100 percent of maximum dry density at moisture content within tolerance specified.
- B. Test Method:
 - 1. Determine the maximum dry density and the optimum moisture content in accordance with ASTM D698.
 - 2. Determine in-place density and moisture content in accordance with ASTM D2922 and ASTM D3017 respectively, or other test methods acceptable to the Authority Representative.

3.10 TUNNELING FOR OR JACKING OF UTILITY FACILITIES:

- A. Location of facility, method of construction, type of equipment and procedures: As approved.

3.11 FINISHING:

- A. On completion of work, clean ditches and channels.
- B. Slope and shape borrow areas to provide positive drainage.
- C. Remove unsuitable and surplus excavated materials to locations outside the Authority's right-of-way.
- D. Leave site in neat, presentable condition.

END OF SECTION

SECTION 02460

PILES (NON-DRIVEN)

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies furnishing and installing bearing piles and performance of Static Pile Load Tests.
1. Sequence of Work:
 - a. Piles shall not be installed until embankments or excavations shown have been completed to the specified grade.
 - b. Perform Static Pile Load Tests per Article 3.2.B.2 on indicator piles designated by the Engineer after all indicator piles have been installed.
 - c. Order and procure production piles based on the approved "Order List".
- B. Definitions:
1. Pile Group: All piles to support a foundation element or column within a specified area, or all piles to support a linear unit of retaining wall. Pile groups are shown on the Contract Drawings.
 2. Production Piles: All piles that are installed after the installation of required test piles in accordance with the contract documents and which upon approval by the Engineer, become part of the permanent structure.
 3. Indicator Pile: Indicator piles are shown on the Contract Drawings. Static load tests shall be conducted on the indicator piles shown on the Contract Drawings or as directed by the Engineer. The Engineer may direct that additional indicator piles be installed and that static testing be conducted on them to verify the load capacity.
 4. Reaction Piles: Piles installed by the Contractor to provide reaction for Static Pile Load Tests.
 5. Predicted Maximum Tip Elevation: The elevation below which indicator pile tips must penetrate by at least one foot.
 6. Production Maximum Tip Elevation: The elevation below which production pile tips must penetrate by at least one foot, based on the indicator pile test program.
 7. Pile Design Load: The load each pile is designed to carry.
 8. Ultimate Bearing Capacity: The maximum bearing capacity that the pile can sustain without rapid progressive settlement of the pile under constant load.
- C. Pile Type:
1. Prestressed precast concrete piles, pre-bored.
- D. Related Information:
1. Grading, Excavating, and Backfilling: Section 02320.
 2. Support of Excavation: Section 02260.
 3. Concrete Formwork: Section 03100.
 4. Concrete Reinforcement: Section 03200.
 5. Cast-in-Place Structural Concrete: Section 03300.
 6. Structural Precast Concrete: Section 03400.
 7. Prestressed Concrete: Section 03415.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. ASTM Standards:
 - a. D1143 - Test Method for Piles Under Static Axial Compressive Load.

1.03 SUBMITTALS:

- A. Submit the following for the Engineer's approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings:
 - a. For Static Pile Load Tests, provide drawings that show load test apparatus setup including the method of applying the load. Drawings must show devices to be used to measure pile top movement.
 - b. For a Static Pile Load Test program, provide detailed sequence of testing, evaluation of results and planned reports.
 - c. Pile splicing is not desired and shall be avoided. In the event that concrete piles are installed below the elevation of bottom of cap, build-ups, precast or cast-in-place splicing may be used when approved by the Engineer. The pile submittal shall include splice details, build-up details and any other details necessary to satisfy the requirements of these specifications.
 - d. The pile submittal shall show prestressing methods, tendon arrangement, working stresses, and methods for pick-up and handling of piles.
 - e. Submit certification of accuracy for all gauges and test equipment.
 - 2. Documentation:
 - a. Submit procedures and details for installation of reinforcement and prestressing, if applicable.
 - b. Submit materials certifications and concrete mix designs for all concrete products to be used during the pile installation.
 - c. Indicator Pile Order List:
 - 1) Submit a list of piles to be installed as part of the indicator pile test program. List shall show type, size, number, location, indicator pile order length, predicted maximum tip elevation, allowable driving stress related to hammer blows, and blow count needed to attain twice the pile design load. If locations for indicator piles differ from those shown on the drawings, provide reasons for change. The proposed revised location will be reviewed and, if appropriate, approved by the Engineer.
 - 2) Submit list prior to ordering indicator piles.
 - d. Test Documentation and Reports:
 - 1) The Contractor shall retain an experienced Testing Engineer competent with pile load testing methods, procedures and reporting. The Testing Engineer shall be an integral part of the Contractor's Quality Control Program. Submit the qualifications of the Registered Maryland Professional Engineer responsible for monitoring Static Pile Testing. The Testing Engineer shall have a minimum of five (5) years experience in similar work.
 - 2) Sample pile installation record/report and sample sketch proposed to show any necessary deviations from planned locations.
 - 3) After completion of each Static Pile Test, submit a test report for review and approval by the Engineer. The test report shall include

reporting information specified in ASTM D1143 and recommendations for the Production Pile Order List.

e. Production Pile Order List:

- 1) After review and approval of the results of the Static Pile Load Test, submit an "Order List" of production piles proposed to be installed in each pile group. The list shall show type, size, number, location, sequence of installation, length, production maximum tip elevation, allowable driving stress related to hammer blows and blow count needed based on end of initial driving results to attain twice the pile design load for all piles in each pile group.

1.04 PRODUCT DELIVERY AND HANDLING:

- A. Lifting loops shall be used as provided by the precaster. Lifting loops shall not be tied in any way to the pile reinforcement. Loops may remain in place during driving. When handling and delivering precast piles, avoid bending and breaking or chipping of piles.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Precast concrete piles:
1. Prestressed precast concrete piles in accordance with Sections 03100, 03200, 03300, 03400, and 03415 of these specifications as applicable, shaped as shown.
- B. Lean concrete: Section 02260.

PART 3 - EXECUTION

3.01 DRIVING EQUIPMENT:

- A. Driven piles not allowed.

3.02 INDICATOR PILE TEST PROGRAM:

- A. Installation:
1. Provide and install indicator piles where shown, to determine lengths of production piles to be furnished to achieve twice the pile design load in the scheduled pile groups.
 2. Locate piles at contract pile locations so they can become part of the completed structure provided they are approved as conforming to requirements specified for production piles. Install indicator piles to achieve pile tips below the predicted maximum tip elevation, in the presence of the Engineer. Assist the Engineer in verifying measurements and installation characteristics as necessary to evaluate the adequacy of the foundation system.
 3. The indicator piles scheduled for Static Pile Load Tests are shown on the Contract Drawings. The Engineer may designate alternate or additional indicator piles that exhibit the weakest bearing capacity for Static Pile Load Tests.
 4. Piles which are subjected to Static Pile Load Tests which do not pass the acceptance requirements shall not be used for structural support.
 5. Additional piles may be installed, at the Contractor's option, in the area of the Static Load Test Piles to be used as reaction piles. All piles installed as indicator piles or reaction piles for load tests in accordance with the plans and specifications and

meeting specified requirements for production piles can, upon approval, be cut off and become a part of the permanent structure.

6. Install all indicator piles that are intended to become part of the permanent structure with the same type and model of equipment and methods to be used to install production piles. Perform work in the presence of the Engineer.
7. Remove piles which are not incorporated into the completed structure or which do not satisfy test requirements. Alternatively, if rejected piles are not removed then cut off at least three (3) feet below finished grade and backfill resulting hole with lean concrete.

B. Pile Testing:

1. Static Pile Load Tests:

- a. Static Pile Load Test equipment and testing procedures shall be in accordance with ASTM D1143, Quick Load Test Method, except as modified herein.
- b. Provide test equipment with capacity greater than three times the pile design load and having means of determining applied load to within five (5) percent of test load. Provide test equipment capable of measuring total settlement at the top of the pile to nearest 0.001 inch.
- c. Perform Static Pile Load Tests. Commence loading the pile no sooner than 72 hours after installation of the pile. The maximum test load shall be equal to three times the pile design load or the ultimate bearing capacity, whichever occurs first.
- d. The ultimate bearing capacity under axial compressive load is that load which produces a settlement of the pile head equal to:
$$S_u = S + (0.15 + 0.008D)$$
Where:
 S_u = Settlement at ultimate bearing capacity in inches
S = Elastic deformation of total unsupported pile length in inches
D = Pile diameter or width in inches
- e. The safe bearing capacity is defined as 50 percent of the maximum test load. Static load test results will be acceptable when the safe bearing capacity equals or exceeds the design bearing capacity.

3.03 PRODUCTION PILE INSTALLATION:

A. Bearing Value, Length and Penetration:

1. Provide production piles of length necessary to attain production maximum tip elevation, twice the pile design load, and to extend into cap or footing block as required.
2. Determine lengths of production piles by analysis of data obtained from Static Pile Load Tests.
3. The Contractor may install additional test piles, make borings or make such other investigations as he may desire at no additional time to the Contract and no cost to the Authority.

B. General Requirements:

1. Install piles only after completion of required excavation or construction of indicated embankments.
2. For production piles pre-drill through fill or embankment to planned tip elevation submitted by Contractor and approved by Engineer.
3. In Terrace deposits and directly above the Monmouth Formation, cobbles, boulders and cemented sand/silt deposits were found. Penetrate into and through these

deposits as necessary to attain twice the pile design load and required maximum tip elevation.

4. Achieve pile penetration through miscellaneous fill, rubble concrete, tires, hardpan, cemented sands/silts, and any other obstruction, natural or man-made, by means of pre-drilling or other approved excavation methods.
5. Pull and replace piles which are not within specified tolerances or, if approved, redesign pile cap as specified. Costs associated with the redesign and construction of modified pile caps will be borne by the Contractor and no additional time to the Contract will be allowed.

C. Pre-drilled Holes:

1. Where shown on the Contract Drawings, drill holes to diameter of greatest cross section dimension of the pile to be installed in accordance with the notes and schedules on the drawings and with Section 204.
2. Set pile in pre-drilled hole to predicted or production maximum tip elevation and twice the pile design load, but in all cases to a minimum depth of five (5) feet below bottom of pre-drilled hole.
3. Fill voids between pre-drilled hole and pile with lean concrete immediately upon completion of the installation sequence, as approved.
4. Dispose of material resulting from drilling holes in accordance with the requirements of Section 204.
5. Fill rejected pre-drilled holes with lean concrete and redrill at approved location.

D. Concrete Piles:

1. Cut off piles at such elevation that they will extend into cap or footing as shown. Saw cut piles with equipment capable of providing a flat smooth surface without spalling or damaging pile below cutoff. Replace or repair piles that are damaged when cut off.
2. Where reinforcing steel dowels are shown, dowels may be anchored in cast or drilled holes in concrete pile. If holes are drilled, drill by methods that will not damage concrete, reinforcing steel or prestressing steel. Drill minimum diameter consistent with placing approved epoxy adhesive and dowel. Leave holes free of dust, moisture or other deleterious material. Place sufficient epoxy in holes before inserting dowels leaving no voids afterwards. Leave dowels undisturbed until epoxy has developed 100 percent of its strength capacity.

3.04 FIELD QUALITY CONTROL:

A. Concrete Pile Allowable Tolerances:

1. Ensure straightness and cross-sectional dimensions of precast piles so that a line stretched from butt to tip on any face is not more than one inch from face of pile at any point.
2. Install piles within the following tolerances:
 - a. Axis of pile within six inches of design location at cutoff elevation.
 - b. Axis of pile not out of plumb or batter by more than one percent of its driven length.
 - c. No encroachment of piles upon neat lines of Authority structures.

PART 4 - MEASUREMENT AND PAYMENT

4.01 BASIS:

- A. Compensation for work specified in this section will be made in the following manner:

1. Furnishing and installing piles: Linear foot in place in the completed work measured from the tip of the pile to the plane of the cut off (top of pile). This price shall include furnishing piles; installing piles; splices; concreting; achieving specified load and tip elevations.
2. Static Pile Load Test: This work will be measured and paid for at the Contract unit price per each static pile load test performed. The payment will be full compensation for furnishing and setup of test equipment, providing reaction piles, conducting test, reporting and incidentals necessary to complete the work. If load test is terminated by the Engineer because of insufficient bearing capacity, test will be measured for payment. If the test is terminated because of malfunction of Contractor's equipment or other reasons that are the fault of the Contractor, the test will not be measured for payment.
3. Pre-drilled holes shown and specified in Article 3.3 will be paid for at the Contract unit price per linear foot measured from the plane of the cut off (top of pile) to the level of the pre-drilled elevation specified. This price shall include providing the equipment, material and labor necessary to drill holes to the scheduled elevation, disposal of materials, placing lean concrete and incidentals necessary to complete the work.

END OF SECTION

SECTION 02468

DRILLED CONCRETE PIERS (CAISSONS)

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Machine drilled shaft, belled base, rock sockets, shear rings, and penetration tests at bottom of caisson shafts.
 - 1. Contaminated ground water removal: If contaminated ground water is encountered during caisson work, Contractor shall conform to the requirements of removal of same contained in the Environmental Reports included as part of the Document 00300 - Information Available to bidders.
- B. Concrete and reinforcement.
- C. Shaft liner, if required.
- D. Unit Prices: Unit Prices for prices to be used in either cost over runs due to extra depths required to be drilled, additional soil excavations, additional penetration tests at bottom of caissons and additional concrete required for caissons. Same cost figures shall be used to credit work which does not require to go as far down.

1.02 RELATED SECTIONS:

- A. Section 03200 - Concrete Reinforcement: Requirements for concrete reinforcement.
- B. Section 03300 - Cast-In-Place Concrete: Requirements for concrete.

1.03 REFERENCES:

- A. ACI 336.1 - Standard Specification for the Construction of Drilled Piers; American Concrete Institute International; 1998.
- B. ASTM A 252 - Standard Specification for Welded and Seamless Steel Pipe Piles; 1998.
- C. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.04 SUBMITTALS:

- A. Contractor shall submit foundation design with calculations, QA/QC plan, and acceptance criteria to AR for approval prior to start of caisson installation work.
- B. Shop Drawings:
 - 1. Provide for reinforcing caissons.
 - 2. Provide concrete mix designs for caissons.
 - 3. Provide signed and sealed caisson design calculations, prepared by a Professional Engineer registered in the State in which the project is located.

- C. Project Record Documents: Record actual locations of piers, pier diameter, and pier length. Accurately record the following:
 1. Sizes, lengths, and locations of piers and footing groups.
 2. Sequence of placement.
 3. Final base and top elevations.
 4. Deviation from indicated locations.

1.05 QUALITY ASSURANCE:

- A. Design piers under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the project is located.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 10 years of documented experience.

1.06 PRE-INSTALLATION MEETING:

- A. Convene two weeks prior to commencing work of this section.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Concrete Materials and Mix: Specified in Section 03300.
- B. Reinforcement: Section 03200; spiral wound and as indicated on contract drawings.
- C. Equipment: Appropriate to dewater excavated shaft.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Use placement method which will not cause damage to nearby structures.
- B. Notify adjacent and affected land owners and building occupants with 30 days notice before proceeding with the work.
- C. Protect structures near the work from damage.
- D. Prepare to place piles from excavated working elevations.

3.02 INSTALLATION:

- A. Construct piers in accordance with ACI 336.1.
- B. Drill vertical pier shafts, belled bases, shear rings, and rock sockets to diameter and depths approved by AR.
- C. Place steel liners during drilling operations. Set firmly in place. Use shaft liner if free water is encountered.

- D. Clean shaft and bottom of loose material. Maintain shafts free of water.
- E. Allow inspection of shaft and liner prior to placement of reinforcement and concrete.
- F. Place reinforcing steel in accordance with Section 03200.
- G. Place concrete in single pour, in accordance with Section 03300 with equipment designed for vertical placement of concrete.
- H. Progressively raise shaft liner during concrete placement. Do not permit top of pier to deform to a mushroom shape due to premature removal of liner.
- I. Extend reinforcement or provide dowels for connection of caps and columns in accordance with contract drawing requirements.
- J. Set tops of piles to elevations approved by AR.

3.03 TOLERANCES:

- A. Install piers with maximum variation from location, plumbness, bottom area, diameter and anchorage locations as specified in ACI 336.1.
- B. Maximum Variation From Vertical: 1 in 48.
- C. Maximum Variation From Design Top Elevation: Plus 3 inches, minus 1 inch.
- D. Maximum Out-of-Position: 2 inches.

3.04 FIELD QUALITY CONTROL:

- A. Field inspection and testing will be performed under provisions of Section 01400.
 - 1. Perform penetration tests at bottom of Caisson shafts as approved by AR.
- B. Test Piers: Same diameter and type as specified for other piling, placed in same manner.
- C. Accepted test piers may be used in the Work, unless indicated otherwise by Engineer.

3.05 UNACCEPTABLE PIERS:

- A. Unacceptable Piers: Piers that fail, are placed out of position, are below elevations, or are damaged.
- B. Provide additional piers or replace piers failing to conform to specified requirements.

END OF SECTION

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SECTION 02515

WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies requirements for providing water mains, appurtenances, fire hydrants, and water meter.
- B. All work in Greenbelt Yard and Shady Grove Yard, including both WSSC and WMATA systems, shall be designed and constructed in accordance with all requirements of the Washington Suburban Sanitary Commission and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.
- C. All work in Brentwood Yard, including both WASA and WMATA systems, shall be designed and constructed in accordance with all requirements of the District of Columbia, Water and Sewer Authority and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.

PART 2- PRODUCTS

2.01 MATERIALS:

All materials for Greenbelt Yard and Shady Grove Yard shall conform to the applicable requirements of the Washington Suburban Sanitary Commission and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.

All materials for Brentwood Yard shall conform to the applicable requirements of the District of Columbia, Water and Sewer Authority and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All work in Greenbelt Yard and Shady Grove Yard shall be performed in conformance with the requirements of the Washington Suburban Sanitary Commission and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.
- B. All work in Brentwood Yard shall be performed in conformance with the requirements of the District of Columbia, Water and Sewer Authority and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.
- C. All inspections and testing in Greenbelt Yard and Shady Grove Yard shall be accomplished in conformance with the requirements of the Washington Suburban Sanitary Commission and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.
- D. All inspections and testing in Brentwood Yard shall be accomplished in conformance with the requirements of the District of Columbia, Water and Sewer Authority and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.

END OF SECTION

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SECTION 02535

SANITARY SEWER

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing sanitary sewers, both WSSC and WASA..
- B. All work in Greenbelt Yard and Shady Grove Yard, including both WSSC and WMATA systems, shall be designed and constructed in accordance with all requirements of the Washington Suburban Sanitary Commission and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.
- C. All work in Brentwood Yard, including both WASA and WMATA systems, shall be designed and constructed in accordance with all requirements of the District of Columbia, Water and Sewer Authority and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.

PART 2-PRODUCTS

2.01 MATERIALS:

All materials for Greenbelt Yard and Shady Grove Yard shall conform to the applicable requirements of the Washington Suburban Sanitary Commission and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.

All materials for Brentwood Yard shall conform to the applicable requirements of the District of Columbia, Water and Sewer Authority and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All work in Greenbelt Yard and Shady Grove Yard shall be performed in conformance with the requirements of the Washington Suburban Sanitary Commission and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.
- B. All work in Brentwood Yard shall be performed in conformance with the requirements of the District of Columbia, Water and Sewer Authority and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.
- C. All inspections and testing in Greenbelt Yard and Shady Grove Yard shall be accomplished in conformance with the requirements of the Washington Suburban Sanitary Commission and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.
- D. All inspections and testing in Brentwood Yard shall be accomplished in conformance with the requirements of the District of Columbia, Water and Sewer Authority and in accordance with the WMATA Stray Current and Cathodic Protection Criteria. The most stringent requirements shall apply.

END OF SECTION

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**SECTION 02554
STORAGE TANK SYSTEMS**

PART1-GENERAL

1.01 DESCRIPTION

This section specifies furnishing and installing double wall underground fiberglass-reinforced polyester fuel storage tanks for gasoline, diesel fuel, heating oil and above ground glycol tanks including pipes, fittings, pumps and appurtenances, and dispensing units.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and 1 Specification Sections, apply to this Section.
- B. Related Work Specified Elsewhere
 - Section 02320 Grading, Excavating and Backfilling
 - Section 02240 Dewatering
 - Section 02750 Concrete Pavement
 - Section 16120 Wire, Cable and Busways
 - Section 16125 Wire Connection Accessories
 - Section 16145 Wiring and Control Devices
 - Section 16060 Grounding and Bonding
 - Section 16225 Motors
 - Section 16425 Motor Starters and Control Centers

1.03 SUMMARY

- A. This section includes storage tanks, tank accessories, piping, valves, and specialties for fuel-oil and glycol distribution outside the building.
- B. A related section is Division 2 Section "Utility Materials" for basic piping joining materials, and joining and installation methods.

1.04 DEFINITIONS

- A. The following are industry abbreviations for storage tanks:
 - 1. AST: Aboveground storage tank(s)
 - 2. UST: Underground storage tank(s)
- B. The industry abbreviation for piping materials is FRP (fiberglass reinforced plastic).

1.05 SYSTEM PERFORMANCE REQUIREMENTS

- A. Aboveground, Fuel-Oil Distribution Piping Minimum Working-Pressure Rating: 150 psig.
- B. Double-Walled-Piping, Carrier-Pipe Minimum Working-Pressure Rating: 150 psig.

- C. Vent, Gage, and Fill Piping Minimum Working-Pressure Rating: 100 psig.
- D. Minimum Test-Pressure Rating for Inner Tank, Smaller Than 12-Foot Diameter: 5 psig.
- E. Minimum Test-Pressure Rating for Containment Shell, Smaller Than 12-Foot Diameter: 5 psig.

1.06 SUBMITTALS

- A. Product Data: Include identification materials and devices; and sizes, dimensions, capacities, pressure ratings, and operating characteristics for the following
 1. Each type and size of storage tank
 2. Submersible, fuel-oil pumps and glycol pumps
 3. Tank accessories and specialty fittings
 4. General- and special-duty valves
 5. Piping systems
 6. Liquid-level gage systems
- B. Shop Drawings
 1. Include storage tanks, accessories, pipe sizes, valves, and specialties. Include details of underground piping. Indicate interface and spatial relationship between piping, adjacent utilities, and proximate structures.
 2. Wiring Diagrams: For each item of equipment with electric power supply. Include ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between factory-installed and field-installed wiring.
- C. Test Reports - As specified in "Field Quality Control" Article
- D. Maintenance Data - For accessories and specialties to include in maintenance manuals specified in Division 1.
- E. Completed Notification for Underground Storage Tank (MDE Form 231).
- F. For each tank:
 1. Calibration chart.
 2. Manufacturer's installation checklist.
 3. Manufacturer's warranty.

1.07 QUALITY ASSURANCE

- A. Product Options - Drawings indicate size, profiles, and dimensional requirements of fuel-oil distribution components and are based on specific types and models indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."
- B. Reference Codes and Specifications
 1. Codes and regulations of jurisdictional authorities
 2. API Bulletin No. 1615, Installation of Underground Gasoline Tanks and Piping at Service Stations
 3. ASTM: A48, A53, C33, D4021
 4. NEMA: 250

- D. Electrical Devices, Components, and Equipment - Listed and labeled according to NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction
- E. Compliance with ASME B31.1, "Power Piping", for fuel oil piping materials and joining requirements.
- F. Compliance with
 - 1. NFPA 30 Flammable and Combustible Liquids
 - 2. NFPA 30A Automotive and Marine Service Station
 - 3. NFPA 31 Installation of Oil Burning Equipment
 for design and construction, installation, inspection, and testing of fuel-oil distribution system tanks, piping, and other components.
- G. Compliance with NFPA 70, "National Electrical Code," for electrical connections between wiring and electrically operated devices.
- H. Compliance with requirements of the EPA (40 CFR 280) and state and local environmental-protection authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks and piping
- I. Compliance with requirements of the Petroleum Equipment Institute (PEI) Standards RP-100, RP-200 and RP-300
- J. Compliance with Underwriters Laboratories Standards UL 1316 and UL 567

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Lift and support storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.
- B. Preparation for Transport: Prepare storage tanks, accessories, valves, and specialties for shipping as follows
 - 1. Ensure that units are dry and internally protected against rust and corrosion.
 - 2. Protect against damage to threaded ends, flange faces, and weld ends.
 - 3. Set valves and specialties in position for handling that avoids damage to seats and operating parts.
- C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent damage and entrance of dirt, debris, and moisture.
- D. Store valves and specialties with end protectors in place, unless necessary for inspection; then reinstall for storage.
- E. Store valves and specialties indoors and maintain temperature higher than ambient dew-point temperature. Support off ground or pavement in watertight enclosures if outdoor storage is necessary.
- F. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor if stored inside.
- G. Protect flanges, fittings, and piping specialties from moisture and dirt.
- H. Store pipes protected from direct sunlight. Support pipes to prevent sagging and bending.

1.09 PROJECT CONDITIONS

Notify Architect not less than two days in advance of proposed utility interruptions.

1.10 COORDINATION

- A. Coordinate installation and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- B. Coordinate sizes and locations of concrete-ballast and -surface bases for UST. Include manholes, fill and sounding boxes, and vent piping terminals.

1.11 WARRANTY

- A. General Warranty - Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty - Written warranty, executed by fuel-oil storage tank manufacturer agreeing to repair or replace tanks that fail in materials or workmanship within specified warranty period, provided tanks are installed according to manufacturer's written instructions. Failures include structural failures of tanks, including cracking, breakup, and collapse; and failure due to external and internal corrosion if used for storage of fuel oils at temperatures not exceeding 150 deg F.
- C. Warranty Period - 30 years from date of Substantial Completion for underground double-wall polyester tanks and one year for above ground steel tanks.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

Refer to Subpart 3.02, of this section, "Piping Applications", for applications of pipe, tube, fitting, double-contained piping, and joining materials.

2.02 PIPES AND TUBES

- A. Steel Pipe - ASTM A 53, Schedule 40, Type S or E, Grade A or B, black
- B. Copper Tube - ASTM B 88, Type L (ASTM B 88M, Type B); water tube; drawn temper
- C. FRP: ASTM D 2310 and complying with UL 971
Note: 2- and 3-Inch NPS - 150-psig minimum working-pressure rating

2.03 PIPE AND TUBE FITTINGS

- A. Steel, Threaded Fittings - ASME B16.11, with threads according to ASME B1.20.1
- B. Steel Flanges and Flanged Fittings - ASME B16.5
- C. Malleable-Iron Threaded Fittings - ASME B16.3, Class 150, standard pattern, with threads

according to ASME B1.20.1

- D. Malleable-Iron Unions - ASME B16.39, Class 150. Include brass-to-iron seat, ground joint, and threads according to ASME B1.20.1
- E. Copper Fittings - ASME B16.22, wrought copper
- F. FRP Fittings - ASTM D 2310 complying with UL 971, and made by FRP manufacturer or approved equal

2.04 DOUBLE-WALLED FIBERGLASS PIPING SYSTEM

- A. Description - Piping includes carrier pipe and fittings, secondary-containment conduit and fittings, centering spacers in annular space between carrier pipe and inside of conduit, and liquid-tight joints. Arrange conduits and spacers so piping can be vented and drained and space is available for installing leak-detection cable.
- B. FRP Double-Walled Piping: UL 971, FRP carrier pipe, FRP secondary-containment conduit, FRP double-walled fittings, and bonded joints.
- C. Steel Pipe/FRP Double-Walled Piping, according to the following
 1. Carrier Piping - Steel pipe; steel, welding fittings; and welded joints
 2. Secondary-Containment Conduit - UL 971, FRP and fittings and bonded joints
- D. Copper-Tube/FRP Double-Contained Piping, according to the following
 1. Carrier Piping - Copper tube, copper fittings, and brazed joints
 2. Secondary-Containment Conduit - UL 971, FRP and fittings and bonded joints

2.05 JOINING MATERIALS

- A. Brazing Filler Metals - AWS A5.8, BAg-1 (silver classification)
- B. Bonding Adhesive - FRP manufacturer's standard, suitable for fuel oil piping application

2.06 PIPING SPECIALTIES

- A. Tank, Pipe Connectors - Comply with UL 567.
- B. Piping, Flexible Connectors
 1. Fabricated from materials suitable for fuel-oil service, including 150-psig minimum working-pressure rating, and having threaded ends for 2-inch NPS and smaller and flanged ends for 2-1/2-inch NPS and larger.
 2. Stainless-Steel-Hose, Flexible Connectors - Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

2.07 VALVES

- A. Bronze, Gate Valves - MSS SP-80, Type 2, Class 200. Include ends threaded according to ASME B1.20.1. Solder ends may be furnished for use with copper tube.
- B. Bronze, Ball Valves - MSS SP-110; three-piece bolted-body; 400-psig minimum, WOG, nonshock, working-pressure rating. Include full-port, cast-bronze, chrome-plated bronze ball; PTFE seats; lever handle; and threaded ends according to ASME B1.20.1. Solder ends may

be furnished for use with copper tube.

- C. Bronze, Check Valves - MSS SP-80, Type 3, Class 200. Include ends threaded according to ASME B1.20.1. Solder ends may be furnished for use with copper tube.
- D. Bronze, Vertical Ball Check Valves - ASTM B 61 or ASTM B 62, two-piece construction; and 400-psig WOG, nonshock, working-pressure rating. Include integral bronze seats, replaceable stainless-steel ball, and threaded ends according to ASME B1.20.1.
- E. Cast-Iron, Gate Valves - MSS SP-70, Type I, Class 250. Include OT construction, all-bronze trim, and flanged ends.
- F. Steel, Ball Valves - MSS SP-72; full-port, chrome-plated steel ball; TFE seats; and flanged ends
- G. Cast-Iron, Check Valves - MSS SP-71, Type I, Class 250, include flanged ends
- H. UL Valves - UL 842, listed for fuel-oil service

2.08 DISPENSER NOZZLE

- A. Gasoline vapor recovery nozzle - UL-listed, with 90 percent capability for retrofit to comply with future no-seal, no-flow requirements. Spout - corrugated rubber with 3/4-inch fuel inlet and 3/4 inch vapor outlet; Emco-Wheaton, Model No. 8300, or approved equal.
- B. Diesel fuel and glycol dispenser nozzle - Manufacturer's standard with 3/4-inch nozzle inlet
- C. Safety shut-off valve - UL-listed, size as shown, Universal, Model No. 520 RU or approved equal

2.09 GLYCOL STORAGE TANKS

- A. Description - Single-wall, horizontal, steel, AST; with enclosed, secondary-containment dike, with capacity a minimum of 110% of tank capacity; suitable for storage of Glycol solution of varying concentrations. Hoover containment or approved equal
- B. Construction - Fabricated with welded carbon steel, suitable for operation at atmospheric pressure and for storing 100% Glycol Solution with maintained temperature up to 150 deg F.

2.10 UNDERGROUND STORAGE TANKS

- A. Description - UL 1316 and ASTM D 4021, double-wall, horizontal, polyester, UST; with interstitial space. Fluid containment, Xerxes, or approved equal.
- B. Construction - Fabricated with fiberglass-reinforced polyester resins suitable for operation at atmospheric pressure. Fabricate tanks for the following internal and external loads
 1. External Hydrostatic Pressure - 3-foot depth of bury from top of tank and hole fully flooded, to withstand general buckling with safety factor of 2:1.
 2. Surface Loads - AASHTO's "Specifications for Highway Bridges," H-20 axle loads of 32,000 lb.

2.11 GLYCOL STORAGE TANK FITTINGS AND ACCESSORIES

- A. Tank Manholes - 24-inch diameter; bolted, flanged, and gasketed; centered on top of tank

- B. Threaded pipe connection fittings on top of tanks, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
- C. Striker Plates - Inside tank, on bottom below fill, sounding vent, gage, and other tube openings.
- D. Lifting Lugs - For handling and installation.
- E. Supply Tube - Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle (1:1 slope).
- F. Sounding and Gage Tubes - Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle (1:1 slope).

2.12 FUEL-OIL STORAGE TANK FITTINGS AND ACCESSORIES

- A. Tank Manholes - 36- to 48-inch diameter; bolted, flanged, and gasketed, with extension collar; for access to inside of tank
- B. Threaded pipe connection fittings on top of tanks, for fill, supply, return, vent, sounding, and gaging, in locations and of sizes indicated. Provide with cast-iron plugs for shipping
- C. Striker Plates - Inside tank, on bottom below fill, sounding vent, gage, and other tube openings
- D. Lifting Lugs - For handling and installation
- E. Supply Tube - Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle (1:1 slope)
- F. Sounding and Gage Tubes - Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle (1:1 slope)
- G. Containment Sumps - PE, (Environ DBS4245 or approved equal) sump base, add-on extension pieces as required, sump top, lid, and gasket-seal joints. Include bulkhead fittings for pipe penetrations through sidewalls. Minimum depth 38-inch and a 42 inch manhole.
- H. Bulkhead Fittings - Two-part pipe fitting for field assembly and of size required to fit over pipe. Include gaskets shaped to fit sump sidewall, sleeves, seals, and clamps as required for liquidtight pipe penetrations
- I. Anchor Straps - Storage tank manufacturer's standard anchoring system, with straps, strap-insulating material, cables and turnbuckles, of strength at least one and one-half times maximum uplift force of empty tank without backfill in place.
- J. Filter Mat - Geotextile woven or spun filter fabric, in one or more layers, for minimum total weight of 3.0 oz/sq. yd.
- K. Submersible, Fuel-Oil Pumps - UL 79, turbine type.
- L. Observation Well - PVC pipe with manhole, per the drawings

2.13 FUEL-OIL TANK SPECIALTY FITTINGS

- A. Fitting Materials
 1. Cast-iron, malleable-iron, brass, or corrosion-resistant metal; suitable for fuel-oil service
 2. Surface, Flush-Mounted Fittings - Waterproof and suitable for fuel-oil truck traffic
- B. Spill-Containment Fill Boxes - Flush mounting, with drainage feature to drain oil into tank, threaded fill-pipe connection, and wrench operation. EBW Flex Catch BG Series, 715-474-01 or approved equal
- C. Supply and Sounding Drop Tubes - Fuel-oil supply piping or fitting, inside tank, terminating 6 inches above bottom of tank, and with end cut at a 45-degree angle (1:1 slope).
- D. Pipe Adapters and Extensions - Compatible with piping and fittings
- E. Suction Strainers, Check Valves, and Overfill Check Valves - Bronze or corrosion-resistant metal components
- F. Weatherproof Up Flow Vent Cap - Increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection
- G. Observation Well Caps - Locking manholes
- H. Overfill Prevention Valve - Automatic operation to prevent product flow prior to tank filling and to permit operator to drain hose into tank following activation.

2.14 GRADE MANHOLES

Cast-Iron Frame and Cover - Heavy-duty (H-20 rated), water-resistant, cast-iron manhole frame, gasket, and bolted cover

2.15 LEAK-DETECTION AND MONITORING SYSTEMS

Calibrated, leak-detection and leak-monitoring system, and liquid-level gage system with probes and other sensors and remote alarm panel, for fuel-oil storage tanks and fuel oil piping.

2.16 SUBMERSIBLE PUMPS

- A. Permanent split-compactor motor, horsepower as indicated, 200-volts ac, single-phase, 60 Hertz, 3450 rpm, UL-listed for Class 1, Group D, Division 1, Hazardous location, product cooled and lubricated, flow capacity as indicated at 200 psig to conform to NFPA 30. Appropriate device to detect and automatically de-energize the motor, if there is an increase in temperature of the motor beyond designed limit.
- B. Aluminum impellers and diffusers, labyrinth liquid flow path seals between stages. Pump completely waterproof, designed for use with automotive fuel having specific gravity of approximately 0.8. Submersible pump for glycol system shall have impeller trimmed to provide specified flow.
- C. Discharge head of cast iron construction, extractable design, and with integral electrical junction box.

- D. Spring-loaded check valve with built-in pressure relief remains in system with head removed.
- E. Across-the-line magnetic starter: Section 1614, with the following additional requirements
 - 1. Enclosures - NEMA 250 type 7, Suitable for Class 1, Division 1, Group D location
 - 2. NEMA size - As required

2.17 PRODUCT DISPENSERS

- A. One hose and nozzle assembly per dispenser. Casting incorporating 120-mesh non-corrosive Monel metal strainer and on-off switch, 240-volts, 10 amperes, 5,000 AIC, UL-Listed for Class 1, Group D, Division 1 locations.
- B. Internally mounted noncomputing four-sheet register with semiautomatic reset. Zero start ticket printer built into non-computing register to provide record of individual type, with antidrain valve.
- C. Gasoline-resistant 3/4-inch hose, 13 feet long, shockproof nozzle, variable flow, nonchattering type, with antidrain valve
- D. Panels
 - 1. removable and replaceable
 - 2. housing joints weather lapped to eliminate need for gaskets
 - 3. modern exterior cabinet of heavy gauge steel, bonderized and finished in red baked-on synthetic enamel
 - 4. rigidized stainless steel scuff panel and stainless steel snap-on trim guards.

2.18 REMOTE CONTROL

- A. Disconnect switch - Mounted on channel support for disconnecting AC power to fuel dispensing booth
- B. Keyed Switch - Wall mounted with the following requirements
 - 1. For remote control of gasoline, diesel fuel and glycol dispensing units to prevent unauthorized use and to shut off both dispensing units in emergencies
 - 2. Nameplates - Black-and-white laminated plastic, one inch high minimum height with adhesive backing, and with in 1/2-inch high with block letters on black background
 - a. One of the following legends, as appropriate
 - i. GASOLINE FUEL DISPENSING UNIT CONTROL
 - ii. DIESEL FUEL DISPENSING UNIT CONTROL
 - iii. GLYCOL DISPENSING UNIT CONTROL
 - b. Switch positions - ON and OFF

2.19 PEA GRAVEL

ASTM C33 - naturally rounded aggregate with particles ranging from 1/8-inch diameter to maximum of 3/8-inch diameter, clean and free-flowing.

2.20 SOURCE QUALITY CONTROL

- A. Perform factory tests on fuel tanks, according to UL 142 and STI F911, after fabrication and before shipment.

- B. Perform factory tests on glycol tanks, according to UL 1316 and ASTM D 4021, after fabrication and before shipment.

PART 3 - EXECUTION

3.02 EARTHWORK

Excavation, trenching, and backfilling are specified in Division 2 Section 204, "Grading, Excavating and Backfilling."

3.03 PIPING APPLICATIONS

- A. Use flanges, unions, transition and special fittings, and valves with pressure ratings same or higher than system's pressure rating in aboveground and containment sump applications, unless otherwise indicated.
- B. Aboveground, Glycol Piping and Fuel Oil Piping - Use 2-Inch NPS and Smaller with steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
- C. Aboveground Vent Piping - Use Schedule 40 galvanized steel, ASTM A53.
- D. Underground Fuel Oil Piping - use the following.
 - 1. 2-Inch NPS - FRP double-walled piping
 - 2. 3- and 4-Inch NPS - FRP double-walled piping
- E. Underground Fuel Oil Riser Piping - Use black steel schedule 40 pipe except for interstitial monitoring riser, which shall be schedule 40 PVC.
- F. Underground, Gage and Vent Piping - Use FRP pipe.

3.04 VALVE APPLICATIONS

Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply.

- A. Shutoff Duty - Use ball valves
- B. Throttling Duty - Use ball valves

3.05 JOINT CONSTRUCTION

- A. Refer to Division 2 Section "Utility Materials" for basic piping joint construction.
- B. Make bonded joints for FRP piping with adhesives according to manufacturer's written instructions.

3.06 GLYCOL STORAGE TANK INSTALLATION

- A. Install glycol storage tanks according to manufacturer's written instructions and standards specified.
- B. Install tank bases and supports.

- C. Set tanks on bases and supports.
- D. Install piping connections and vent fittings.
- E. Install ground connections.

3.07 FUEL-OIL STORAGE TANK INSTALLATION

- A. Install fuel-oil storage tanks according to manufacturer's written instructions and standards specified.
- B. Excavate to sufficient depth for a minimum of 51 inches of earth cover from top of tank to finished grade. Allow for cast-in-place, reinforced concrete anchor pad plus 18 inches of pea gravel between ballast base and tank. Extend excavation at least 24 inches around perimeter of tank.
- C. Set tiedown eyelets for hold-down straps in reinforced concrete anchor pad and tie to reinforcing steel.
- D. Place 18 inches of pea gravel on top of reinforced concrete anchor pad.
- E. Set tank on fill materials and install FRP hold-down straps.
- F. Install piping connections.
- G. Install tank leak-detection and -monitoring devices.
- H. Install containment sumps.
- I. Install observation wells.
- J. Backfill excavation with pea gravel.
- K. Install fuel-oil storage tanks, manhole extensions, and manhole risers.
- L. Install reinforced concrete tank pad over tank excavation.

3.08 CONCRETE BASES

- A. Construct concrete tank and equipment bases according to supported tank and equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive-strength concrete.
- B. Refer to Division 3 Section 03300; Cast-in-place Structural Concrete for concrete.
- C. Refer to Division 4 Section 04050; Mortar, Grout and Masonary Accessories for grout.

3.09 PIPING INSTALLATION

- A. Install piping free of sags and bends.
- B. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

- C. Install fittings for changes in direction and branch connections.
- D. Install rigid, underground, single wall fiberglass vent piping at a minimum uniform slope of 2 percent downward toward fuel-oil storage tank sump.
- E. Install flexible, double wall FRP, fuel-oil pipe at a minimum slope of 1 percent downward toward fuel-oil storage tank sump. Primary pipe shall be 2 inches within a 3 inch containment pipe. Pipe well shall be install in diesel piping per the drawings.
- F. Assemble and install bulkhead fittings for pipe penetrations through storage tank sump sidewalls. Follow fitting manufacturer's written instructions and use components required for liquidtight joints.
- G. Install reductions in pipe sizes using concentric reducer fittings.
- H. Install tank, pipe connectors at piping connections to UST.
- I. Install, flexible connectors at piping connections to vibration-producing equipment. Use according to the following applications.
 - 1. Steel Piping - Stainless-steel-hose, flexible connectors
 - 2. FRP - Stainless-steel-hose or bronze-hose, flexible connectors
- J. Install double walled piping according to manufacturer's written instructions for assembly, joining, trench preparation, and installation.
- K. All underground metallic piping shall be wrapped and coated.

3.010 VALVE INSTALLATIONS

Install valves in accessible locations. Protect valves from physical damage and install metal tag attached with metal chain indicating fuel oil piping systems.

3.10 CONNECTIONS

- A. Connect vent, fill, sounding, gage, and other piping to fittings and specialty devices.
- B. Piping Connections - Make piping connections as follows, unless otherwise indicated.
 - 1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
 - 2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - 3. Install dielectric unions to connect piping of dissimilar metals.
- C. Make connections to liquid-level gage system.
- D. Make connections to tank leak-detection system.
- E. Make electrical connections to pumps, control panels, liquid-level probes, and leak-detection and -monitoring devices.
- F. Electrical wiring, disconnect switches, and motor controls are specified in Division 16.
- G. Ground equipment and AST and tighten electrical connectors and terminals according to

manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.11 LIQUID-LEVEL GAGE SYSTEM INSTALLATION

- A. Install liquid-level gage systems according to manufacturer's written instructions.
- B. Locate panel inside building where indicated.

3.12 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION

- A. Install leak-detection and monitoring systems according to manufacturer's written instructions.
- B. Install alarm panel inside fuel boot as indicated on the drawings.
 - 1. Fuel-Oil Storage Tanks - Install probes in interstitial space of double-wall tanks.
 - 2. Fuel-Oil Double-Walled Piping - Install sump sensors.
 - 3. Install liquid-level gage systems according to manufacturer's written instructions.

3.13 LABELING AND IDENTIFYING

- A. Equipment - Install engraved, plastic-laminate equipment nameplates and signs on AST and equipment. Text of signs:
 - 1. Name of identified unit
 - 2. In addition to name of identified unit, distinguish between multiple units.
 - 3. Inform operator of operational requirements
 - 4. Indicate safety and emergency precautions, and warn of hazards and improper operations. T
 - 5. Tanks shall be identified for type of product and capacity
- B. Piping - Install pipe markers on aboveground piping.
- C. Warning Tapes - Arrange for installation of continuous, underground, detectable warning tapes during backfilling of trenches for piping. Locate tapes 6 to 8 inches below finished grade and directly over piping and edges of each fuel-oil storage tank.

3.14 PAINTING

- A. Refer to Division 9 Section 09920; Field Painting for field-painting requirements.
- B. Use materials and procedures in "Exterior Paint Schedule" Article's "Ferrous Metal" Paragraph and "Full-Gloss, Alkyd-Enamel Finish" Subparagraph in Division 9 Section "Painting," using color selected by Architect.
- C. Prime and paint AST and metal supports, except units with factory-applied paint or protective coating. Restore damaged finish to original condition. Painting shall be in accordance with WMATA color codes for storage tanks.
- D. Prime and paint aboveground pipe, fittings, valves, and supports.

3.15 FIELD QUALITY CONTROL

- A. Perform pressure test for tightness, with air, inert gas, or water according to NFPA 30 and NFPA 31 on tanks before installation.

1. Apply soap solution to joints and check for leaks.
 2. Do not exceed 5-psig test pressure with tanks smaller than 12-foot diameter
- B. Repair or replace defective tanks and retest until there are no leaks.
- C. Test fuel-oil distribution piping according to NFPA 30 and NFPA 31. Remake leaks and defects with new materials and retest until there are no leaks.
- D. Test and adjust leak-detection and -monitoring system controls and devices. Replace damaged and malfunctioning controls and devices.
- E. Report test results promptly in writing to Architect and authorities having jurisdiction.

3.16 ADJUSTING

Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

3.17 DEMONSTRATION

Engage a factory-authorized service representative for leak-detection system to train Owner's maintenance personnel to adjust, operate, and maintain systems.

- A. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining leak-detection equipment and pumps.
- B. Review data in maintenance manuals.
- C. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION

SECTION 02585

UNDERGROUND ELECTRICAL AND COMMUNICATIONS DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

This section specifies providing new ducts, manholes and handholes for electrical and communications facilities.

- A. Related Work Specified Elsewhere:
 - 1. Grading, excavating and backfilling: Section 02320.
 - 2. Support of excavation: Section 02260.
 - 3. Maintenance, support and restoration of utility facilities: Section 02270.
 - 4. Grounding and bonding: Section 16060.
 - 5. Concrete formwork: Section 03100.
 - 6. Concrete reinforcement: Section 03200.
 - 7. Cast-in-place structural concrete: Section 03300.
 - 8. Structural precast concrete: Section 03400.

- B. Definitions:
 - 1. Conduit: Individual raceway.
 - 2. Ductbank: Assembly of conduits in configurations shown, with concrete encasement, with or without reinforcement.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Drawings for each cast-in-place manhole and handhole.
 - 2. Drawings for each size and configuration of precast manhole and handhole with details of accessories and joints.
 - 3. Diagrams showing dimensioned locations for openings and knockout panels for ductbank penetrations of manhole and handhole walls.

- B. Documentation:
 - 1. Submit calculations to demonstrate compliance with required load-bearing capacity, certified by a professional engineer registered in the jurisdiction where the work is to be installed.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AASHTO: H15-44, H20-44.
 - 3. ANSI: C80.1.
 - 4. ASTM: A36, A48, A123, A185, A615, C33, C109, C173, C231, D570, D638, D790, F512.

5. NEMA: TC-14.
6. UL: 6.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Transport those materials supplied by utility companies from companies' storage facilities to construction site.
- B. Protect materials stored on site from damage prior to incorporation into work and during handling.

1.05 JOB CONDITIONS:

- A. Coordination with Utility Companies:
 1. Arrange with the Engineer to contact utility companies early enough to allow sufficient time for them to accomplish work they are required to perform, giving special consideration to lead times required for cable work.
 2. Establish liaison with utility companies furnishing materials for the work in order to determine availability, locations, methods of storage and care of materials prior to incorporation into work.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Concrete Formwork: Section 03100.
- B. Reinforcing Steel: Section 03200.
- C. Concrete:
 1. Cast-in-place: Section 03300, Class 3500 or as required by the power company for its facilities.
 2. Precast: Section 03400, Class 5000, unless otherwise shown on the drawings.
- D. Materials Supplied by Utility Company: As listed.
- E. Conduit and Fittings:
 1. PVC conduit and fittings: ASTM F512; modulus of elasticity, 500,000 psi.
 2. Concrete encased: Schedule 40.
 - a. Direct burial: Schedule 80 heavy wall.
 - b. Solvent cement: As recommended by conduit manufacturer.
 3. Galvanized rigid steel conduit and fittings: UL 6 and ANSI C80.1.
 4. Fiberglass conduit and fittings:
 - a. Rigid fiberglass reinforced epoxy conduit, UL 1684, IPS (Iron Pipe Size) based conduit.
 - b. Rigid fiberglass-reinforced epoxy, filament wound with minimum fiberglass content of 65 percent by weight and no fillers.
 - c. Type SW (Standard Wall) of IPS based standard conduit with nominal wall thickness of .09 inch for five-inch nominal conduit size, and nominal wall thickness of 0.07 inch for two through four-inch nominal conduit size.
 - d. Conduits, elbows and fittings manufactured from the same material and using the same manufacturing process.

- h. Conduit, elbows and fittings shall be suitable for encasement in concrete below grade and conform to UL 1684, and listed and labeled by UL, meeting the requirement of NEC Article 347 for Rigid Nonmetallic Conduit and its use.
 - i. Conduit for above ground surface mounted duct systems shall pass the UL1684 mandatory flame test (UL 1684, Section 5.12.1) and be certified by the manufacturer as such.
 - j. Each piece of the straight length conduit and each piece of the elbow and other bend made from and for use with such conduit is to be labeled with the following information, marked clearly legible and durably every 10 feet or as recommended by the manufacturer:
 - a. "Reinforced Thermosetting Resin Conduit", "RTRC", or equivalent wording such as "FRE" (Fiberglass Reinforced Epoxy) conduit.
 - b. Nominal size: (IPS)
 - c. Manufacturer's name and trademark.
 - d. Temperature range for conduit application.
 - e. "Above ground", "AG", "Below ground", "BG", or equivalent wording.
 - f. "FT4" when flame test is required for above ground conduit.
5. Conduit seal fittings:
- a. To provide watertight seal between concrete and conduit where it penetrates wall, floor or ceiling.
 - b. Size as shown or necessary.
 - c. Materials: Body and pressure clamp of malleable or cast iron with a neoprene sealing grommet and PVC-coated or galvanized-steel pressure rings, oversized sleeve of PVC or galvanized steel.
 - d. Seal between conduit and concrete to withstand pressure from 50-foot head of water without leakage.
- F. Channel Inserts: Stainless steel, size and shape as shown, 12-gauge minimum thickness, with 7/8-inch slot; surface-mounted; slotted-base channel with 9/16-inch by 3/16-inch nominal mounting slots on eight-inch centers.
- G. Cable Pulling Eye: Fabricated of plain steel reinforcement bar, ASTM A615, Grade 60; welded; size as shown. Hot-dip galvanized after fabrication, ASTM A123. Pulling tension: 5,000 pounds.
- H. Manhole Frame and Cover:
- 1. Authority manhole: Cast-iron, ASTM A48, Class 30, with METRO logo.
 - 2. Utility company manhole: Manhole frame and cover furnished as part of the Contract or furnished by the utility as shown on the drawings.
 - 3. Rust-resistant cast iron or rust-resistant malleable cast iron.
 - 4. True to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes and defects affecting strength.
 - 5. Fillets at angles in casting with arises sharp and perfect.
 - 6. Sandblasted to effectively remove scale and sand, presenting smooth, clean and uniform surfaces. Coated with bituminous coating.
 - 7. Covers to receive paver tile:
 - a. Omit bituminous coating.
 - b. Provide positioning lug and lug receptor as a permanent part of the cover and frame rim so that the cover can only be installed (flush) in one position.
- I. Manhole Steps:
- 1. ASTM A48, cast-iron, Class 30A.
 - 2. Molded rubber or plastic on cast-iron or reinforcing steel core.
- J. Handhole and Manhole: Option of cast-in-place or precast.

1. Cast-in-place concrete handhole and manhole: As shown and specified.
2. Precast concrete:
 - a. Shape shown. If precast manholes are selected and size shown is not standard, use nearest larger standard precast unit; where added size will conflict with other utilities or structures, use cast-in-place unit.
 - b. Designed for AASHTO H20-44 truck loading.
 - c. Manhole: Include lifting rings, manhole steps, pulling eyes, sump, hole through floor for ground rod, and seal or sealant for sealing joints between sections, precast extensions included where required by utility.
3. Precast concrete handhole: Compressive strength 3,500 psi, air entrainment six-percent minimum, ASTM C173 or ASTM C231; Section 03300 and Section 03400 and in accordance with the following:
 - a. Box: Concrete formed with closed bottom and sides and recess at top of box or at edge of cover to provide mating surfaces to prevent lateral movement of flush-mounted cover. Knockouts provided to accommodate conduits as shown on the drawings..
 - b. Cover:
 - a. Material same as for box. Use of metallic cover and cover frame prohibited.
 - b. Metro Type "B" logo with 3-1/8 inch by 4-inch envelope and service designation recessed in center of cover.
 - c. Non-protruding provisions provided for lifting.
 - c. Reinforcement:
 - a. Sidewalk and landscape locations: Welded-wire fabric, ASTM A185.
 - b. Areas subject to vehicular traffic: Deformed steel bars, ASTM A615.
 - d. Loading:
 - a. Sidewalk and landscape locations: AASHTO H15-44.
 - b. Areas subject to vehicular traffic: AASHTO H20-44.
 - e. Hardware: Stainless steel.
 - f. Size: As shown or next available larger size.

- K. Precast composite material handhole: Sand and gravel bound together with a polymer and reinforced with continuous woven glass strands and in accordance with the following:

Physical Properties	Values	Methods
Compressive strength	11,000 psi	ASTM C109
Tensile strength	1,700 psi	ASTM D638
Flexural strength	7,500 psi	ASTM D790
Water absorption (24 hours)	0.5 percent	ASTM D570

1. Box: Gray-color material formed with closed bottom and sides and flange with recess at top of box to accommodate flush-mounted cover.
2. Cover:
 - a. Material same as for box.
 - b. Skid-resistant top surface with minimum 0.5 coefficient of friction.
 - c. Metro Type "B" logo with 3-1/8 inch by 4-inch envelope and service designation recessed in center of cover.
 - d. Secured to box with bolts.
 - e. Non-protruding provisions provided for lifting.
 - f. Loading:

- g. Sidewalk and landscape locations: AASHTO H15-44.
 - h. Areas subject to vehicular traffic: AASHTO H20-44.
 - i. Hardware: Stainless steel.
 - j. Size: As shown or next available larger size.
- L. Aggregate for Subgrade Foundation: ASTM C33, coarse aggregate No. 4 and No. 67.
 - M. Spacer: As shown or recommended by conduit manufacturer.
 - N. End Bells: Flared, smooth-surfaced fittings of same material as conduit; if of different material, include adaptor for connection to conduit.
 - O. Grounding: Section 16060.
 - P. Brick: Section 04215.
 - Q. Mortar: Section 04050.

PART 3 - EXECUTION

3.01 EXCAVATING AND BACKFILLING:

- A. Excavating and backfilling: In accordance with Section 02320.
- B. If ducts and manholes are to be installed on backfill over subway structure, place and compact backfill up to grade shown for ductbanks, conduits, manholes and handholes; compact as specified in Section 02320; ensure the manhole sets level. Schedule completion of backfilling to allow sufficient time for installation of ductbanks, conduits, manholes and handholes.
- C. Where shown for subgrade foundation, use layers of coarse aggregate No. 4 and No. 67 in combinations and proportions determined by field conditions.

3.02 PAVEMENTS, SIDEWALKS, CURBS AND GUTTERS:

- A. Remove pavements, sidewalks, curbs and gutters where necessitated by construction of ductbanks, manholes and handholes in accordance with Section 02220.
- B. Place temporary bituminous pavement in accordance with Section 02740, when necessary because of sequence of operations.
- C. On completion of construction, replace pavements, sidewalks, curbs and gutters in accordance with Section 02205.

3.03 INSTALLATION:

- A. General:
 - 1. Use size, type, general routing and locations of ductbanks, conduits, manholes and handholes as shown and specified.
- B. Ductbanks:
 - 1. Place conduits in ductbanks on spacers or construct concrete base prior to placing bottom row of conduits.
 - 2. Use spacers to provide conduit spacing and support as recommended by conduit manufacturer.

3. Make conduit joints watertight by complying with recommendations of conduit manufacturers and as follows:
 - a. PVC conduit: Use solvent cement to join conduits, elbows and fittings.
 - b. Galvanized steel rigid conduit: Use lead-free conductive anti-seize compound on threaded conduit joints.
 - c. Fiberglass conduit: Use adhesive to join conduits, elbows and fittings for water tightness and pull out strength. Follow instructions of conduit manufacturer for using adhesive during periods below the recommended temperature range. Use of rubber sealing gaskets and interference type joints is prohibited.
4. Use Schedule 40 PVC conduit for underground ductbanks except as follows:
 - a. Use galvanized steel rigid conduit only in specific locations as shown.
 - b. Use fiberglass conduit only for providing utility company's 13.8 kv electric services.
5. Place and compact concrete around conduits in accordance with Section 03300.
6. Where shown, install reinforcing steel in concrete encasement in accordance with Section 03200.
7. Bends:
 - a. Unless otherwise shown or specified, install conduit bends in accordance with reference codes.
 - b. Install bends in buried conduit in accordance with the following:

Size of conduit in inches	Minimum radius of factory-bend in inches	Minimum radius of field-bend in inches
3	18	24
4	24	30
5	48	48
6	48	48
 - c. Total bends in each conduit run for traction-power cable: 225 degrees maximum.
 - d. Bend conduit so that field-made bend is free from cuts, dents and other surface damage.
 - e. Field-made bends in fiberglass conduits are prohibited.
8. Support conduit during construction using compatible conduit supports and spacers to maintain positions of conduit during placement of concrete and to ensure independent support.
9. Install conduit so that it drains to adjacent manhole or handhole.
10. Prevent concrete and other foreign materials from entering, obstructing or deflecting conduit. Cap or plug conduit ends prior to pouring concrete.
11. Remove burrs from conduit ends, clean and dry before applying solvent cement to PVC conduit joints or adhesive to fiberglass conduit joints.
12. Pull approved test mandrel and swab through each conduit after installation. Cap or plug conduit ends. If mandrel cannot be pulled through conduit, replace conduit.
13. Leave approved nylon or polyester pull-line in each conduit.
14. At the ends of each conduit, use corrosion-resistant metallic tags with stamped markings to establish identification in accordance with designations shown. Install tags securely to permanent structure near each conduit as approved by the Engineer.
15. Install caps at empty conduit ends for future use.

C. Conduits Without Concrete Encasement:

1. Use Schedule 80 for direct-buried train control conduit.
2. Install caps on ends of empty train control conduits and identify locations of conduit ends with stakes.

3.04 CONSTRUCTION OF MANHOLES AND HANDHOLES:

- A. Provide drainage facilities for manholes and handholes where shown. If connection is made to existing sewer line, install connection in accordance with applicable local regulations
- B. Erect formwork in accordance with Section 03100.
- C. Place reinforcing in accordance with approved shop drawings.
- D. Provide for location of ductbank entrances and inserts in walls as shown.
- E. Place concrete as specified in Section 03300.
- F. Install conduits of material shown.
- G. Install end bells on conduits where ductbanks terminate in manholes and handholes.
- H. Build ductbank formation into walls of manholes and handholes and seal around opening.
- I. If location of manholes and handholes openings will be obstructed, so inform the Engineer.
- J. Install frame and cover, adjusting to finished grade, building brick chimney as specified in Section 02535.
- K. Seal conduit openings with approved conduit plugs.
- L. Install cable pulling eyes and steps as shown. Test pulling eye for compliance with specified pullout load rating.
- M. Install ground rods, 2-inch by 1/4-inch by 12-inch long ground bus bar and insulated grounding conductors where shown. If soil conditions prevent driving rod to required depth, install alternative grounding system as approved. Provide grounding for personnel protection as specified in Section 16060.
- N. When installing sections of precast manholes and handholes, prevent damage to joints seals.
- O. Provide full-height stainless steel channel inserts approximately two feet on center along interior walls, spaced to clear ductbank entrances and steps. Use expansion bolt anchors to secure channel inserts to walls. Install and test channel inserts in accordance with Section 16130.

3.05 INSTALLATION OF HANDHOLES:

- A. Bury precast concrete or composite material handholes with cover mounted flush with finish grade or pavement. Comply with installation procedures furnished by manufacturer.

3.06 CLEAN UP:

- A. Remove debris from manholes and handholes and ensure complete installation is left in neat and finished condition.

3.07 FIELD QUALITY CONTROL:

- A. Arrange with the Engineer for inspection and approval of conduits in ductbank and cast-in-place manholes and handholes prior to concrete placement.
- B. Arrange with the Engineer for a representative of the utility company to inspect and approve service conduits for Authority facilities, relocated utility conduits, manholes and handholes prior to concrete placement.
- C. Arrange with the Engineer for inspection and approval of direct-buried conduits for future train control circuits, prior to backfilling.

END OF SECTION

SECTION 02635

STORM SEWER

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies installing storm sewers, roadway drains, roadway underdrains, ditch lining and slope protection.
- B. Related Work Specified Elsewhere:
 - 1. Section 02320 Grading, excavating and backfilling
 - 2. Section 02270 Maintenance, support and restoration of utility facilities
 - 3. Section 13110 & 13115 Stray current and cathodic protection
- C. Definitions:
 - 1. Granular bedding required by WSSC is equivalent to aggregate for pipe cradle as specified.
 - 2. WSSC: Washington Suburban Sanitary Commission.
 - 3. WASA: District of Columbia Water and Sewer Authority.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Drawings for each size and configuration of precast manhole with details of accessories and joints.
 - 2. Diagrams showing dimensioned locations for openings in precast concrete manhole walls.
- B. Documentation:
 - 1. Submit calculations for modified or special designs to demonstrate compliance with required load-bearing capacity, certified by a professional Authority Representative registered in the jurisdiction where the work is to be installed.
- C. Samples:
 - 1. Sewer brick: Ten.
 - 2. Manhole brick: Ten.
 - 3. Slope protection materials:
 - a. Concrete blocks: Ten each.
 - b. Paving bricks: Ten each.
 - c. Riprap: 1.5 cubic yards.
 - d. Gabions: Two each, complete.
 - 4. Geotextile filter fabric: Two, 12 inches long by 12 inches wide, minimum.
- D. Certification.
- E. WASA Documentation:

1. Submit two copies of records of inspection of new and relocated sewers, one copy to WASA and one copy to the Authority Representative. Include video-tape cassette of television inspections and logs, photographs and other records specified by WASA for visual walk-through inspections.
2. Obtain and submit a written approval and acceptance from WASA.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. Building Stone Institute: Stone Catalog.
 3. CISPI: HSN 85.
 4. WSSC: AASHTO: M33, M36, M153, M175, M176, M190, M252, M288, T85, T96, T104.
 5. WASA: AASHTO: H20, M33, M36, M153, M175, M176, M190, M252, M288, T85, T96, T104.
 6. ANSI/ASME: B16.1.
 7. ACI: 318.
 8. WSSC: ASTM: A36, A48, A53, A74, A167, C14, C32, C33, C76, C144, C150, C207, C361, C425, C443, C478, C507, C700, D698, D1682, D3034, D5034, D5035.
 9. WASA: ASTM: A36, A48, A53, A74, A167, C14, C32, C33, C76, C144, C150, C207, C361, C425, C443, C478, C700, D698, D1682, D3034, D5034, D5035.
 10. MS: MIL-P-23236.
 11. SSPC: SP-6.
 12. WSSC: General Conditions and Standard Specifications.
- B. Source Quality Control:
1. Ditch lining and slope protection materials:
 - a. After approval, do not change source.
 - b. Replace defective material.
- C. Allowable Tolerances:
1. Subgrade: Plus-or-minus 1/2 inch of elevation shown.
- D. WASA : Inspection:
1. Prior to paving or other construction over new or relocated sewers, conduct visual walk-through inspection of sewers larger than 36 inches in diameter and of associated structures and internal television inspection of sewers 36 inches and smaller in diameter.
 2. Employ the services of a sewer inspection company which has been regularly engaged in television sewer inspections and which is acceptable to WASA to perform preconstruction and post-construction inspections of sewers 36 inches and smaller in diameter.
 - a. Submit to WASA for prior approval one sample of the cassettes to be used.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Formwork: Section 03100.

- B. Reinforcing Steel: Section 03200.
- C. Portland Cement Concrete: Section 03300, Class 3500, unless otherwise shown.
- D. Aggregate for Subgrade Foundation: ASTM C33, coarse aggregate, No. 4. Where shown use layers of No. 4 and No. 67 in combinations and proportions determined by field conditions and as approved.
- E. Aggregate for Pipe Cradle: ASTM C33, coarse aggregate No. 67.
- F. Concrete Pipe:
 - 1. 10-inch diameter and smaller:
 - a. ASTM C14, Class 2, nonreinforced concrete pipe.
 - b. Bell-and-spigot type.
 - c. Joints fabricated in accordance with ASTM C361. Physical characteristics for rubber gaskets in accordance with ASTM C443.
 - 2. 12-inch diameter and larger:
 - a. ASTM C76, bell-and-spigot or tongue-and-groove, Class IV, unless otherwise shown.
 - b. Radius (bevel) pipe, with drop between two pipe sections not exceeding the common wall thickness.
 - c. Rubber gasket joints, when required, fabricated in accordance with ASTM C361. Physical characteristics for rubber gaskets in accordance with ASTM C443.
 - d. Acceptance tests as specified in ASTM C76 form basis of acceptance for concrete pipe in accordance with the following:
 - 1) 72-inch diameter and smaller: Acceptance on the Basis of Plant Load Bearing Test, Material Tests and Inspection of Manufactured Pipe for Visual Defects and Imperfections.
 - 2) Larger than 72 inches in diameter: Acceptance on the Basis of Material Tests and Inspection of Manufactured Pipe for Defects and Imperfections.
 - e. Minimum laying lengths: Four feet.
 - f. WSSC: Rubber gaskets: ASTM C361.
 - g. WASA: Rubber gaskets: ASTM C443.
 - h. Jointing mastic: Elastic, water-resistant, formulation of plastic bituminous materials, nonflammable solvent and inert fillers so combined that:
 - 1) When applied to a vertical metal surface and heated to 120F, jointing mastic will neither slump nor lose plasticity.
 - 2) When applied directly from container without further fixing, jointing mastic can be applied in even, adherent coat within temperature range of 20F to 100F.
 - i. WSSC: Reinforced concrete elliptical pipe: ASTM C507.
 - 3. Perforated nonreinforced concrete pipe: AASHTO M175, Type 1 or 2, bell-and-spigot or tongue-and-groove type.
 - 4. Porous concrete pipe: AASHTO M176, tongue-and-groove.
- G. Plastic Pipe:
 - 1. Polyvinyl chloride (PVC) pipe: ASTM D3034, SDR-35.
 - 2. Polyethylene corrugated pipe: AASHTO M252.

- H. Bituminous-Coated Corrugated Metal Pipe: AASHTO M190, Type A or C, with connecting bands, AASHTO M36.
- I. Vitrified Clay Pipe: ASTM C700; Joints, ASTM C425, using plastic materials.
- J. Cast-Iron Soil Pipe and Fittings: ASTM A74, extra-heavy (XH), with hub and spigot ends so constructed that joints may be made with gaskets conforming to CISPI Designation HSN 85 and the requirements of the relevant plumbing codes.
- K. Lubricant for Rubber Gasket Pipe Joints: Vegetable oil soap.
- L. Mortar Materials:
 - 1. Portland cement: ASTM C150, Type I.
 - 2. Sand: ASTM C144, natural sand.
 - 3. Lime: Pressure-hydrated, ASTM C207, Type S.
 - 4. Water: Potable.
 - 5. Pigment: As approved.
- M. Brick: ASTM C32; solid brick; Grade MS for manhole brick, Grade SS for sewer brick; 2-1/4 inches by 3-3/4 inches by eight inches.
- N. WSSC: Precast Concrete Manhole Sections:
 - 1. ASTM C478.
 - 2. Joint entry seal gasket: A-LOK as manufactured by Atlantic Precast Concrete, Inc.; A-LOCK gaskets, manufactured by A-LOK Products Corporation, Trenton, N.J.; DURAC-SEAL gaskets, manufactured by DURA-CRETE, Inc., Dayton, Ohio; or equal.
- O. WASA: Precast Concrete Manholes:
 - 1. Cylindrical, eccentric and conical: ASTM C478.
 - 2. Other configurations: ACI 318, AASHTO H20.
- P. Manhole Steps:
 - 1. Cast iron: ASTM A48 Class 30 A.
 - 2. Rebar: No. 4 reinforcing bar with molded polypropylene or rubber encasement.
- Q. Manhole Frame and Cover; Inlet Frame and Grate; and Ballast Screen;
 - 1. Authority manhole: Cast-iron, ASTM A48, Class 30, with METRO logo.
 - 2. *Rust-resistant cast iron or rust-resistant malleable cast iron.*
 - 3. *True to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes and defects affecting strength.*
 - 4. *Fillets at angles in casting with arises sharp and perfect.*
 - 5. *Sandblasted to effectively remove scale and sand, presenting smooth, clean and uniform surfaces. Coated with bituminous coating.*
 - 6. *Covers that receive paver tile:*
 - a. *Omit bituminous coating.*
 - b. *Provide positioning lug and lug receptor as a permanent part of the cover and frame rim so that the cover can only be installed (flush) in one position.*
- R. Metal Water Seals for Basin Connections: Neenah Foundry Model No. R-3707 or equal.
- S. Structural Steel Members: ASTM A36.

- T. Steel Pipe: ASTM A53, black finish, extra strong wall class.
- U. Stainless Steel Angle: ASTM A167, Type 304.
- V. Jute for Caulking: Good quality jute, free from tar, oil, or grease and dry when installed.
- W. Preformed Expansion Joint Fillers: AASHTO M153, Type I, Type II or Type III.
- X. Bituminous Expansion Joint Filler: AASHTO M33.
- Y. Galvanizing: Section 05120.
- Z. Ditch Lining and Slope Protection:
 - 1. Riprap: Material meeting the following requirements:
 - a. Hard, durable and free of fractures; angular in shape; weather-resistant; and free from overburden, spoil, shale and organic material.
 - b. Size: Weight distribution of pieces provided in accordance with the following:
 - 1) Class I: From 50 to 150 pounds with 60-percent minimum weighing 100 pounds or more; approximately 10 percent may weigh 50 pounds or less.
 - 2) Class II: From 150 to 500 pounds with 50-percent minimum weighing more than 300 pounds; approximately 10 percent may weigh 150 pounds or less.
 - c. Quality:
 - 1) Water absorption: 3.0-percent maximum when tested in accordance with AASHTO T85.
 - 2) Specific gravity: 2.5 minimum when tested in accordance with AASHTO T85.
 - 3) Resistance to abrasion: Grade B maximum when tested in accordance with AASHTO T96.
 - 4) Soundness: Loss 20-percent maximum when tested in accordance with AASHTO T104.
 - 2. Aggregate filter:
 - a. Coarse aggregate, ASTM C33, Size 357.
 - b. Use only tough, durable materials free of thin, flat, elongated or soft friable particles and free of organic matter.
 - 3. Granite block facing: Type 4, quarry split finish on face and edges.
 - 4. Sand cushion for concrete block: Section 03300, fine aggregate.
- AA. Geotextile Filter Fabric: AASHTO M288 and the following additional requirements:
 - 1. Woven or non-woven pervious filter fabric weighing approximately 0.03 to 0.05 pounds per square foot; free of defects.
 - 2. Fabric: Long chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, amide or vinyl-chloride and with stabilizers or inhibitors to make fabric resistant to deterioration due to ultraviolet and heat exposure.
 - 3. Fabric formed or treated so that filaments retain their positions relative to each other.
 - 4. Edges selvaged.
 - 5. Physical strength:
 - a. Tensile strength: 200-pound minimum in each direction, ASTM D1682.
 - b. Elongation at failure: 10 to 30 percent, ASTM D5034 and D5035.
 - c. Puncture strength: 70-pound minimum, ASTM D5034 and D5035.
 - 6. Percent of open area: Not less than five percent nor more than six percent.

7. Equivalent opening size (E.O.S.): 70-100 US Standard Sieve, CW-02215-77.
8. Securing Pins: As recommended by manufacturer of filter fabric.

BB. Gabions:

1. Wire mesh: Galvanized steel wire 0.105 minimum diameter, 60,000 pounds per square inch tensile strength, galvanized at rate of 0.80 ounces per square foot. Wires twisted to form nonraveling hexagonal openings of uniform size, not to exceed 4-1/2 inches in length nor eight square inches in area of mesh opening. Horizontal dimension uniform, not to exceed 36 inches. Gabion dimensions not to vary more than three percent from manufacturer's stated size.
2. Tie devices: Malleable iron or steel, producing frictional force of 160 pounds per foot of spacing. Sized to conform to requirements of jurisdictional agency.
3. Stone: Durable, free from cracks and seams, unweathered, weighing between four pounds (four-inch average diameter) and 30 pounds (eight-inch average diameter) except five percent may vary more or less and 50 percent to exceed 10 pounds.
 - a. Stone size:

Basket Thickness (Inches)	Size of Stones (Inches)
6	3 to 5
9, 12, 18	4 to 7
36	4 to 12

CC. Coal-Tar Epoxy Coating:

1. Two-component.
2. Chemically cured.
3. Conforming to MS MIL-P-23236 (Ships), Type I, Class 2.
4. Thinner: As recommended by manufacturer of coating and as approved.

DD. WSSC: Pipe Supports:

1. Pipe: Three-inch diameter, ASTM A53, Weight B, Class 1.
2. Flanges: ANSI/ASME B16.1, 125-pound Class, galvanized after fabrication.

EE. Prince George's County: Underdrain Filter Material: ASTM C33, Size 57.

2.02 MORTAR AND GROUT MIXES:

A. General Requirements:

1. Mix dry in specified proportions by volume. Control and maintain accurate measurement throughout progress of work.
2. Add sufficient water as specified to produce approved consistency.
3. Do not mix in amount exceeding that which can be used within one hour after introduction of water.
4. Do not retemper mix that has begun to set nor use such mix in the work.
5. Where shown, specified or directed, mix pigment into dry mix to attain color selected by the Authority Representative. Pigment not to exceed 10 percent of dry batch weight of cement.

B. Proportions:

1. Mortar: One part portland cement, 2-1/2 parts sand and water sufficient to produce stiff workable mix.
2. Grout: One part portland cement, 2-1/2 parts sand and water sufficient to produce plastic flowable mix.
3. Mortar for setting and pointing granite: One part portland cement, four to five parts sand, one part lime and water sufficient to produce approved consistency.
4. Mortar for setting granite paving and grouted granite blocks: One part portland cement, four parts sand, with water sufficient to produce approved consistency.

PART 3 - EXECUTION

3.01 EXCAVATION FOR SEWER AND DRAINAGE STRUCTURES:

- A. Perform excavation for sewers and drainage structures to line and grade shown in accordance with Section 02320 and the following additional requirements:
 1. Excavate test pits sufficiently in advance of construction of sewers and drainage structures so that reasonable changes in line and grade can be made where location of existing structures varies from that shown.
 2. Excavate below horizontal plane extending two feet above top of sewer or drainage structures to maximum width of trench pay width shown. Where dimensions are not shown, make maximum horizontal width of excavation 18 inches from outside of sewer or drainage structure and minimum six inches. Where approved, excavation above such plane may exceed specified dimensions.
 3. If excavation exceeds permissible dimensions, encase pipe or install pipe of higher strength.
 4. Where necessary to place backfill or embankment so that trench can be excavated, extend backfill or embankment full depth laterally at least 2-1/2 times diameter of pipe on each side measured from centerline of pipe.

3.02 GEOTEXTILE FILTER FABRIC:

- A. Prepare surface to receive fabric to relatively smooth condition free of obstructions, depressions, debris and soft or low density pockets of material.
 1. Place fabric with long dimension parallel to centerline of trench and lay smooth and free of tension, stress, folds, wrinkles or creases with sufficient excess to allow for minimum overlap of 12 inches.
 2. Place strips in trench to provide minimum width of 12 inches of overlap for each joint.
 3. Insert securing pins with washers through both strips of overlapped fabric at not greater than 3-foot intervals along a line through the midpoint of overlap at joints.
 4. Where this method of placement conflicts with manufacturer's instructions, the manufacturer's instructions prevail.
- B. At time of installation fabric to be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation, storage or handling.
- C. Place fabric in manner and at location shown.

3.03 PIPE CRADLE:

- A. Place pipes on cradle of aggregate or concrete where shown.

- B. Place aggregate so as to avoid segregation; compact to maximum practicable density so that pipe can be laid to required tolerances.

3.04 LAYING PIPE:

A. General Requirements:

1. Excavate to lines and grades shown in accordance with Sections 02320 and herein. Excavate depressions for bells.
2. Protect pipe and fittings during handling to prevent damage.
3. Place, shape and compact bedding material to receive barrel of pipe. Type and thickness of bedding material as shown.
4. Start laying pipe at lowest point; lay true to line and grade shown.
5. Install pipe to bear on bedding material along entire length. Shape bedding material to fit bells and flanges.
6. Install perforated pipe with perforations downward.
7. Install pipe so that bells and grooves are on upstream end.
8. Align each section of pipe with adjoining section with uniform annular space between bell and spigot and so as to prevent sudden offsets in flow line.
9. As each section of pipe is laid, place sufficient backfill to hold it firmly in place.
10. Keep interior of sewer clean as work progresses. Where small pipe size makes cleaning difficult, keep suitable swab or drag in pipe and pull through each joint immediately after jointing is completed.
11. Keep trenches and excavations free of water during construction and until backfilled. Each day, excavate only as much trench as needed to lay pipe.
12. When work is not in progress, securely plug ends of pipe and fittings to prevent trench water or other substances from entering pipes and fittings.
13. Where length of stub is not shown, install four-foot length and seal free end with brick masonry bulkhead or approved stopper.
14. Have work approved prior to covering pipe.
15. Where shown, place additional aggregate filter around and over pipe in lifts not exceeding six inches loose. Compact each lift before placement of next lift.
16. Backfill in accordance with Section 02320.
17. Accomplish compaction by method that will avoid damage to pipe and will not disturb its alignment and grade. The use of vibratory rollers is prohibited until compacted cover over pipe has reached three feet or half the pipe diameter, whichever is greater.
18. Where cathodic protection is shown, apply coal-tar epoxy coating.

B. Vitrified Clay Pipe:

1. Nonperforated pipe:
 - a. Use pipe hoist, crane or other approved device when laying pipe greater than 18 inches diameter.
 - b. Prevent damage to premolded joint rings or attached couplings.
 - c. Clean joint contact surfaces immediately prior to jointing. To complete joint, use lubricants, primers or adhesives as recommended by pipe or joint manufacturer
2. Perforated pipe:
 - a. Firmly position spigot in bell of preceding pipe. Saturate jute gasket in cement grout and caulk into annular space. Ensure that jute is long enough to reach entirely around pipe and is of such thickness to bring pipe sections to same grade.
 - b. After pipe sections have been caulked and centered, fill annual space with cement mortar.

- c. After mortar joints have set, place additional aggregate filter material as specified.
- C. Concrete Pipe:
 - 1. Bell-and-spigot joints:
 - a. Lay bell-and-spigot joint pipe as specified for vitrified clay pipe.
 - 2. Tongue-and-groove joints:
 - a. Clean groove end of preceding pipe with wet brush and apply soft mortar to lower 1/4 of groove. Clean tongue end of succeeding pipe with wet brush and position it. Remove mortar from interior surface if squeezed out of joint.
 - b. Complete mortaring interior and exterior portions of joint for entire circumference, extending from previously placed mortar. Perform final exterior mortaring of joints three lengths of pipe behind laying.
- D. Plastic Pipe:
 - 1. Perforated pipe:
 - a. Use sleeve couplings designed to hold pipe in alignment without use of sealing compound or gaskets.
 - b. Place additional aggregate filter material as specified.
 - c. Cap open ends of underdrains.
 - 2. Nonperforated pipe:
 - a. Join sections of pipe with couplings recommended by pipe manufacturer.
- E. Corrugated Metal Pipe:
 - 1. Perforated pipe:
 - a. Place additional aggregate filter material as specified
 - 2. Nonperforated pipe:
 - a. When pipe is shown to be bituminous paved, place paved area on bottom.
 - 3. Connections for corrugated metal pipe:
 - a. Join sections of pipe with coupling bands arranged to fit corrugations accurately.
 - b. Do not damage protective coating when tightening bolts.
 - c. After final tightening of connection bolts, apply brush coat of bituminous paint to bands and bolts.
- F. Porous Concrete Pipe:
 - 1. Fill joints with mortar as specified for tongue-and-groove joints of concrete pipe.
 - 2. After pipe joints have been made, place additional filter material as specified.
- G. WASA: Inspections Of Sewers:
 - 1. Perform all work in accordance with current requirements of WASA.
 - 2. Perform inspections on new or relocated storm sewers installed by tunneling or jacking under active yard tracks, as follows:
 - a. Make inspections upon completion of tunneling and cut-and-cover operations, but prior to paving.
 - b. Obtain video-tape television inspection records of sewers 36 inches and smaller in diameter.
 - c. By means of visual walk-through inspection, obtain coordinated logs, photographs and other records specified by WASA of sewers larger than 36 inches in diameter and of associated structures.
 - 3. Coordinate all television and walk-through inspection field operations with WASA. All such work to be performed in the presence of a WASA representative.

3.05 BACKFILL:

- A. Perform backfilling only after inspection and approval of pipe laying.
- B. On completion of construction, backfill excavation in accordance with Section 02320.

3.06 JOINTS FOR CONCRETE STORM SEWER 12 INCHES TO 33 INCHES:

- A. Use cold applied jointing mastic for joints of storm sewer 12 inches to 33 inches in diameter.
- B. Bell-and-Spigot Joints:
 - 1. Clean interior surface of bell and fill lower portion with mastic of sufficient thickness to make inner surfaces of abutting sections flush.
 - 2. Install spigot end of adjoining pipe into bell so that sections are closely fitted and aligned.
 - 3. Apply sufficient jointing mastic to fill remaining void in joint.
 - 4. Remove excess mastic from interior of pipe.
- C. Tongue-and-Groove Joints:
 - 1. Clean groove. Apply mastic to lower half of groove.
 - 2. Clean tongue of next pipe and apply layer of mastic to upper half.
 - 3. Fit tongue into groove until pipes are closely fitted and aligned and mastic covers inner and outer surfaces.
 - 4. Remove excess mastic from interior of pipe.

3.07 JOINTS FOR CONCRETE STORM SEWER 36 INCHES AND LARGER.

- A. Where not prohibited by jurisdictional agencies, Use mortar for joints of storm sewers 36 inches diameter and larger.
- B. Bell-and-Spigot Joints:
 - 1. Where pipe cradle is aggregate, place shallow bed of mortar under joint.
 - 2. Thoroughly wet bell and fill lower half with mortar.
 - 3. Thoroughly wet spigot and uniformly fit into bell so that sections are closely fitted and aligned.
 - 4. Fill remaining annular space in bell with mortar sufficient to form bead around outside of spigot end of pipe.
 - 5. Remove excess mortar from interior of pipe and finish exterior and interior to smooth surfaces.
- C. Tongue-and-Groove Joints:
 - 1. Thoroughly wet groove; apply mortar to lower half of groove.
 - 2. Thoroughly wet tongue of next pipe and apply a layer of mortar to top half.
 - 3. Fit tongue into groove until pipes are closely fitted and aligned and mortar covers inner and outer surfaces of the joint.
 - 4. Clean inner surface of pipes at joint and point up outside with bead of mortar.

3.08 Not Used

3.09 JOINTS FOR VITRIFIED CLAY PIPE:

- A. Immediately before joining vitrified pipe, liberally coat bell with lubricant and fit spigot with gasket.
- B. Join pipes using equipment designed for purpose.

3.10 JOINTS FOR CAST-IRON SOIL PIPE AND FITTINGS:

- A. Immediately before joining cast-iron soil pipe and fittings, liberally coat hub with lubricant and fit spigot with pipes using equipment designed for purpose.

3.11 CONNECTIONS WITH EXISTING SEWERS:

- A. Make connections with existing public sewers in accordance with requirements of the jurisdictional authority.
- B. Do not connect existing sewer to sewer under construction unless approved.

3.12 TUNNELING AND JACKING:

- A. Perform tunneling and jacking by approved methods.
- B. Where open cut is specified and the Authority Representative permits the work to be done by tunneling or jacking, perform such work as specified and as approved.
- C. Cost of material substitutions required by change of methods will be borne by the Design-Builder.
- D. Make horizontal borings necessary to lay pipe lines true to line and grade.
- E. When sewers are laid in borings, completely fill void between outside barrel of pipe and boring with cement grout pumped into place.
- F. When drainage pipes are laid in borings, completely fill void between pipe and boring with sand, using water pressure to ensure that voids are filled.
- G. Methods of boring and filling of voids between pipe and boring are subject to approval.

3.13 CAST-IN-PLACE CONCRETE CONSTRUCTION:

- A. Conform to applicable requirements of Sections 03100, 03200 and 03300. Section designer to specify the type of cement to be used. The type of cement will vary depending upon the jurisdiction where the work is performed.
 - 1. Cement: Meet requirements of applicable jurisdiction.
- B. Construct concrete support systems where shown. Section designer to specify the type of mortar to be used. Mortar type will vary depending upon jurisdiction in which the work is performed.
 - 1. Mortar and cement: Meet requirements of applicable jurisdiction.

3.14 BRICK CONSTRUCTION:

- A. Perform brick construction as specified in Section 04215, with the following additional requirements:
 - 1. Use sewer brick wherever brick construction is exposed to flow; otherwise, use manhole brick.
 - 2. Lay sewer brick on edge so that 2-1/4 by 8-inch side is exposed to flow.
 - 3. Lay manhole brick so that every sixth course is a header course.
 - 4. Where practicable, lay each course with a line. For curved courses or those in nonparallel planes, use bonded-and-keyed construction.
 - 5. Do not exceed joint thickness of 3/8 inch in straight courses in parallel planes; for courses curved or in nonparallel planes, make thickest part of joint as thin as practicable.
 - 6. Rack or tooth uncompleted brick construction and parge unexposed surfaces with 1/2 inch of mortar.

3.15 MANHOLES:

- A. Construct manholes of precast sections, cast-in-place concrete or brick as shown.
- B. Provide base of precast or cast-in-place construction. Make watertight connection between base and risers.
- C. Unless otherwise shown, place axes of manholes directly over centerlines of pipes.
- D. Construct appropriate flow channels in bottom of manholes.
- E. Where necessary, build connections for public and residential sewers into manholes. Cut pipe flush with inside wall of structure. Do not build pipe into wall; provide mortar joint between pipe and structure.
- F. Install manhole steps and cast iron frame and cover for each manhole; adjust frame and cover to proper grade by brick construction.
- G. WSSC: Install joint entry seal gaskets in openings in the walls of 48-inch precast manholes with O-ring joint.

3.16 CATCH BASINS AND INLETS:

- A. When grading has been substantially completed as approved, construct catch basins of cast-in-place concrete using Class 3500 concrete and steel reinforcement as shown, precast sections or brick as shown.
- B. Cut pipe flush with inside wall of structure. Provide mortar joint between pipe and structure or install water seal as shown.
- C. Install cast iron frame and grate or cover and adjust to proper grade.
- D. WSSC: Install pipe supports as shown. Fill with concrete after installation.

3.17 DITCH LINING AND SLOPE PROTECTION:

A. Slope Preparation:

1. Excavate or fill slopes to the required cross section, lines and grades.
2. Compact earth slopes to not less than 95 percent of the maximum dry density for a depth of not less than 12 inches, as specified in Section 02725.
3. Where lining or protection is to be applied to rock surfaces, clean off mud, debris and loose fragments.
4. Construct toe or cut off walls where shown.
5. Remove loose material and buried debris protruding from subgrade.
6. Placement of aggregate filter:
 - a. Place filter aggregate where shown to depth shown.
 - b. Compact each layer of aggregate filter in accordance with ASTM D698, Method D, to 100 percent at plus-or-minus one percent of optimum moisture content.

B. Ungrouted Riprap:

1. Place aggregate filter as specified.
2. Place riprap by machine to full course thickness in one operation upward from bottom of slope. Prevent displacement of underlying materials. Dumping of riprap is prohibited.
3. Fill spaces between larger stones to produce nearly even surface with minimum of voids. Manually supplement machine placement of stone to choke in voids.
4. Rearrange individual stones as necessary to ensure that finished configuration conforms to lines, grades and thickness shown.

C. Bituminous Concrete Paving:

1. Place bituminous concrete where shown to the lines, grades, thickness and shapes shown.
2. Give base course prime coat of medium-curing, cutback asphalt and allow to cure before hot bituminous concrete is placed.
3. Place hot-mix bituminous concrete by hand or by machine.
4. When hand methods are used, place mixture by means of hot shovels or forks and spread with hot rakes to thickness required to obtain specified compacted thickness. Thoroughly rake loose material throughout its depth, to eliminate honeycombing. Use screed boards of width equal to required thickness of lining.
5. After spreading, compact until specified compacted thickness is obtained.
6. Place mixture as continuously as practicable to eliminate joints. Where joints are required at end of a day's work or when the placing is discontinued for such period of time that material becomes chilled, form joints as specified.

D. Cast-in-Place Concrete:

1. Use Class 3500 concrete unless otherwise shown.
2. Use wood or steel forms.
3. Place reinforcing steel or wire mesh as shown.
4. Provide and install dowel bars where shown in accordance with Section 02750.
5. Locate expansion and contraction joints where shown in accordance with Section 02750.
6. Unless otherwise shown, give surface wood float finish.
7. Protect and cure concrete in accordance with Section 03300.

- E. Concrete Masonry Units:
1. Place two-inch layer of sand cushion on previously prepared slope.
 2. Set units firmly by hand in sand cushion with long dimension parallel to base of slope so as to produce even surface.
 3. Lay blocks with open 3/8-inch joints and with joints staggered as shown.
 4. Completely fill joints with mortar.
 5. Protect and cure newly laid blocks for seven days using wet cotton mats or wet burlap.
 6. Lay blocks when the temperature is 40F or above.
- F. Paving Brick:
1. On the previously prepared slope, place concrete base of thickness shown.
 2. Give concrete smooth screed finish.
 3. Clean base, dampen and lay one-inch thick mortar bed.
 4. Lay bricks with long dimension parallel to base of slope, with open 3/8-inch joints and with joints staggered.
 5. Bed bricks firmly in mortar bed so as to produce even surface free from depressions or high spots.
 6. Fill joints completely with mortar.
 7. Protect and cure newly laid brick for a period of seven days using wet cotton mats or wet burlap.
- G. Sodding: Section 02920.
- H. Concrete Pavement:
1. Lay plastic pipe as shown.
 2. Place aggregate filter as specified.
 3. Place concrete base in accordance with specified requirements for cast-in-place concrete.
- I. Concrete with Granite Block Facing:
1. Lay plastic pipe as shown.
 2. Place aggregate filter as specified.
 3. Place concrete base in accordance with specified requirements for cast-in-place portland cement concrete.
 4. Installation of granite block facing:
 - a. Set granite blocks in bedding course, one-inch minimum depth with 3/4-inch joint width.
 - b. Slope bedding to true surface parallel to finished surface of blocks; strike off bedding until true alignment is attained.
 - c. After final sloping, do not disturb bedding prior to laying blocks.
 - d. Lay blocks on bedding course in successive courses with quarry split finish up.
 - e. Align each course, lay true and even and bring to true grade by use of wood mallets or similar tools.
 - f. Lay blocks in continuous sequence.
 - g. Lay no more mortar than can be covered with blocks before end of work day.
 - h. Point voids in joints with preshrunk mortar. Do not point when ambient temperature is 50F and falling. After pointing, scrub surfaces with soap solution and remove stains. Rinse immediately with clean water. Leave work in first class condition, free from mortar stain and other defacement as approved.

- J. Gabions:
 - 1. Prepare ground surface smooth and even where gabions will be installed.
 - 2. Assemble gabions and tie together in accordance with manufacturer's instructions.
 - 3. Fill gabions in lifts of 12 inches maximum. Install tie devices in all units with exposed faces, spaced in accordance with requirements of jurisdictional agency.
 - 4. Ensure stone fill is placed without voids larger than approximately smaller stones. Hand-place stones in exposed faces.

3.18 CONCRETE HEADWALLS AND WINGWALLS:

- A. Excavation:
 - 1. Excavate for foundations and walls to lines and grades shown in accordance with Section 02320.
- B. Formwork and Reinforcement:
 - 1. Erect formwork and install reinforcement as shown and in accordance with Sections 03100 and 03200.
- C. Concrete Work:
 - 1. Place concrete of class shown and protect and cure in accordance with Section 03300.
- D. Backfilling:
 - 1. Backfill and compact in accordance with Section 02320.

3.19 COATING APPLICATION AND REPAIR:

- A. Preparation of surface: Perform the following in order given:
 - 1. Clean surfaces contaminated with oil or grease using naphtha or xylol.
 - 2. Remove rust and mill scale from surfaces by dry abrasive blasting to commercial finish in accordance with SSPC SP-6.
 - 3. Coat surfaces within 24 hours and before dew point is reached.
 - 4. Apply coating only to surfaces which are dry and free of contaminants. Whip blast surfaces not coated within specified time limit.
 - 5. Application of coating:
 - a. Mix coating in quantity which can be applied within its pot life if in accordance with manufacturer's recommendation. Thin only with approval.
 - b. Apply coating to exterior surfaces of pipes and fittings in accordance with recommendations of coating manufacturer and as follows:
 - 1) Two coats of equal thickness.
 - 2) Total dry film thickness: 20 mils.
 - 3) Pretreat first coat as required prior to application of second coat.
 - 4) Apply second coat before first coat has dried tack-free but not later than 24 hours after application of first coat, unless otherwise recommended by coating manufacturer.
 - 5) Inspect coating prior to burial. Repair damages in accordance with recommendations for field corrections by coating manufacturer.
 - 6. Test cathodic protection as specified in Section 13115.

3.20 Not Used

3.21 FIELD QUALITY CONTROL:

- A. Maximum Surface Variation Tolerances:
 - 1. Grouted riprap: 1-1/4 inches in four feet from true plane.
 - 2. Bituminous concrete: Plus-or-minus 1/4 inch from specified grade in 25 feet.
 - 3. Cast-in-place concrete: Plus-or-minus 1/4 inch from specified grade in 15 feet.
 - 4. Precast concrete block: Plus-or-minus 1/2 inch from specified grade in 25 feet.
 - 5. Paving brick: Plus-or-minus 1/2 inch from specified grade in 25 feet.

- B. Obstruction Tests:
 - 1. Perform field tests to verify that installed storm systems are free from obstructions.
 - 2. Remove obstructions by excavating at the apparent obstruction and repairing or replacing the defective pipe as directed by the Authority Representative.

3.21 Not Used

3.21 ABANDONED STORM SEWERS:

- A. Meet requirements of Section 02270.
- B. Fill abandoned sewer with sand.

END OF SECTION

SECTION 02636

STORMWATER MANAGEMENT, SEDIMENT AND EROSION CONTROL, AND WETLANDS MITIGATION.

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies installing ditch lining, slope protection, stormwater management, wetlands mitigation, and low impact development strategies where appropriate and applicable, and sediment and erosion controls.
- B. All work shall be constructed in accordance with the applicable sections and requirements of the following jurisdictional agencies:
 - 1. The Maryland Department of the Environment
 - 2. The Maryland State Highway Administration
 - 3. The District of Columbia Department of Health, Environmental Health Administration, Bureau of Environmental Quality, Watershed Protection Division
 - 4. The U. S. Army Corps of Authority Representatives
 - 5. Prince Georges County Department of Environmental Resources
 - 6. Montgomery County Department of Environmental Protection

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. All materials shall conform to the requirements of the applicable jurisdictional agency.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All work shall be performed in conformance with the requirements of the applicable jurisdictional agency.
- B. All inspections and testing shall be accomplished in conformance with the requirements of the applicable jurisdictional agency.

END OF SECTION

THIS PAGE NOT USED

SECTION 02725
BASE FOR PAVEMENTS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies furnishing, placing, shaping and compacting aggregate base on previously constructed subgrades.

- B. Related Work Specified Elsewhere:
 - Section 02320 Grading, excavating and backfilling
 - Section 02740 Bituminous pavement
 - Section 02750 Concrete pavement

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM: D1241, D1557.

- B. Source Quality Control:
 - 1. Not less than 10 days prior to the beginning of work, inform the Engineer of source of material to be used.
 - 2. Once approved, do not change source of supply.
 - 3. Do not construe approval as approval of the entire location but as approval only insofar as material continues to conform to specified requirements.
 - 4. Cooperate with the Engineer so that the Engineer may take samples and make tests as often as he deems necessary.
 - 5. The Engineer has the right to reject material at the job site by visual inspection, pending sampling and testing.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Aggregate Base Materials:
 - 1. ASTM D1241.

2. Grading requirements:

Sieve Designation	Percentage By Weight Passing Square Mesh Sieves
2-1/2 inches	100
1 inch	85 - 100
1/2 inch	50 - 92
Size 10	35 - 65
Size 40	15 - 45
Size 200*	3 - 15

*Fraction passing the Size 200 sieve to be not greater than 2/3 of the fraction passing the Size 40 sieve.

PART 3 - EXECUTION

3.01 EQUIPMENT:

- A. Place material using equipment designed for the purpose. Use equipment of size and weight necessary to shape material as shown and to compact material to specified minimum density.
- B. Provide sufficient equipment to achieve specified compaction at rate consistent with rate of placement of base material.
- C. Obtain approval of equipment prior to use on the work.
- D. Maintain equipment in first class operating condition while in operation.

3.02 PLACING MATERIAL:

- A. Subgrade Preparation: In accordance with Section 02320.
- B. Place material in its final location so as to provide uniformity of grading throughout work.
- C. Use graders for touching up and for working materials into areas which do not permit use of other equipment providing there is continuing conformance to specified requirements and providing approval is obtained.
- D. Place material in uniform layers so that each layer has compacted lift thickness of six inches maximum and three inches minimum.
- E. Where thickness is shown or specified is more than six inches, place material in two or more layers of equal thickness so that specified requirements are met.

3.03 COMPACTION:

- A. During placing and compacting, obtain moisture content and dry density within the allowable tolerances specified.
- B. Compact each layer to required density before placing next layer.
- C. Compact areas not accessible to rollers to required density by means of approved mechanical tampers.
- D. Puddling or jetting is prohibited.
- E. Density:
 - 1. Compact material under curbs and gutters, gutters, curbs and pavement to 98 percent of maximum density at proper moisture content.
 - 2. Compact material under sidewalks to 95 percent of maximum density at proper moisture content.

3.04 FIELD QUALITY CONTROL:

- A. Allowable Tolerances:
 - 1. Construct base to the following tolerances:
 - a. Thickness of base: Plus zero or minus 3/8 inch.
 - b. Surface of base:
 - 1) Plus 1/8 inch or minus 3/8 inch of elevation shown.
 - 2) Deviation not more than 1/2 inch from steel straightedge as specified in Section 02750.
 - 2. Maintain moisture content within two percent of optimum moisture content.
- B. Tests: Determine optimum moisture content and maximum density in accordance with ASTM D1557.

3.05 MAINTENANCE:

- A. Throughout placing and compacting, and until the placing of the succeeding pavement course, maintain base for pavement in specified condition.

3.06 DEFICIENT BASES:

- A. Where directed, repair or remove and replace, with new material, pavement base that does not meet requirements.

END OF SECTION

THIS PAGE NOT USED

SECTION 02726

SUB-BALLAST

PART 1 - GENERAL

1.01 DESCRIPTION:

This section specifies furnishing, placing and compacting sub-ballast on previously constructed subgrade.

1.02 QUALITY ASSURANCE:

Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of the jurisdictional authorities.
2. Comply with reference standards:
 - a. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
 - b. ASTM C117 - Standard Test Method for Materials Finer than 75 Micro Meter (No. 200) Sieve in Mineral Aggregates by Washing
 - c. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
 - d. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - e. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - f. ASTM C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates
 - g. ASTM C702 - Standard Practice for Reducing Samples of Aggregate to Testing Size
 - h. ASTM D75 - Standard Practice for Sampling Aggregates
 - i. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
 - j. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
 - k. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 - l. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

B. Testing:

1. Except for gradation QC testing, sampling and testing shall be performed by an independent testing laboratory approved by the Authority Representative. The independent laboratory shall prepare the test report.

C. Source of Materials, Qualification:

1. The source of the sub-ballast material shall be qualified and approved by the Authority Representative prior to commencing sub-ballast delivery to project site.

- a. Sample and test sub-ballast source material as specified herein for sub-ballast material.
 - b. To qualify and to be approved, source materials shall meet requirements specified herein.
 2. If the source of sub-ballast material is changed, the new source shall be qualified and approved before delivering sub-ballast from the new source.
- D. Gradation Quality Control:
1. Prior to shipment, the Design-Builder shall sample and prepare a gradation QC report for each 2,000 tons of sub-ballast being loaded for shipment.
 - a. The sample shall be representative of the sub-ballast being loaded for shipment.
 - b. The sample shall be taken in accordance with ASTM D75.
 - c. The sample size shall be in the quantities listed in ASTM D75 for gradation testing.
 - d. The gradation report shall be prepared for each sample and shall include the following information.
 - 1) Identification of the source material.
 - 2) Date of sample.
 - 3) Sample number.
 - 4) Shipment number.
 - 5) Sieve analysis.
 2. In the event any two individual samples fail to meet the specified gradation requirement, immediate corrective action shall be taken to restore the production process to the specified gradation. The Design-Builder shall advise in writing the Authority Representative of the corrective action being taken.
 3. In the event of repeated failures, i.e., two or more samples failing in two successive shipments, the Authority Representative reserves the right to reject the shipment.
- E. Sub-Ballast Quality Control.
1. QC samples shall be taken at the project site from every 15,000 tons of sub-ballast delivered. Samples shall be representative of sub-ballast delivered. Samples shall be tested and shall meet the specified requirements.
- F. Inspection:
1. The Authority Representative has the right to stop delivery of sub-ballast to the job site based on visual inspection pending sampling and testing.
 2. If sub-ballast loaded, being loaded or installed does not conform to specified requirements, the Authority Representative will reject the sub-ballast and no further delivery will be accepted until the deficiency is corrected.
- G. Field Quality Control of Placement and Compaction:
1. Allowable Tolerances:
 - a. Construct surface of sub-ballast to the following tolerances:
 - 1) Within 0.1 foot of elevation shown.
 - 2) Deviation not more than 1/2 inch from 10-foot straightedge.
 - b. During compaction maintain moisture content within two percent of optimum moisture content.
 2. Tests:
 - a. Determine optimum moisture content and maximum dry density in accordance with ASTM D698.

- b. Determine in-place density in accordance with ASTM D2922 or ASTM D 1556 and moisture content in accordance with ASTM D3017.
 - 1) Only one method, ASTM D2922 or ASTM D 1556, shall be used through out the project.
- H. Defective Sub-Ballast and Workmanship:
 - 1. Remove from site and replace defective sub-ballast.
 - 2. Remove from and replace sub-ballast placed on muddy or frozen subgrade or subgrade with standing water.
 - 3. Reshape sub-ballast to the specified compacted thickness, shape and elevation.
 - 4. Re-compact while maintaining optimum moisture content until specified compaction is achieved.
- I. Subsequent Work:
 - 1. Subsequent work such as placing or storing ties, ballast, rail, etc. done on top of the sub-ballast before the sub-ballast placement, shaping and compaction has been completed, tested and approved shall be temporary work and shall be removed to replace defective sub-ballast, to repair defective workmanship, and to complete shaping, compaction and testing of the sub-ballast.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Independent Testing Laboratory: The following data shall be submitted and approved prior to required sampling and testing is performed.
 - 1. Name of laboratory
 - 2. Address (location) of laboratory
 - 3. Telephone number
 - 4. Name of Owner or Principal with Authority
 - 5. Key Technical Personal with resumes
 - 6. Laboratory resume with qualifying work experience
- B. Certification: The following certifications shall be submitted in a timely manner and shall be approved before final subsequent work on top of the sub-ballast is started.
 - 1. Qualification of source material.
 - a. Qualification samples were taken from and are representative of the material from the source that will be used to furnish the sub-ballast.
 - b. Qualification tests were performed as specified on the qualification samples by the approved independent laboratory.
 - c. Qualification test reports are the test results from the qualification tests performed on the qualification samples.
 - d. Reported test results meet the specified requirements.
 - 2. At time of delivery.
 - a. With each delivery, submit certificates attesting that sub-ballast furnished is typical of the qualified material and submit gradation QC reports for the delivered ballast.
 - 1) Gradation QC samples were taken from 2,000 tons of sub-ballast being loaded for shipment.
 - 2) Sieve analysis was performed on the gradation QC samples.

- 3) Gradation QC reports are the test results from the sieve analysis performed on the gradation QC samples.
3. QC of sub-ballast delivered to site.
 - a. QC samples were taken from sub-ballast delivered to the site at the specified frequency.
 - b. QC tests were performed as specified on the QC samples by the approved independent laboratory.
 - c. QC test reports are the test results from the QC tests performed on the QC samples.
 - d. Reported test results meet the specified requirements.
 4. Field QC of placed and compacted sub-ballast
 - a. Sub-ballast was placed as specified.
 - b. The compacted final shape, thickness and elevation meets the tolerances specified.
 - c. Field QC tests were performed as specified on the placed and compacted sub-ballast by the approved independent laboratory.
 - d. Field QC test reports are the test results from the field QC tests.
 - e. Reported test results meet the specified requirements.
 5. Defective sub-ballast and workmanship
 - a. Discovered defective sub-ballast has been removed from site, replaced, shaped and compacted as specified.
 - b. Sub-ballast improperly placed on muddy or frozen subgrade or subgrade with standing water has been removed from site, replaced, shaped and compacted as specified.
 - c. Sub-ballast discovered not meeting the compacted shape, thickness and elevation requirements has been reshaped to the specified compacted shape, thickness and elevation requirements.
 - d. Sub-ballast discovered not meeting the compaction requirements has been re-compacted and the specified compaction has been achieved.
- C. Samples and Documentation:
1. Qualification: Submit samples, source of supply, test results and report, and certification sufficiently in advance to obtain approval not less than 30 days prior to date of commencing delivery.
 - a. If material or source is to be changed, then submit samples, source of supply, test results and report, and certification sufficiently in advance to obtain approval not less than 30 days prior to date of commencing delivery of sub-ballast from the new material or source.
 2. Gradation QC Reports: Certified Gradation QC Reports shall be prepared and submitted with each sub-ballast delivery.
 3. QC of sub-ballast delivered: Certified QC Test Reports shall be prepared and submitted in a timely manner.
 4. Field QC: Certified Field QC Test Reports shall be prepared and submitted in a timely manner.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Sub-Ballast: Crushed stone free of vegetable matter and other deleterious substances, with the following additional requirements:

1. Samples shall be secured, reduced, shipped and identified in accordance with ASTM D75 and ASTM C702.
2. Gradation: ASTM C136 and ASTM C117 with the following additional requirements:

Sieve Size	Percent Passing By Weight
1 inch	100
3/8 inch	50 to 85
4	35 to 65
10	25 to 50
40	15 to 25
200	5 to 15

- a. Fraction passing the Size 200 sieve less than two thirds of fraction passing Size 40 sieve.
3. Clay lumps and friable particles: ASTM C142, 0.5 percent maximum.
4. Wear: ASTM C131, 40 percent maximum.
5. Absorption: ASTM C127, 0.5 percent maximum.
6. Soundness: ASTM C88, weighted average loss 15 percent maximum after five cycles of magnesium sulfate tests.

PART 3 - EXECUTION

3.01 PLACING MATERIAL:

- A. Immediately prior to placing sub-ballast, subgrade shall conform to the subgrade compaction and shape requirements.
- B. Do not place sub-ballast on subgrade that is muddy, rutted or frozen or has standing water.
- C. Prior to placing sub-ballast, repair subgrade using sub-ballast and remove loose or extraneous material.
- D. Place sub-ballast to provide uniformity of grading throughout work.
- E. If subgrade is dusty, sprinkle it prior to placing sub-ballast.
- F. Deliver sub-ballast as uniform mixture and spread sub-ballast without causing segregation.
- G. Sub-ballast shall be kept free and clean of foreign material during delivery, placement and shaping.
- H. Install sub-ballast to shape shown and to a minimum compacted thickness of 8 inches. Place sub-ballast in two or more layers of equal thickness of not more than six inches each.

1. Measure and verify that the compacted sub-ballast is at specified minimum thickness and shape.

3.02 COMPACTION:

- A. During placing and compacting, maintain moisture content within specified tolerance.
- B. Compact sub-ballast for its full depth to 100 percent of maximum dry density.
 1. Measure and verify specified compaction has been achieved.

END OF SECTION

SECTION 02727

BALLAST

PART 1 - GENERAL

1.01 DESCRIPTION:

This section specifies furnishing mineral aggregate for use as ballast for ballasted track construction.

1.02 QUALITY ASSURANCE:

Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of the jurisdictional authorities.
2. Comply with reference standards.
 - a. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
 - b. ASTM C117 - Standard Test Method for Materials Finer Than 75 Micro Meter (No. 200) Sieve in Mineral Aggregates by Washing
 - c. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
 - d. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - e. ASTM C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates
 - f. ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - g. ASTM C702 - Standard Practice for Reducing Samples of Aggregate to Testing Size
 - h. ASTM D75 - Standard Practice for Sampling Aggregates
 - i. ASTM D4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
 - j. ASTM E11 - Standard Specification for Wire Cloth and Sieves for Testing Purposes
 - k. AREMA - Manual for Railway Engineering

B. Testing:

1. Except for gradation QC testing, sampling and testing shall be performed by an independent testing laboratory approved by the Authority Representative. The independent laboratory shall prepare the test report.

C. Source of Materials, Qualification:

1. The source of the ballast material shall be qualified and approved by the Authority Representative prior to commencing ballast delivery to project site.
 - a. Sample and test ballast source material as specified herein for ballast material.

- b. To qualify and to be approved, source materials shall meet requirements specified herein.
2. If the source of ballast material is changed, the new source shall be qualified and approved before delivering ballast from the new source.

D. Gradation Quality Control:

1. Prior to shipment, the Design-Builder shall sample and prepare a gradation QC report for each 1000 tons of ballast being loaded for shipment.
 - a. The sample shall be representative of the ballast being loaded for shipment.
 - b. The sample shall be taken in accordance with ASTM D75.
 - c. The sample size shall be in the quantities listed in ASTM D75 for gradation testing.
 - d. The gradation report shall be prepared for each sample and shall include the following information.
 - 1) Identification of the source material.
 - 2) Date of sample.
 - 3) Sample number.
 - 4) Shipment number.
 - 5) Sieve analysis.
2. In the event any two individual samples fail to meet the specified gradation requirement, immediate corrective action shall be taken to restore the production process to the specified gradation. The Design-Builder shall advise in writing the Authority Representative of the corrective action being taken.
3. In the event of repeated failures, i.e., two or more samples failing in two successive shipments, the Authority Representative reserves the right to reject the shipment.

E. Ballast Quality Control.

1. QC samples shall be taken at the project site from every 4,000 tons of ballast delivered. Samples shall be representative of the ballast delivered. Samples shall be tested and shall meet the specified requirements.

F. Inspection:

1. The Authority Representative has the right to stop delivery of ballast to job site by visual inspection, pending sampling and testing.
2. If ballast loaded, being loaded or installed does not conform to specified requirements, the Authority Representative will reject the ballast and no further delivery will be accepted until the deficiency has been corrected.

G. Defective Ballast:

1. Remove from site and replace defective ballast.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Independent Testing Laboratory: The following data shall be submitted and approved prior to required sampling and testing is performed.
 - 1. Name of laboratory
 - 2. Address (location) of laboratory
 - 3. Telephone number
 - 4. Name of Owner or Principal with Authority
 - 5. Key Technical Personal with resumes
 - 6. Laboratory resume with qualifying work experience

- B. Samples and Documentation:
 - 1. Qualification: Submit samples, source of supply, test results and report, and certification sufficiently in advance to obtain approval not less than 30 days prior to anticipated date of commencing delivery.
 - a. If material or source is to be changed, then submit samples, source of supply, test results and certification sufficiently in advance to obtain approval not less than 30 days prior to date of commencing delivery of ballast from the new material or source.
 - 2. Gradation QC Reports: Certified Gradation QC Reports shall be prepared and submitted with each ballast delivery.
 - 3. QC of ballast delivered: Certified QC Test Reports shall be prepared and submitted in a timely manner.

- C. Certification: The following certifications shall be submitted in a timely manner.
 - 1. Qualification of source material.
 - a. Qualification samples were taken from and are representative of the material from the source that will be used to furnish the ballast.
 - b. Qualification tests were performed as specified on the qualification samples by the approved independent laboratory.
 - c. Qualification test reports are the test results from the qualification tests performed on the qualification samples.
 - d. Reported test results meet the specified requirements.
 - 2. At time of delivery.
 - a. With each delivery, submit certificates attesting that ballast furnished is typical of the qualified material and submit gradation QC reports for the delivered ballast.
 - 1) Gradation QC samples were taken from 1,000 tons of ballast being loaded for shipment.
 - 2) Sieve analysis was performed on the gradation QC samples.
 - 3) Gradation QC reports are the test results from the sieve analysis performed on the gradation QC samples.
 - 3. QC of ballast delivered to site.
 - a. QC samples were taken from ballast delivered to the site at the specified frequency.
 - b. QC tests were performed as specified on the QC samples by the approved independent laboratory.
 - c. QC test reports are the test results from the QC tests performed on the QC samples.

- d. Reported test results meet the specified requirements.
- 4. Defective ballast.
 - a. Discovered defective ballast has been removed from site and replaced.

1.04 PRODUCT DELIVERY, HANDLING, AND STORAGE:

- A. Deliver, handle, and store the ballast by methods that prevent damage, fouling and segregation.
 - 1. Ballast shall be loaded only into rail cars or trucks that are tight enough to prevent leakage and are clean and free from rubbish and other foreign substance that would foul the ballast.
 - 2. Ballast shall be unloaded as close as possible to the point of use t minimize the amount of handling.
- B. The following are prohibited:
 - 1. Storage of ballast in cone-shaped piles.
 - 2. Subjecting ballast to repeated passes of equipment over same levels in stockpile area.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Ballast: Crushed stone shall be from diabase rock and shall be hard, strong, angular, durable, free from injurious amounts of vegetable matter and other deleterious substances, with the following additional requirements:
 - 1. Ballast samples shall be secured, reduced, shipped and identified in accordance with ASTM D75 and ASTM C702.
 - a. Minimum sample size: 200 pounds.
 - 2. Ballast shall be graded in accordance with ASTM C136 using wire-cloth sieves conforming to ASTM E11. Gradation shall meet the following requirements:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
	AREMA SIZE 5 Yard
2 inches	-
1-1/2 inches	100
1 inch	90 to 100
3/4 inch	40 to 75
1/2 inch	15 to 35
3/8 inch	0 to 15
Size 4	0 to 5

3. Fine particles - Material finer than Size 200 sieve, ASTM C117, one percent by weight maximum.
4. Flat and elongated particles - Use dimension ratio of 1:3 - ASTM C4791, five-percent by weight maximum.
5. Clay lumps and friable particles - ASTM C142, 0.5-percent maximum.
6. Wear - ASTM C535, 40-percent maximum.
7. Absorption - ASTM C127, 1.5-percent maximum.
8. Soundness - ASTM C88, 10-percent maximum loss after five cycles of the sodium-sulfate test.

PART 3 - EXECUTION

3.01 INSTALLATION:

Install ballast in accordance with the ballasted trackwork construction requirements of Section 05652.

END OF SECTION

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SECTION 02740

BITUMINOUS PAVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing bituminous pavement.
- B. All bituminous pavement work in Greenbelt Yard, Shady Grove Yard and Brentwood Yard, shall be designed and constructed in accordance with all requirements of the Maryland State Highway Administration (SHA) and in accordance with the latest Maryland SHA Standard Specifications for Construction and Materials.

PART 2-PRODUCTS

2.01 MATERIALS:

- A. All bituminous pavement materials for Greenbelt Yard, Shady Grove Yard and Brentwood Yard, shall conform to the applicable requirements of the Maryland State Highway Administration (SHA) and in accordance with the latest Maryland SHA Standard Specifications for Construction and Materials.
 - 1. Section 904.02 Performance Graded asphalt Binders - PG 64-22.
 - 2. Section 904.04 - The Contractor shall develop a Superpave mix design in conformance with ASSHTO M-323-04, and shall design for a thirty (30) million Equivalent Single Axle Loading (ESAL).

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All pavement work in Greenbelt Yard, Shady Grove Yard and Brentwood Yard, shall be performed in conformance with the requirements of the Maryland State Highway Administration (SHA) and in accordance with the latest Maryland SHA Standard Specifications for Construction and Materials.
- B. All inspections and testing in Greenbelt Yard, Shady Grove Yard and Brentwood Yard, shall be accomplished in conformance with the requirements of the and in accordance with the Maryland State Highway Administration (SHA) and in accordance with the latest Maryland SHA Standard Specifications for Construction and Materials.

END OF SECTION

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SECTION 02750
CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing portland cement concrete pavement, plain or reinforced or both, in conformance with the sections, lines and grades shown.
- B. Related Work Specified Elsewhere:
 - Section 02725 Base for pavements
 - Section 03200 Concrete reinforcement
 - Section 03300 Cast-in-place structural concrete

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings: Joint devices.
- B. Certification: As specified in Section 03300, including design mixes.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AASHTO: M33, M74, M81, M148, M153, M171, M182, M194, M220, M227, T51, T148.
 - 3. FS: TT-P-86, TT-S-00227.
 - 4. ASTM: A185, A370, A615, C33, C294, C920, D3405.
- B. Concrete: Conform to quality assurance requirements as specified in Section 03300 and this section.
- C. Testing: Subject concrete for pavements to test procedures specified in Section 03300.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Aggregates and Cement: As specified in Section 03300.

1.05 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. Do not place concrete on frozen soil base.
 - 2. Apply joint sealer when the air temperature is 50F or higher.

- B. Refrain from placing concrete while the temperature is lower than 40F or when by the National Weather Service forecast it may be expected to reach 40F or lower during the 24-hour period following placement of concrete.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Subgrade Paper: AASHTO M74.
- B. Polyethylene sheet and tape: AASHTO M171, white opaque for curing.
- C. Wire Fabric: Welded steel-wire fabric, ASTM A185.
- D. Bituminous Paint: AASHTO M81, Grade RC-250.
- E. Joint Devices:
 - 1. Tie bars: ASTM A615, Grade 60.
 - 2. Tie rod assemblies: Tensile requirements of AASHTO M227, Grade 80 based on measured cross-sectional area of unthreaded portion of bar when tested in assembled condition in accordance with ASTM A370.
 - 3. Dowels:
 - a. Plain round bars, AASHTO M227, Grade 80 coated with paint, FS TT-P-86, Type I.
 - b. Dowel sleeves in accordance with the following:
 - 1) Snug fit with dowel bar.
 - 2) Closed end.
 - 3) Limit stop for dowel approximately one inch from closed end.
 - 4) Sufficient rigidity to prevent entry of fresh concrete and collapse during construction.
 - 4. Hook bolt:
 - a. Material: As specified for dowels.
 - b. Fabrication: As shown.
- F. Grease for Dowels: Approved water-resistant grease.
- G. Expansion Joint Materials:
 - 1. Preformed expansion joint fillers:
 - a. Bituminous: AASHTO M33.
 - b. Cork: AASHTO M153, Type II.
 - c. Preformed joint seals: AASHTO M220.
 - 2. Expansion joint sealing compounds:
 - a. Hot-poured: ASTM D3405 and when tested in accordance with AASHTO T51 having ductility not less than 40 centimeter and flow at 140F not greater than one centimeter. Use of ground rubber scrap is prohibited.
 - b. Cold-applied: Single-component type, ASTM C920.
 - c. Elastomeric: FS TT-S-00227, Type 1, Class A.
- H. Burlap: AASHTO M182, Class 3 or 4.
- I. Waterproof paper: AASHTO M171.

- J. White burlap-polyethylene sheet shall conform to AASHTO Designation M171.
- K. Liquid Membrane Forming Curing Compounds: AASHTO M148, Type 1, resin base, wax-free.
- L. Concrete: Section 03300, Class 3500, air-entrained, with the following additional requirements:
 - 1. Portland cement: Type I.
 - 2. Minimum cement content: Six bags per cubic yard of concrete.
 - 3. Maximum water content: Water/Cement ratio of 0.45 by weight.
 - 4. Air content: 6-1/2 percent plus-or-minus 1-1/2 percent by volume.
 - 5. Slump: 2-1/2 inches plus-or-minus 1/2 inch.
 - 6. Water reducing admixture: AASHTO M194, Type A or D as directed.
 - 7. Coarse aggregate:
 - 8. Size: ASTM C33 and as follows: 57; 67; 57 and 67; 57 and 4; 67 and 4; or 57, 67 and 4.
 - 9. Deleterious materials: Maximum amount of soft fragments, 2.0 percent by weight; maximum amount of coal and lignite 0.25 percent by weight; and material passing Size 200 sieve 0.5 percent by weight.
 - a. Maximum abrasion loss: 40 percent by weight.
 - 10. Fine aggregate:
 - a. Deleterious material: Maximum amount of friable particles, 0.5 percent by weight; maximum amount of coal and lignite 0.25 percent by weight; material passing Size 200 sieve three percent maximum by weight.
 - 11. For bridge decks and bridge sidewalks: Use only crushed trap rock aggregate, trap rock to be diabase rock, ASTM C294.
- M. High-Early-Strength Concrete: As specified for concrete and modified to produce high-early-strength concrete by one or a combination of the following methods.
 - 1. Substitution of Type III or Type I cement in approved mix.
 - 2. Addition of Type I cement to the approved mix, but so that the total cement does not exceed eight bags per cubic yard of concrete.
 - 3. Addition of an approved accelerating admixture to approved mix as specified in Section 03300.

PART 3 - EXECUTION

3.01 EQUIPMENT:

- A. Provide appropriate equipment in sufficient quantity and sizes to perform work as specified and shown.
- B. Maintain machinery and equipment on site in first class working condition. Provide necessary tools and supplies for maintenance.
- C. Straightedges and Templates:
 - 1. Use metal straightedges, 10 feet long, rigidly constructed so as to prevent vertical deflection exceeding 1/32 inch and fitted with handles for ease of use.
 - 2. Use templates, constructed so as to extend from form to form and to ride on form, having adjustable tines spaced at six-inch intervals and rigidly constructed so as to prevent vertical deflection exceeding 1/32 inch.

3.02 BASE:

- A. Check previously placed base for grade and crown with templates and straightedges for compliance with tolerances specified in Section 02725.
- B. Correct deficiencies in grade, contour and compaction.
- C. Obtain approval of base prior to placing forms and impervious material.

3.03 SETTING FORMS:

- A. Unless concrete is placed against abutting structures, use steel forms to maintain concrete within required tolerance and to support paving equipment.
- B. Use flexible steel forms for curve radii less than 250 feet. For small radius curves and non-standard closures, use approved wood forms. Provide properly drilled forms to accommodate tie rod assemblies.
- C. Set forms accurately and firmly to line and grade throughout entire length of approved base.
- D. Set forms sufficiently ahead of other work to avoid conflict during operations.
- E. Concurrent with setting of forms, cover base with layer of impervious material of either subgrade paper or polyethylene sheet.
 - 1. Subgrade paper: Overlap adjacent strips at least four inches and ends not less than 12 inches.
 - 2. Polyethylene sheet: Overlap sides at least 12 inches.
 - 3. Maintain cover intact until concrete is placed.
- F. Apply one coat of bituminous paint to contact areas of abutting structures and previously placed slabs.

3.04 FIELD QUALITY CONTROL:

- A. Allowable Tolerances:
 - 1. Joints and joint devices: Maximum deviation of 1/4 inch from position shown and 1/8 inch from ten-foot steel straightedge.
 - 2. Dowels: Aligned to tolerance of not more than 1/8 inch in 12 inches.
 - 3. Fabric reinforcement:
 - a. Clearance from vertical surfaces and joints: Minus 1/4 inch or plus 1/2 inch.
 - b. Clearance from top and bottom surfaces: Plus-or-minus 1/4 inch.
 - c. Clearance from top surface of additional reinforcing at penetrating structures: Plus-or-minus 1/8 inch.
 - 4. Top surface of concrete: Maximum deviation of 1/8 inch from ten-foot steel straightedge and within plus-or-minus 1/8 inch of the required elevation.
 - 5. Grooves for joints: Within minus 1/16 inch or plus zero inch of dimensions shown.
 - 6. Thickness of concrete pavement: Within minus 1/8 inch of the thickness shown, in accordance with AASHTO T148.
- B. Testing of Concrete:
 - 1. Conform to requirements specified in Section 03300.

3.05 JOINT DEVICES:

A. General:

1. Place and secure joint devices to ensure that deviation does not exceed specified tolerances. Finish joints to such tolerances.
2. Provide acceptable means of splicing.
3. Provide satisfactory gages for checking position of joint devices.
4. Where joints are to be completed after placing concrete, mark location of joint devices so as to permit installation of joint to tolerances specified.
5. Where options for construction are permitted, use approved method.
6. Do not disturb joint devices. Do not permit workers to step on joint devices. Realign devices immediately if displaced.
7. Hold initial installation of devices firmly in place by tap bolts installed in holes drilled in forms. If holes in forms have been formed by method other than drilling, use steel washers in addition to tap bolts. After removal of forms replace tap bolts until adjoining subgrade is ready for concrete placement. Remove tap bolts and install remainder of tie devices prior to placing adjoining slab. Apply heavy coating of bituminous paint prior to placing concrete for adjacent slab.

B. Construction Joints:

1. Make transverse construction joints at locations shown; use joint device applicable to particular type of joint.
2. Install dowels at transverse construction joints, spaced as shown but clearing pavement edges and longitudinal joints by a minimum of six inches. Align dowels both vertically and horizontally to tolerance specified.

C. Contraction Joints:

1. Provide longitudinal contraction joints between previously placed slabs and new slabs and between slabs and abutting curbs and gutters.
2. Tie longitudinal contraction joints together by installation of 1/2-inch tie rods or tie-rod assemblies 30 inches long placed across longitudinal contraction joint and spaced as shown. Do not install tie rods or tie-rod assemblies closer than 18 inches to transverse joints.
3. Make groove for contraction joints by formwork or using an approved joint tooling device. When latter method is used saw joint to one third depth of slab within 24 hours of concrete placement.

D. Expansion Joints and Joint Filler: Make grooves for expansion joints by forming. Where grooves are made by device, use approved device of such design that work can be properly performed.

1. Prepare preformed expansion joint filler in greatest length possible and no less than ten feet.
2. Cut filler for joints transverse to the slab in a single piece of the required shape.
3. Cut pieces for curb and gutter as directed to exact size, from larger pieces.
4. When splicing joint filler, butt tightly to prevent penetration of concrete between adjacent strips of joint filler.
5. For longitudinal joints, except at curb and gutter sections, use preformed tongue and groove filler as shown.
6. Where dowels or other approved load-transfer devices have to penetrate joint filler, properly locate and drill holes of correct size or diameter through filler at required intervals to receive bars and to achieve tight fit.
7. Make groove for cement pavement for surface course by forming, sawing or leaving preformed joint in place.

- 8. Protect preformed joint filler during placing of concrete.

3.06 PLACING REINFORCEMENT:

- A. Install welded steel wire fabric in flat sheets where shown in accordance with Section 03200.
- B. Unless otherwise noted, use wire fabric as follows:

Depth of Slab/Inches	Pounds Per 100 Square Feet
6	30
8	50
10	61

- C. Place wire fabric to clear vertical surfaces and joints by two inches and within tolerances specified. Lap sheets distance equal to spacing of wires and tie securely.
- D. Place two layers of wire fabric in concrete pavements over trench cuts, each layer to be of weight and type as specified for thickness of concrete. Position each layer two inches clear of top and bottom surfaces of slab and within tolerance specified. Extend each layer nine inches beyond sides of trench.
- E. Where other structures, such as manholes, penetrate concrete pavements, place wire fabric on one inch centers in each direction so that there is a minimum of two feet of fabric extending horizontally around perimeter of structure. Install layer of fabric one inch clear of top surface of slab and within tolerance specified.
- F. In surface courses, place wire fabric two inches clear of top surface of slab and within tolerance specified.
- G. Install layer of wire fabric to serve as top layer over trenches. Install additional fabric around penetrations.
- H. Except for pavements over trench cuts and around penetrations, do not place wire fabric in base course.

3.07 PLACING CONCRETE:

Supply and place portland cement concrete as specified in Section 03300, with the following additional requirements:

- A. Place concrete only during daylight unless otherwise approved. If placement is authorized during darkness provide adequate lighting system.
- B. Prior to placing concrete around poles, manholes or other structures projecting through pavement, coat such structures heavily with bituminous paint.
- C. Place concrete to the full thickness, deposited in successive batches for full width of slab by means of discharging device which does not cause segregation of materials.

- D. Compact concrete thoroughly during placement.
- E. When spreading by hand, employ sufficient work force for leveling, spading and spreading concrete in front of screed. Do not use rakes for handling concrete.
- F. Deposit concrete as near as practicable to joints but not touching expansion and contraction joint devices. Shovel concrete to height approximately two inches more than depth of the joint. As soon as forms are removed, clean ends of expansion joints of concrete and expose full width of preformed joint filler for full depth of slab. Place concrete against previously constructed slabs only after ends of preformed joint filler have been so cleaned and ends of performed joint filler in slab being poured have been neatly and firmly butted.
- G. Where wire fabric is required, place concrete in layers so that wire fabric may be properly placed. Requirements for machine placing and for vibration apply for each layer. Place layers and wire fabric, large wires running in longitudinal direction in such rapid sequence that monolithic slab will result.
- H. Compact concrete both by internal and surface vibration. Vibrators may be combined with spreading and finishing machines. Compact concrete adjacent to forms, joints, existing concrete or other structures by use of spud vibrator. Insert vibrator in concrete and work along entire length. Avoid contact with joint devices or underlying base. Evidence of honeycomb or lack of compaction constitute basis for rejection of concrete pavement as deficient.
- I. Construction Joints:
 - 1. Form construction joints where it is necessary and approved to stop concreting for 30 minutes or longer, by staking in a bulkhead and finishing the concrete to the bulkhead.
 - 2. If, due to an emergency, concreting must be stopped within less than ten feet of a previously formed joint of any type, remove the concrete to the joint prior to resuming the placing of the slab.

3.08 INITIAL FINISHING, FLOATING AND FINAL FINISHING:

- A. Give concrete initial finish by use of finishing machines operated so as to minimize formation of laitance and to give required uniformity of surface and compaction. Remove laitance in approved manner.
- B. Avoid prolonged operation over a given area. Operate the machine over each area of pavement as directed and only as many times and at such intervals as required to give the proper compaction and uniformity of surface.
- C. Keep tops of forms clean to permit true and accurate movement of machine.
- D. On completion of screeding, bring surface to smooth finish by use of floats, eight inches wide and a minimum of four feet long, with handles at least four feet longer than width of slab and not less than 16 feet long.
- E. Operate float transversely with combined longitudinal and transverse motion for sufficient number of passes to smooth ridges and fill depressions.

- F. On completion of floating operations, screed top surface of concrete with deviation not exceeding 1/8 inch from straightedge and within tolerance specified for required elevation. Correct deficiencies by handwork if approved.
- G. After floating and verifying that surface is within specified tolerances, drag surface in longitudinal direction with longitudinal and crosswise motions using burlap so to prevent edges digging into surface of concrete or working crown out of pavement.
- H. Brooming:
1. Upon completion of burlap dragging, broom finish top surface of pavement. Use street brooms made for the purpose with split bamboo bristles or metal bristles
 - a. Broom width: 14 inches.
 - b. Broom handle: At least one-half slab width.
 2. In general make brooming perpendicular to centerline of paving unless otherwise shown. Prior to brooming, obtain the Engineer's approval of the direction of brooming for each area.
 3. Pull broom gently over surface of pavement from edge to edge walking back and forth on bridge over pavement, holding handle almost vertical and allowing broom to drag lightly over surface without interruption, leaving slight ridges in concrete perpendicular to centerline of pavement.
 4. Overlap ridging. Ridging not more than 1/8 inch in depth with corrugations of uniform character and width.
 5. Complete brooming before rounding edges of pavement and joints.
- I. Round joints and edges to radius shown.
- J. To form flow line for gutters, trowel smooth 12-inch width of pavement adjacent to curbs unless otherwise shown.
- K. Joint Work and Edging: Where there is an option of method for doing joint work, secure approval for the method elected and use only that method.
1. Perform joint work and edging when condition of concrete permits.
 2. Ensure that joints are within tolerances specified and that there is no perceptible lip or depression other than rounding.
 3. Prepare clean grooves rounded to 1/4-inch radius with smooth even walls.
 4. Make grooves for expansion joints by forming. See requirements above for expansion joints.
 5. For joints to be sealed with poured sealer, prepare grooves with dimensions as shown and within tolerance specified. For joints to be sealed with preformed elastomeric seals, leave grooves of dimensions and within tolerances shown. Provide suitable gauges for checking dimensions.
 6. Where joints in surface course are sealed with cold-poured joint sealer, break bottom bond by placing polyethylene tape full width of groove, laid flat along top of preformed joint filler prior to joint sealing.
 7. When using hot-poured or cold-applied joint sealer, use only equipment designed for purpose. Hand-pouring pots are prohibited. Maintain material within temperature range recommended by manufacturer. Apply sealer when air temperature is as specified. Construct so that resulting stripe is straight, neat, of uniform width and joint is filled to 1/4 inch from top surface of pavement.
 8. When placing elastomeric joint seals, use equipment and methods recommended by manufacturer.

3.09 CURING:

- A. Allow finished concrete to cure by one of the following methods for seven days or until concrete has developed flexural strength of 500 psi:
 - 1. Wet burlap: Cover pavement with double thickness of thoroughly wet burlap, overlapping adjacent sheets by at least six inches. Maintain burlap in saturated state by sprinkling until it is removed. Use only clean material free from holes.
 - 2. Waterproof paper, polyethylene sheet or white burlap-polyethylene sheet: Place material so that adjacent sheets overlap by at least 12 inches. Secure material along side and ends so as to maintain reasonably airtight seal.
 - 3. Use approved liquid-membrane curing compounds as recommended by manufacturer, using equipment designed for purpose.

3.10 REMOVAL OF FORMS:

- A. Remove forms as soon as condition of concrete permits, but in no case sooner than 12 hours after placement.
- B. When the temperature is below 40F, leave forms in place for at least 48 hours or as directed.

3.11 COLD WEATHER CONSTRUCTION:

- A. Whenever, by the National Weather Service forecast for the locality, the temperature may be expected to reach 50F or lower during the 24-hour period following placement concrete mix, include an approved accelerating admixture in the concrete mix as specified in Section 03300.
- B. Place concrete when temperature conditions are as specified, unless otherwise directed. If placing of concrete is so directed, in addition to adding an accelerating admixture heat aggregates, water or both, so that mix when placed is not less than 55F nor more than 90F. Do not exceed 140F for mixing water and 150F for aggregates.
- C. As soon as concrete has hardened sufficiently to prevent marring, cover pavement surface and edges with dry burlap, building paper or other approved material and subsequent layer of at least six inches of dry hay, straw or other approved material. Maintain such protection for at least three days or until field tests indicate that concrete has attained required strength.
- D. During low temperatures, install truck-mixed concrete immediately upon delivery.
- E. When temperature by National Weather Service forecast will be 40F or lower during the 72-hour period following placement of concrete, do not use membrane curing compound.

3.12 HOT WEATHER CONSTRUCTION:

- A. When by National Weather Service forecast, temperature will be 90F or higher during the 24-hour period following placement of concrete, cover pavement by wet-burlap method for first 24 hours, after which curing may be completed by one of the specified methods.

3.13 PROTECTION OF CONCRETE PAVEMENT:

- A. Obtain approval prior to permitting use of completed pavement by public and construction traffic.

3.14 DEFICIENT PAVEMENT:

- A. Where directed, remove and replace with new materials or correct concrete pavement that does not meet requirements.

END OF SECTION

SECTION 02765
PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing pavement markings and striping.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Samples:
1. Paint: One quart of each color.
 2. Spheres: Two pounds.
 3. Thermoplastic compound: Ten pounds of each color.
 4. Preformed plastic markings: Five each of plain and reflective, each three inches wide by one-foot long.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. AASHTO: M249-79.
 3. USDOT/FHWA: Manual on Uniform Traffic Control Devices for Streets and Highways.
 4. Federal Test Method Standard 141.
 5. FED STD: 595.
 6. FS: TT-P-85, TT-B-1325.
 7. ASTM: D638.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver materials in factory-sealed containers plainly marked as follows:
1. Manufacturer's name and address.
 2. Location of plant.
 3. Material.
 4. Color of material.
 5. Amount of contents.
 6. Date of manufacturer and lot number.

1.05 JOB CONDITIONS:

- A. Environmental Requirements:
1. Traffic zone paint:
 - a. Apply only when ambient air temperature is above 40F and temperature of surface to be painted is above 45F.
 - b. If pavement is wet, allow surface to dry for eight hours minimum after surface appears dry.
 - c. Do not apply glass spheres in strong windy conditions.

2. Extruded thermoplastic compound:
 - a. Apply by extrusion at 400F minimum, 440F maximum, when air temperature is more than 35F and pavement temperature is above 50F.
 - b. If pavement is wet, delay application until the pavement has been exposed to at least two hours of direct sunlight after surface appears dry.
 3. Preformed plastic traffic markings:
 - a. Apply on dry pavement when ambient temperature and temperature of pavement surface is above 60F.
 - b. When temperature of pavement surface is less than 60F and when approved, apply surface heating to degree necessary for application of plastic marking.
- B. Protection:
1. Provide traffic protective devices and methods of protection to comply with requirements of the jurisdictional authorities.
 2. Provide and maintain traffic cones, barricades, lights and other protective devices necessary to protect traffic, workmen and completed pavement marking and striping. Remove such devices when marking and striping, including painted sections of curbing and raised traffic bars, have sufficiently cured for intended use.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Traffic Zone Paint:
1. Primer: If recommended by paint manufacturer or required by jurisdictional authorities, type as recommended by paint manufacturer.
 2. Paint: Traffic, FS TT-P-85, white and yellow.
- B. Glass Beads: Retroreflective glass spheres, FS TT-B-1325, with the following additional gradation requirements:

US Sieve Size	Percentage Passing
40	100
50	80 - 100
80	35 - 80
100	20 - 50
200	0 - 15

- C. Extruded Thermoplastic Compound: Hot-applied alkyd thermoplastic per AASHTO M249-79 and as follows:
1. Thermoplastic compound:
 - a. Mixture of thermoplastic resins and other substances compounded for use in traffic markings which, when extruded hot in place and cooled to ambient temperature, will produce stark white or yellow reflective marking stripe.
 - b. Permanently white or yellow, without blemish or discoloration, with straight, clean cut, sharply defined, parallel edges and of uniform cross section.
 - c. Shaped to minimize tire impact and adhere permanently to road.
 - d. Set to solid, non-tacky, non-slippery line of sufficient elasticity to resist cracking and chipping caused by weather and temperature changes, traffic

- e. action, as well as pavement crawl and lift in freezing weather.
 - f. After curing, does not react with nor deteriorate in contact with snow removal chemicals, oil and other substances common to roadway surfaces.
 - g. Chemically stable and emitting no dangerous fumes.
 - h. Especially compounded for traffic markings, with no change in color and brightness characteristics after prolonged exposure to sunlight.
 - i. No breakdown or deterioration when held at plastic temperature for extended periods of time nor when repeatedly reheated to plastic temperature.
 - j. No change in temperature versus viscosity characteristics through repeated reheatings and from batch to batch.
2. White thermoplastic compound:
- a. Pure white, free from dirt or tint after drying.
 - b. Maximum allowable compound deviations from magnesium oxide standard when tested by standard color difference meter, Gardner Color Difference Meter, Gardner Laboratories, Inc. Bethesda, Maryland or equal, with the following minimum requirements:

Scale	Definition	Magnesium Oxide Standardized	Sample
Rd	Reflectance	100	70 minimum
a	Redness - Greenness	0	Minus five to plus five
b	Yellowness - Blueness	0	Minus 10 to plus 10

- c. The white compound pigment containing not less than six-percent titanium dioxide (TiO₂).
3. Yellow thermoplastic compound:
- a. After drying, yellow, FED STD 595, Color 33538, tested in accordance with Federal Test Method Standard 141, Method 4252.
 - b. Pigmented binder well dispersed and free from skins, dirt, foreign objects or ingredients that will cause bleeding, staining or discoloration and consisting of mixture of non-drying synthetic resins at least one of which is solid at room temperature.
 - c. Total binder content of thermoplastic compound: 15-percent minimum, 35-percent maximum by weight.
 - d. Filler incorporated with resins or binder: White calcium carbonate with compressive strength of 5,000 psi.
- D. Preformed Plastic Traffic Markings:
- 1. Composed of preformed plastic, smooth on top surface, undersurfaces factory-coated with pressure-sensitive adhesive coating overlaid with protective paper, polyethylene or other suitable material which remains in place until plastic is ready for application to pavement.
 - 2. Plain or reflectorized.
 - 3. White or yellow.
 - 4. Composition:
 - a. Nonreflectorized plastic material: Consisting of basic plastic and plasticizers, 50-percent minimum by weight.
 - b. Reflectorized plastic material: Consisting of 40-percent minimum by weight

of basic plastic and plasticizer and 30-percent minimum by weight of clear, reflective glass spheres, thoroughly and uniformly dispersed throughout plastic.

5. Pigmentation:
 - a. White plastic markings: Pure white, free from tint and containing not less than six-percent titanium dioxide.
 - b. Yellow plastic markings: Yellow, FED STD 595, Color 33538, Federal Test Method 141, Method 4252.
 - c. Uniform coloring throughout cross section of plastic.
6. Low-temperature stress resistance: No indication of breaking, chipping or cracking when sample of specified thickness is abruptly bent to right angle after being immersed in water at 32F for 30 minutes.
7. Resistance to wear: Endure not less than 2,500 cycles of a Taber Abraser, using CS-17 wheels under a load of 1,000 grams, when each 0.001-inch thickness of plastic is tested at 21C.
8. Tensile strength: Nonreflectorized markings not less than 1500 psi; reflectorized markings not less than 750 psi when tested in accordance with ASTM D638.
9. Bond strength: Withstand 50-pound static shear load for 15 seconds average at 21C before complete parting of bond when pair of two-inch wide strips are overlapped two inches and adhesive faces placed together.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL:

- A. Layout of Work:
 1. Lay out lane widths, parking spaces and crosswalks in accordance with regulations of jurisdictional authorities and as shown.
- B. Letters and Symbols:
 1. Unless otherwise shown or specified, apply letters, directional arrows and other pavement markings of size and configuration in accordance with referenced USDOT/FHWA Manual on Uniform Traffic Control Devices for Street and Highways.
 2. Apply letters, directional arrows and other markings in color shown.
- C. Width and Color of Lines for Pavement Striping:
 1. Apply lines for pavement striping as follows:
 - a. Width:
 - 1) Continuous centerline striping and parking space markings: Four inches.
 - 2) Dashed lane striping: Four inches.
 - 3) Solid crosswalk lines: Six inches.
 - 4) Solid stop lines: Twelve inches.
 - b. Lines:
 - 1) Dashed lane lines: White stripes nine feet in length separated by 15 feet of unmarked surface.
 - c. Color:
 - 1) Stripes:
 - a) Solid centerline stripe: White or yellow as shown.
 - b) Lane striping, parking space marking, crosswalk and stop lines: White, unless otherwise shown.
- D. Allowable Tolerances:

1. Traffic-zone paint:
 - a. Width of lines not to vary from specified width by more than 1/8 inch in each linear foot.
 - b. Lengths of skip or lane lines and unpainted surface between skip lines not to vary by more than three inches from specified length.
 - c. Coverage rate maximum: 100 square feet minimum and 110 square feet maximum of surface coverage per gallon of paint, yielding wet-film thickness of 0.015 inches minimum.
 - d. Coverage rate of glass spheres: Ten pounds per gallon of paint minimum.
2. Extruded thermoplastic compound:
 - a. Thickness of stripe: 90 to 125 mils.
 - b. Rate of application of binder-sealer: Between 800 linear feet and 1,000 linear feet per gallon for four-inch wide lines. For lines of other widths, apply in proportion based on such rate.
3. Preformed plastic traffic markings:
 - a. Thickness: 0.095 inch, minus 0.005 inch or plus 0.010 inch.
 - b. Width: Four inches, plus-or-minus 1/8-inch per 12-inch length.
4. Painting of curbing and raised traffic bars:
 - a. Wet-film thickness: 0.015 inches minimum.

3.02 APPLICATION:

A. Traffic Zone Paint:

1. Equipment:
 - a. Use equipment suitable for mechanical application of paint and glass spheres.
 - b. Apply paint with atomizing spray machines designed for striping to apply stripes of uniform cross section, and thickness, at specified coverage with clean-cut edges permitting easy and accurate adjustment of width and rate of application as well as immediate shutoff.
 - c. Use automatic mechanical equipment designed and constructed to distribute glass spheres in uniform pattern and at prescribed coverage regardless of variation in speed of travel. Equipment may be integral part of striping machines or self-contained unit designed for attachment to striping machines, so that glass spheres will be applied immediately following application of paint. Use equipment designed and constructed to permit adjustment of coverage rate.
2. Method of application:
 - a. Schedule marking and striping operations to permit paint to set and harden before roadway is opened to traffic.
 - b. Allow hot laid bituminous material to cool, prior to beginning striping operations.
 - c. Remove foreign matter from surfaces prior to painting.
 - d. Apply pigmented binder and glass spheres, mix and thin pigmented binder in accordance with manufacturer's recommendations.
 - e. Apply glass spheres uniformly, immediately following application of paint. Do not premix paint and spheres.
 - f. Apply pavement markings accurately with straight, clean-cut, sharply defined parallel edges and of uniform cross section.
 - g. Clean striping machines as often as necessary to ensure application of markings of specified quality and physical requirements.

- B. Extruded Thermoplastic Compound:
1. Equipment:
 - a. Master kettle:
 - 1) Minimum capacity: 800 pounds of melted compound.
 - 2) Double oil jacket.
 - 3) Thermostatic controls.
 - 4) Approved heating device.
 - 5) Temperature gauges for oil and compound.
 - 6) Integrally mounted chopping device to chop and drop solid compound into kettle.
 - b. Liner:
 - 1) Use liners with self-contained heat source, such as propane heater, capable of maintaining compound at drawing temperature of not less than 420F as well as radiant heater installed over die for same purpose.
 - 2) For installation of crosswalk lines, stop lines and solid center lines, use liner with capacity of approximately 150 pounds and automatic sphere dispenser capable of distributing reflective spheres on surface of line while still plastic.
 - 3) For centerline and lane line installation, use mobile unit equipped to automatically install dashed lines in combinations of line and skip up to 40 feet and for application of reflective spheres as specified for smaller liner.
 - 4) Provide for varying die widths in liner to produce specified line widths, including shaping die cutoff device to provide clean, square ends at beginnings and ends of lines.
 2. Application of binder-sealer:
 - a. Before applying binder-sealer or thermoplastic compound, prepare roadway surface by buffing and cleaning or other appropriate method.
 - b. Where thermoplastic stripe is to be installed, spray surfaces with binder sealer consisting of two parts epoxy and one-part hardener-catalyst immediately prior to installation of compound.
 - c. Mix binder-sealer fresh each day. Do not premix.
 3. Application of thermoplastic compound:
 - a. Apply compound in colors shown and at locations shown.
 - b. Do not use pans and aprons to control width of lines.
 - c. Use equipment including extrusion dies capable of maintaining compound at specified extrusion temperature and density and capable of producing stripe of specified width.
 4. Application of glass spheres:
 - a. Perform reflectorizing of thermoplastic compound by immediate application of glass spheres to specified density.
 - b. Perform reflectorizing so that completed line registers not less than 55 on Hunter Nite Visibility Meter.
- C. Preformed Plastic Traffic Markings:
1. Prepare roadway surface by removing dirt, dust, oily substances and other foreign matter before installing plastic markings.
 2. Do not install plastic marking on wet or damp pavement.
 3. Make installations in neat, workmanlike manner with ends and edges of successive strips of material even.
 4. Position center and lane markings using chalk as guides.

5. Installation on sheet-asphalt surfaces:
 - a. When plastic markings are to be installed on new sheet-asphalt surfaces, install while asphalt is still hot and immediately before final rolling is performed.
 - b. As part of final rolling operation, position and embed plastic marking into surface.
 - c. To install plastic markings on existing sheet asphalt, accurately locate and press marking into place and obtain final bond by at least two longitudinal passes of ten-ton roller.
 6. Installation on asphaltic-concrete surfaces:
 - a. Install as specified for sheet-asphalt surfaces except apply prime coat recommended by manufacturer of plastic markings to pavement surface prior to installation of markings.
 7. Installation on portland-cement concrete pavement:
 - a. Seal surface of concrete pavement with quick-setting primer to reduce capillary action and improve bond between marking and pavement surface.
 - b. Otherwise install as specified for sheet-asphalt pavement.
- D. Painting of Curbing and Raised Traffic Bars:
1. Paint curbing and raised traffic bars with traffic-zone paint.
 2. Clean surfaces to be painted of dirt, dust, laitance, oil or other foreign substances.
 3. Allow 14 days minimum after installation of portland-cement concrete before painting.
 4. Curbing:
 - a. Paint top and front of curbing in locations shown with one coat of nonreflectorized traffic-zone paint as specified.
 5. Raised traffic bars:
 - a. Paint surfaces, except bottom of raised traffic bars with one coat of white traffic-zone paint and apply glass spheres before paint has hardened.
 - b. Apply paint and glass spheres as specified.

END OF SECTION

THIS PAGE NOT USED

SECTION 02772

CURBS, GUTTERS AND WALKS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing curbs, gutters, curb and gutters and walks.
- B. Related Work Specified Elsewhere:
 - Section 02320 Grading, excavating and backfilling
 - Section 02725 Base course for pavements
 - Section 02750 Concrete pavement
 - Section 03200 Concrete reinforcement
 - Section 03300 Cast-in-place structural concrete

1.02 SUBMITTALS: Not used.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM: C979.

1.04 Not used

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Concrete: Section 02750 and as specified in this section.
- B. Carbon Black:
 - 1. Emulsified: At least 25 percent by weight standard carbon-gas black colloiddally dispersed in liquid medium so that when one part of product is stirred into ten parts of water, resulting liquid, after standing undisturbed for 72 hours, is uniformly colored and contains no fillers nor other material that would adversely affect quality or appearance of concrete.
 - 2. Powder:
 - a. Concrete grade carbon black, meeting the requirements of ASTM C979.
 - b. Carbon black powder to disperse in water without floating and to be capable of uniform dispersion in plastic concrete.
- C. Joint Devices: In accordance with Section 02750, with the following additional requirements:
 - 1. Dowels: 14 inches long, 3/4-inch diameter for curb and gutter and 1/2-inch diameter for sidewalk.
 - 2. Plates for construction joints and planes of weakness: 14-gauge galvanized sheet metal cut to section as necessary.

- D. Expansion Joint Materials: In accordance with Section 02750, with the following additional requirements:
 - 1. Preformed joint filler for stone curb, 1/4-inch thick; otherwise, 1/2-inch thick, subject to specified construction requirements.
- E. Polyethylene Tape: Section 02750.

2.02 MIXES:

- A. Mix exposed aggregate surface course concrete comprising by volume, one part portland cement to three parts granite aggregate or gravel, crushed gravel or crushed stone aggregate as shown, with sand added to form workable mix.
- B. Where concrete walks are shown to be darkened, add 1/2 pound of emulsified carbon black or 1/3 pound of carbon powder per bag of portland cement.

2.03 FABRICATION AND MANUFACTURING: Not used.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL:

- A. Allowable Dimensional Tolerances:
 - 1. Concrete surfaces constructed in accordance with the following:
 - a. Plus-or-minus 3/16 inch of elevation shown.
 - b. Deviation: 1/8-inch maximum from steel straightedge as specified in Section 02750.

3.02 BASE:

- A. Ensure that previously placed base is satisfactorily compacted and free from loose material.
- B. Have base approved prior to placing forms and base covering.
- C. Correct deficiencies in grade, contour and compaction.

3.03 FORMS:

- A. Place forms as specified in Section 02750.

3.04 JOINT DEVICES AND CONTRACTION JOINTS:

- A. General Requirements:
 - 1. Place joint devices and contraction joints as specified in Section 02750.
 - 2. Where work abuts concrete pavement, adjust spacing of joints so that joints of same type coincide with transverse joints of concrete pavement.
 - 3. Width of preformed expansion joint filler: Same as thickness of concrete pavement minus 3/4 inch.
 - 4. Concrete curb, gutter and curb and gutter:
 - a. Place two dowels in each joint between eight and twelve inches apart; for curb and gutter place one of the dowels four inches from back of curb. For curb and gutter abutting concrete pavements, complete partial tie rod

- assemblies in slab. Place preformed expansion joint filler in single piece depressed 1/2-inch below finished surface.
- b. For curves of 100 feet radius or less, space expansion joints equally at intervals of approximately 15 feet; for radii greater than 100 feet space expansion joints at intervals of 45 feet, with contraction joints at intervals of 15 feet. Form contraction joints, with plates left in place, depressed 1/2-inch below finished surface.
 - c. Where placed in curves of 100 feet radius or less, stop reinforcing steel two inches clear of expansion joints.
5. Sidewalk:
- a. Place 1/2-inch preformed expansion joint material between sidewalks and curb where sidewalks are constructed between permanent structure and curb.
 - b. Place transverse expansion joints at intervals of 45 feet.
 - c. Provide dowels in expansion joint spaced at two-foot intervals, clearing edges of sidewalk by one foot. Where sidewalks intersect, place expansion joints in each sidewalk for full width along extension of back edges.
6. Uniform Joint Spacing: For the entire length of each straight or curved run of sidewalk or curb to be placed, lay out the work and adjust joint spacing to provide intervals of equal dimension between joints, including grooves, unless otherwise shown.

3.05 CONCRETE AND WIRE FABRIC:

- A. Place concrete and wire fabric in accordance with applicable requirements of Section 02750 except that top layer of fabric over trench-cuts to clear top surface by 1-1/2 inches, plus-or-minus 1/4-inch tolerance.
- B. Place pipe for weep holes through curbs for rain leaders from building downspouts where shown.

3.06 STONE CURB: Not used.

3.07 FINISHING CONCRETE CURB, GUTTER AND CURB AND GUTTER:

- A. Remove curb and face forms as soon as condition of concrete permits and perform finishing work on exposed surfaces.
- B. Finish face edge of curb to one-inch radius. Finish other edges to 1/4-inch radius.
- C. Provide steel troweled finish followed by brushing with fine-hair brush.
- D. Remove other forms when condition of concrete permits, but no sooner than 12 hours after placing. Rub surfaces with carborundum stone where necessary.

3.08 FINISHING SIDEWALK:

- A. Work on Authority Property:
 1. Strike off and screed top surfaces so that resulting surface is smooth and within specified tolerances.
 2. As soon as condition of work permits, perform joint work, edging and marking.
 3. Finish edges to 1/4-inch radius.

4. Scoring pattern: Unless otherwise shown, as follows:
 - a. Expansion joints: Install on 45-foot centers. For the entire length of each straight or curved run of sidewalk to be placed, layout the work and adjust joint spacing to provide intervals of equal dimension between joints, including grooves, unless otherwise shown.
 - b. Contraction joints: Make transverse grooves 1/3 depth of the concrete at approximately nine-foot equal intervals between expansion joints perpendicular to longitudinal grooves.
 - c. Control joints: Make transverse grooves 1/2-inch deep at approximately three foot equal intervals between contraction joints perpendicular to longitudinal grooves.
 - d. Make longitudinal grooves 1/2-inch deep at approximately three foot equal intervals between and parallel to sides of sidewalk.
5. Finish surface with final light broom finish with fine-hair broom.
6. Construct wheel chair ramps at locations shown.
7. Remove forms when condition of concrete permit, but no sooner than 12 hours after placement. Rub surfaces with carborundum stone where necessary.

B. Non-Authority Work:

1. In accordance with codes and regulations of the jurisdictional authorities.

3.09 CURING:

- A. In accordance with Section 02750, except that liquid membrane curing compounds not to be used on curb of curb and gutter when temperatures tend to go lower than 40F within 24 hours after application.
- B. Do not use liquid membrane curing compounds on exposed aggregate concrete or darkened concrete surfaces.

3.10 SEALING JOINTS:

- A. Immediately prior to sealing joints, place polyethylene tape width of groove flat on preformed expansion joint filler.
- B. Seal expansion joints in concrete curb, gutter and curb and gutter with poured joint sealer in conformance with Section 02750. Do not seal expansion joints in sidewalk and stone curb.

3.11 HIGH EARLY STRENGTH CONCRETE:

- A. Use high-early-strength concrete in accordance with Section 02750 when approved.

3.12 CORES:

- A. Where directed, provide test cores in accordance with Section 02750.

3.13 PROTECTION OF THE WORK:

- A. Protect new work in accordance with Section 02750.

3.14 DEFICIENT WORK:

- A. Remove and replace with new materials or correct as directed work which does not meet specified requirements.

END OF SECTION

THIS PAGE NOT USED

SECTION 02820

FENCING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing chain-link fencing, gates and fan guards.
- B. Related Work Specified Elsewhere:
 - Section 03300 Cast-in-place Structural Concrete
 - Section 16060 Grounding and Bondings

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Manufacturer's product data and installation instructions for fence, posts, fabric, gates, hardware and accessories.
 - 2. Site plan with fence showing locations of bracing, fan guards, gates, ground rods, depression closures and other special fence construction.
 - 3. Details of gates, depression closures and other special construction showing fabrication and installation.
 - 4. Details for installation of accessories.
- B. Samples:
 - 1. Chain link fabric: One of each width and type, each 24 inches long.
 - 2. Posts, railing, braces, gate frames: One of each size and type, each 24 inches long.
 - 3. Truss rod and turnbuckle: One each.
 - 4. Tension wire: One, 24 inches long.
 - 5. Barbed wire: One, 24 inches long.
 - 6. Tension bar: One, 24 inches long.
 - 7. Gate corner assembly: One.
 - 8. Fabric ties: Four each.
 - 9. Rail and brace ends and post caps: Two each.
 - 10. Barbed wire extension arms: One each.
 - 11. Other materials and accessories: One each.
- C. Certification.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AWS: D1.1.
 - 3. MS: MIL-P-21035.

4. FS: FF-T-791, RR-F-191/2D, RR-F-191/3D, RR-F-191/4D.
5. ASTM: A121, A392, A413, C1107, F668.

1.04 JOB CONDITIONS:

- A. Right of Access to Adjacent Private Property: As shown.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Fabric:
1. Steel, hot-dip galvanized after weaving, ASTM A392; Class 2 coating, two-inch mesh, No. 9 gauge wire, height shown, both top and bottom selvage twisted and barbed unless otherwise indicated on Contract Drawings.^{**}
 2. PVC-coated steel: ASTM F668 Class 2b; two-inch mesh, 0.148-inch diameter zinc-coated steel core wire, height as shown, black color PVC; top and bottom selvages twisted and barbed, unless otherwise shown on Contract Drawings.
- B. Posts, Top Rails and Braces: FS RR-F-191/3D, with the following additional requirements:
1. Posts: Class 1, Grade. Size in accordance with Table I unless otherwise shown.
 2. Top rails: Class 1, Grade A; Size SP1.
 3. Bracing: Class 1, Grade A; Size SP1.
 4. Color coating: Where PVC-coated fabric is specified, provide matching PVC color ASTM F668 Class 2b coating.
- C. Accessories: FS RR-F-191/4D, with the following additional requirements:
1. Hot-dip galvanized, unless otherwise specified.
 2. Wire ties:
 - a. Fabric: No. 9-gauge steel.
 - b. Tension wire: No. 11-gauge steel.
 3. Tension wire: No 7-gauge Steel. ^{**}
 4. Color coating: Where PVC-coated fabric is specified, provide matching PVC color ASTM F668 Class 2b coating.
- D. Barbed Wire: ASTM A121, Chain Link Fence Grade, 12-1/2 gauge steel wire with 14-gauge, four-point round barbs, five inches on center.
- E. Turnbuckle: FS FF-T-791, Type 1, Form 1, Class 8, Size 3/8 by six, hexagonal heads, UNC threads, hot-dip galvanized. Where PVC-coated fabric is required, provide matching PVC color coating thermally fused to the galvanized steel substrate.
- F. Latch: Plunger bar full height of gate, to engage stop at double gates.
- G. Security Chain: ASTM A413, Grade 43 High Test Chain, case-hardened carbon-steel, 3/8-inch diameter; hot-dipped galvanized at exterior locations.
- H. Padlock: Corbin Russwin, Catalog No. PL5090 IC high security or equal.
1. Removable interchangeable core; with two keys, keyed and master-keyed as directed.

2. Body: Solid extruded brass.
 3. Six-pin tumblers.
 4. Shackle: Hardened steel, zinc-plated, 2-5/8 inch shackle length, ball bearing locking heel and toe.
- I. Concrete: Section 03300, Class 3500, air-entrained
 - J. Grout: Non-shrink, in accordance with ASTM C1107.
 - K. High Zinc-Dust Content Paint: MS MIL-P-21035.

2.02 SWING-TYPE GATES:

- A. Provide swing-type gates, size as indicated on the Contract Drawings, complete with latches, stops (if required by the manufacturer), keepers, hinges and three strands of above the fabric (if shown on the Contract Drawings).
- B. Conform to Federal Specifications RR-F-191/2D, Single Swing Type I, Double Swing Type II, and as follows:
 1. Hot-dipped galvanized.
 2. Fabrication:
 - a. Fabricate gate perimeter frame from Class 1, Size SP2 pipe per Federal Standard RR-F-191/3D.
 - b. Fabric: Same fabric as used on the fence. Attach fabric securely to the gate frame at intervals not exceeding 15 inches.
 - c. Barbed wire: As specified in 2.1. D above.
 - d. Fan Guard: Materials and fabrication as specified for fencing.
 3. Hardware:
 - a. Hinges: Two or more galvanized steel or malleable iron, to suit the gate size: non-lift type, offset to permit 180 degrees opening.
 - b. Latch: Galvanized steel or malleable iron, combination type with provision for padlock.
 - c. Gate stops and center rest: Manufacturers' standard.

2.03 CANTILEVERED SLIDE GATE:

- A. Conform to Federal Specification RR-F-192/2D, Type III.
- B. Barbed Wire: As specified in 2.01 D. above.

PART 3 - EXECUTION

3.01 FENCE INSTALLATION:

- A. Perform necessary clearing, grubbing, excavation and filling to provide clear line-of-fence runs.
- B. Set posts in concrete footings, sized as shown.
- C. Extend concrete to two inches above ground line at posts and slope to drain away from posts. Form top 12 inches of footing, with remainder poured against excavated hole.

- D. Space posts at 10 feet maximum and eight feet minimum on centers. Place additional posts at each abrupt change in grade.
- E. Where rock is encountered, drill holes two inches deeper than depth shown and two inches greater than outside diameter of post. After post is placed as shown and specified, and supported, fill remaining void with one-to-three grout mixture of cement and sand.
- F. Where fence is located on concrete structure, weld post to base plate, thickness and size as shown on Contract Drawings. Erect fence post truly vertical, where necessary using shims of approved alloy. Secure to structure with anchor bolts; number, diameter and length as shown on Contract Drawings. Fill void under base plate with non-shrink grout. Bolts, base plate and weld to be hot-dipped galvanized.
- G. Space pull posts at approximately 500-foot intervals for straight runs and at each vertical angle point. Install corner posts at each horizontal angle point. Provide corner, end and pull posts with horizontal braces and tie rods on each side of posts extending to and connecting to adjacent line posts.
- H. After posts are installed and grout has set, install top rail or tension wire and securely anchor at ends and to line posts before hanging fabric.
- I. Secure ends of fabric by tension bars threaded through loops in fabric and secured to posts by bands with bolts and nuts or other approved devices.
- J. Attach fabric outside framing system, away from Authority property. Stretch fabric by securing one end and applying sufficient tension by mechanical fence stretchers. Fasten fabric to line posts, tension wire and top railing with tie wires at spacing shown.
- K. Hold bottom of fabric as uniformly as possible to, but in no case to exceed, two inches above finished grade.
- L. Provide barbed wire where shown. Install support arms at 45 degrees upward and outward from Authority property; extend corner, gate and end posts as shown. Stretch barbed wire to remove kinks and sags and secure to bracket arms, using tension bands for attachment to posts.
- M. Install gates, gate stops and fan guards as shown.
- N. Set gate stops in concrete accurately so that plunger can be fully engaged.
- O. Furnish one chain with one padlock for each gate.
- P. Grounding: Section 16060.

3.02 GATE INSTALLATION

- A. Install gates plumb, level and secure for full opening without interference. Install ground-set items in concrete for anchorage, as detailed on the Contract Drawings. Adjust the hardware for smooth operation and lubricate where necessary.

- B. Attach barbed wire as shown on the Contract Drawings.

3.03 DEFECTIVE WORK:

- A. Remove and replace fencing which is improperly located and is not true to line and grade, and posts which are not plumb.
- B. Repair damaged galvanizing by thoroughly wire brushing damaged area to remove loose and cracked zinc coating, and paint with two coats of high zinc-dust content paint. Allow first coat to dry thoroughly before applying second coat.

END OF SECTION

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SECTION 02845

TRAFFIC CONTROL DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing vehicular traffic barriers and raised concrete traffic bars.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Certification:
 - 1. Certificates from guardrail element manufacturer and pressure preservative-treatment plant stating that materials furnished meet specified requirements.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AWPA: C1, P8.
 - 3. AASHTO: T68.
 - 4. ASTM: A36, A123, A153, A307.
 - 5. FS: TT-P-641.
- B. Allowable Dimensional Tolerances:
 - 1. Steel guardrail elements fabricated to width and depth tolerance of minus 1/8 inch.
 - 2. Dimensions of concrete posts and raised concrete traffic bars: Plus-or-minus 1/8 inch of dimensions shown.
 - 3. Dimensions of timber posts and bracket blocks: Plus-or-minus 1/2 inch of dimensions shown.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Guardrail:
 - 1. Steel posts and brackets:
 - a. Structural steel: ASTM A36.
 - 2. Wood posts and bracket blocks:
 - a. Number 1 Dense SR southern pine, minimum stress-grade 1400f.
 - b. Well-seasoned, sound and free from splits, cracks and other defects.
 - c. Pressure treated in accordance with AWPA Standard C1 using pentachlorophenol preservative in light petroleum solvent conforming to AWPA Standard P8.
 - 3. Concrete posts:
 - a. Concrete reinforcement: Section 03200.
 - b. Concrete: Section 03300 and 03400.

4. Rail elements and terminal sections:
 - a. Rail elements and terminal sections fabricated from open-hearth or electric-furnace steel of thickness shown. Sheet shaped into beam with longitudinal corrugations forming section 12 inches minimum width and three inches minimum depth.
 - b. Fabrication:
 - 1) Edges of rail element straight and smooth.
 - 2) Steel sheet subject to standard mill tolerances for gauge.
 - c. For steel-beam type guardrail installed on curves having radius of more than 20 feet and less than 150 feet: Rail elements convex or concave as shown.
 - d. Elongation of two-inch specimen of sheet steel used for rail elements: 12-percent minimum when tested in tension in accordance with AASHTO T68.
 - e. Comply with the following:
 - 1) Tensile strength of specimen of full size of rail element, including a splice at center of specimen: 70,000-psi minimum.
 - 2) Post connections to withstand 5,000-pound side pull in both directions.
 - 3) Section of rail with traffic face up, freely supported at both ends of 12-foot span, to support concentrated load of 2,000 pounds at center of span with maximum deflection of two inches.
 - f. Rail elements and terminal pieces hot-dip galvanized after fabrication.
5. Hardware:
 - a. Bolts and nuts: Steel, ASTM A307, Grade A.
 - b. Post and splice bolts machined, button-head, shoulder bolts with roll threads, Class 2A fit before galvanizing. Shoulder or neck to have an oval shape as shown. Hexagon nuts for rail connections to be machined American Standard heavy-type with recess to accommodate shoulder on bolts.
 - c. Bolts and nuts for offset steel brackets: American Standard heavy-type.
 - d. Plate washers fabricated from steel conforming to requirements specified for rail elements and terminal connections.
 - e. Hot-dip galvanized after fabrication.
6. Galvanizing:
 - a. Steel posts, post anchors, brackets, rail elements and terminal sections hot-dip galvanized after fabrication in accordance with ASTM A123.
 - b. Hardware hot-dip galvanized after fabrication in accordance with ASTM A153. Zinc coating: Two ounces per square foot minimum.
 - c. Replace components on which galvanizing is damaged with new material having properly galvanized surfaces.
7. Primer coating: FS TT-P-641.
8. Non-shrink grout: Section 03300, shrinkage compensating.
9. Welding: Section 05120.

B. Raised Traffic Bars:

1. Formwork: Section 03100 or 03400.
2. Reinforcing steel: Section 03200.
3. Concrete: Section 03300, Class 3000, air-entrained.
4. Portland-cement grout: Section 03300.
5. Adhesive for attaching traffic bars to pavement: Polyvinyl acetate or asphaltic emulsion. If asphaltic emulsion is used, do not use clay or similar substances as emulsifying agents. Consistency of adhesive suitable for heavy trowel application at prevailing ambient temperature.
6. Anchor pins: Section 03200, concrete reinforcing rods.

2.02 FABRICATION AND MANUFACTURE:

- A. Steel Posts, Brackets and Post Anchors:
 - 1. Cut ends square. Punch or drill posts and brackets as shown.
 - 2. After being cut to length and punched or drilled, hot-dip galvanize posts and brackets separately before bolting.
 - 3. On end steel posts and adjacent posts weld steel channel anchor, 15.3 pounds per linear foot and one-foot three-inches long minimum.
 - a. Weld anchors to posts and hot-dip galvanize.
 - b. Welding: Section 05120.
 - 4. Replace components on which galvanizing is damaged with new material having properly galvanized surfaces.

- B. Wood Posts and Bracket Blocks:
 - 1. Cut ends square. Drill posts and bracket blocks as shown.
 - 2. After cutting to length and drilling, saturate cut ends and holes with same preservative as that used for pressure treatment.

- C. Concrete Posts:
 - 1. Precast concrete, Class 5000, in accordance with Section 03300, eight inches square by five feet-nine inches.
 - 2. Reinforcement as shown and in accordance with Section 03200.
 - 3. Cure in accordance with Sections 03300 and 03400.

- D. Traffic Bars:
 - 1. Apply shop mark on each raised traffic bar with water-resistant paint showing the following:
 - a. Date of manufacture.
 - b. Identifying mark of manufacturer.

PART 3 - EXECUTION

3.01 EQUIPMENT:

- A. Where posts are to be set in drilled holes, use mobile auger.
- B. Where steel posts are to be driven in place, use mobile drop hammer equipped with leads and mounted on track or on crawler treads. Protect heads of posts with driving cap designed to fit section of post being driven.

3.02 POSTS IN DRILLED HOLES:

- A. Drill holes plumb, accurately positioned and of diameter and depth shown.
- B. Position posts in hole to alignment shown; brace in position until remainder of hole has been backfilled with excavated material or concrete as shown.
- C. Place backfill in layers six inches maximum and compact in accordance with Section 02320.
- D. Dispose of surplus excavated material in accordance with Section 02320.

- E. In unpaved areas, carry backfill to height of two inches above surface of ground and slope to drain away from post.
- F. When holes in paved areas are shown to be backfilled with excavated material, place and compact backfill to bottom of pavement. Where pavement is portland-cement concrete pavement, fill remainder of hole with concrete to surface of pavement. Where pavement surface is asphaltic concrete, stop concrete fill two inches below final grade and fill remainder of hole with asphaltic concrete of same type as existing surface. Tamp asphaltic concrete well and slope to drain away from post.
- G. Where shown to be encased in concrete, compact concrete well and carry it to height of two inches above natural ground and slope to drain. Trowel finish surface.

3.03 POST DRIVEN IN PLACE:

- A. Ensure that posts are plumb and located as shown. Remove and re-drive posts which are not in compliance.
- B. Drive steel posts before offset bracket is attached.
- C. After driving, top of posts to have substantially same cross-sectional dimensions as body of posts and be free of bends and damage to galvanizing coat. Remove posts not in compliance and drive new replacement post.
- D. Drive posts carefully to prevent damage to utility facilities; if such facilities are encountered, relocate posts. Repair facilities damaged by construction operations.

3.04 POST SET ON CONCRETE PAVEMENTS AND DECK SLABS:

- A. Where steel-beam guardrail is installed on existing portland-cement concrete pavement or deck slabs, fabricate steel post assembly as shown. Anchor assembly to pavement or deck slab with through-bolts or four-unit expansion anchors as shown.
- B. Clean pavement or deck surface area where base plate is to be installed. Set post with base plate over bolts; plumb and shim posts to proper grade and alignment with metal shims.
- C. Work nonshrink grout under plate to ensure full contact of bearing area. Remove shims as soon as concrete has hardened sufficiently to support weight of post. Finish edges true and smooth.

3.05 INSTALLATION OF STEEL-BEAM GUARDRAIL:

- A. Install brackets and blocks on roadway side of posts. Tighten bolts after rail elements have been attached and entire assembly adjusted to line and grade.
- B. Erection of Rail Elements and Terminals Sections:
 - 1. Erect rail elements and terminal sections on posts and post brackets previously set to produce smooth continuous rail to line and grade shown. Install rail with double-corrugation face toward traffic.
 - 2. Bolt edges and center corrugation fully.
 - 3. Make vertical adjustment at posts by use of oversize bolt holes in posts and brackets as shown. If oversize holes do not permit sufficient adjustment, reset post until

- guardrail is properly aligned.
4. After rail has been correctly aligned, tighten bolts. Check or burr threads projecting beyond nut to prevent removal.
 5. Where steel beam-type guardrail is shown anchored to bridge piers or terminating at concrete parapet walls, punch slotted bolt holes in rail elements terminating at such locations and make connections as shown. Flame-cutting is prohibited.
- C. Where approved, repair damaged zinc coating by wire brushing damaged area to remove loose or cracked zinc coating and applying two coats of primer.
 - D. Punching, drilling, reaming, cutting or welding rail elements or terminal pieces in the field is prohibited except as approved.

3.06 INSTALLATION OF RAISED TRAFFIC BARS

- A. Install raised traffic bars at locations shown.
- B. Before adhesive is applied, remove dirt, dust, grease, oil and other foreign matter that would adversely affect bond of adhesive.
- C. Apply adhesive to surfaces in such quantity that firm even bearing is obtained throughout entire contact area. Remove excess adhesive.
- D. Where use of steel pins is shown, drill holes through pavement, before adhesive is applied.
- E. After adhesive has been applied and bars properly positioned, drive steel pins in place with top of pin two inches below top of bar. Firmly press bar into adhesive, fill pin holes with portland-cement grout flush with top of bar.
- F. Where traffic bars extend across pavement joints, cut bars and make open joint of same width as joint in pavement.
- G. Painting: In accordance with Section 02765.
- H. Installation of traffic bars which are chipped, cracked or otherwise defective is prohibited.
- I. Protect completed installation until final acceptance.

3.07 FIELD QUALITY CONTROL:

- A. Top of post: Plus-or-minus 1/4 inch of elevation shown.
- B. Location of post: Plus-or-minus 1/4 inch of location shown.

END OF SECTION

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SECTION 02890

MARKERS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing markers.
- B. Related Work Specified Elsewhere:
 - Section 03200 Concrete reinforcement
 - Section 03300 Cast-in-place concrete
 - Section 03400 Precast Structural Concrete

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data:
 - 1. Manufacturer's construction details showing materials, dimensions and profiles for each individual component.
- B. Shop Drawings:
 - 1. Plans, elevations and sections detailing fabrication and erection. Show anchors, reinforcements, accessories, layout, installation details, colors and finish treatments.
 - 2. Message list including wording and lettering layout. Include full-size details of special graphics.
 - 3. Setting drawings, templates and directions for installation of anchors to be installed as work in other sections.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications.
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. FS: QQ-B-654, WW-T-791.
 - 3. ASTM: B36, B135
- B. Survey Certification:
 - 1. All Right-Of-Way markers shall be set by a surveyor registered in the area where the work is to be performed.
 - 2. The following certification statement or a similar statement is required and shall be placed on all approved Mylar sepia as-built Right-of-Way drawings:

"I hereby certify to the best of my knowledge that the Right-Of-Way markers shown on this as-built drawing have been set in accordance with the coordinate information provided by WMATA as shown on the Contract Documents."

(seal)
Registered Surveyor in the State of Maryland

(seal)
Registered Surveyor in the District of Columbia

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Precast Concrete: Section 03400.
- B. Concrete: Section 03300, Class 3500, air-entrained.
- C. Concrete Reinforcement: Section 03200.
- D. Bronze Discs:
 - 1. 3 ½ inch diameter domed survey marker forged from solid unleaded bronze in accordance with ASTM B98-98 with a classic 3 inch long and 5/8 inch diameter split-style tapered stem designed for use in concrete or rock (the Corp of Engineers Type 1 disc). Like or equivalent to the Berstsen C-1 Bronze 3 ½ inch domed marker #C35DB.
 - 2. Refer to Standard Drawings ST-C-3 and ST-C-19 for additional details on bronze discs and installation.
- E. Epoxy Hilti

2.02 FABRICATION AND MANUFACTURE:

- A. Markers and Monuments:
 - 1. Legend:
 - a. Apply legend shown for various markers and monuments using characters of size and type shown. Clearly indicate use.
 - 2. Bronze disc markers:
 - a. Bronze discs as specified with imprinted or stamped legend.
 - 3. Precast-concrete markers and monuments:
 - a. Four inches square by length shown, with 1/2-inch chamfered edges.
 - b. Precast concrete.
 - c. One 29-inch long, No. 4 steel-reinforcing bar centered in casting.
 - d. With lettering, when shown, incised v-shaped, 1/4-inch wide and 3/16-inch in depth.

PART 3 - EXECUTION

3.01 BRONZE DISCS FOR MARKERS AND MONUMENTS:

- A. Except as shown, form discs into convex shape 3/16 inch in depth with edges free from burrs and blemishes.
- B. Press legend into the upper surface of disc so that surface is not raised. Ensure that legend conforms to that shown for markers and monuments.
- C. Do not place letters closer than 1/8 inch to outer rim of marker. Letters in outer ring of legend, 1/2-inch high; medium-sized letters, 7/32-inch high. Place letters along radius of disc. Imprint legend symmetrically about center of disc.
- D. When bronze-disc markers are set in concrete pavements and roadways, set stem in drilled hole and secure with approved epoxy cement, like or equivalent to Hilti HIT Hy 150.
- E. At other locations, set bronze-disc markers into tops of markers and monuments as specified; set markers and monuments in ground at locations shown.

3.02 PRECAST-CONCRETE MARKERS AND MONUMENTS:

- A. Install precast-concrete markers and monuments at locations and to elevations shown or as directed.
- B. Set markers and monuments as shown. Compact bottom of excavation to prevent settlement.

END OF SECTION

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SECTION 02920

TOPSOIL, SEEDING AND SODDING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing and maintaining seeding and sodding, including grass, crownvetch and lespedeza.
- B. Related Work Specified Elsewhere.
 - Section 02320 Site grading
 - Section 02205 Removal and restoration of existing facilities
 - Section 02930 Landscaping
- C. Definitions:
 - 1. UMPC: University of Maryland, College Park
 - 2. Numerical fertilizer analysis: Three-digit number indicates nitrogen, phosphoric acid and potash percentages by weight. Thus, 3-25-25 means three-percent nitrogen, 25-percent phosphoric acid and 25-percent potash by weight.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications: Keep always available at the work site a copy of each of the cited references.
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. USDA-SCS.
 - 3. UMPC: Current publication of Agronomy Mimeo #77 (Turfgrass Cultivar Recommendations for Maryland).
 - 4. ASTM: C51.
- B. Personnel Qualifications:
 - 1. Superintendent: Use a Superintendent with previous knowledge and verifiable experience in supervising seeding and sodding work of similar size and scope. Have the Superintendent present whenever work is being performed and have the Superintendent responsible for controlling the quality of work and inspecting completed work to ensure that Contract requirements are met. The Superintendent is the primary contact person with the Engineer regarding seeding and sodding work.
 - 2. Workers: Have the work performed only by experienced workers, who through related training and verifiable previous on-the-job experience, are familiar with the technical aspects of seeding and sodding, and with the materials and equipment used for each operation. Have each worker abide by the code of ethics or professional conduct established by the Landscape Contractors Association MD-DC-VA.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Samples and Certification:

1. Submit in accordance with Table 02920-1 and as follows:
 - a. Seed: Each seed bag bearing the following upon delivery:
 - 1) Analysis tag.
 - 2) Certification tag.
 - 3) Maryland or Virginia State tags where applicable.
 - b. Inoculant: Sample packet of inoculant, viable bacteria, true to legume strain required and listing source.
 - c. Sod: Maryland or Virginia State-Certified, each delivery bearing a Maryland or Virginia certification tag and label as required by law.
 - d. Topsoil: Submit supplier's name and address and source of topsoil. Submit certified report of soil laboratory test results listing textures, pH, P and K nutrients, soluble salt, organic matter and mechanical analysis as to percentage of sand, silt and clay. Do not deliver topsoil to site until approved. Approval does not constitute final acceptance.
 - e. Fertilizer: Labeled with manufacturer's name and address, guaranteed analysis, including nutrient and its derived source and listing of potential acidity.
 - f. Limestone and acidifying agent: Labeled with manufacturer's name and address, chemical analysis, oxide content and size gradation of each used.
 - g. Mulch and mulch binder: Labeled with manufacturer's name and address, material components, trademark, chemical analysis, species, size, age and source.
 - h. Herbicide: Labeled with manufacturer's name and address and chemical analysis. Include in submittal the Material Safety Data Sheet, with copies to the Engineer and Contractor's Safety Officer.
2. Usable samples will be returned.

B. Documentation:

1. Personnel qualifications: A list of the qualifications and experience of the workers, and qualifications and experience of the Superintendent, as attested by knowledge and experience in supervising contracts of similar size and scope in the past.
2. Soil tests for crownvetch and lespedeza areas: Submit certified report of soil tests *made by a local state agricultural experiment station or agricultural laboratory recommended by U.S. Department of Agriculture*. Test for pH, P and K nutrients, soluble salt, organic matter and mechanical analysis as to percentage of sand, silt and clay; and include recommended quantities of soil amendments to be added to produce the target pH value and to produce optimal growing conditions for the target crop.
3. Furnish one test for each 500 square feet of each crownvetch and lespedeza planting area, and not less than one test for each area.
4. Equipment list: A list of the equipment anticipated for use, including the make and model, year manufactured.

1.04 PRODUCT INSPECTION, DELIVERY, STORAGE AND HANDLING:

- A. General: Materials and supplies are subject to inspection and sampling for testing. Allow no seed, sod, fertilizer, straw or other agronomic materials or supplies on site other than those for the project
- B. Seed: Deliver with labels and tags.
- C. Inoculants: Store inoculant containers below 70F until used. Keep containers sealed until

contents are used in their entirety. Use inoculants before expiration date shown on packet. Using inoculants exposed to temperatures of 70F or greater is prohibited.

- D. Sod: Deliver sod with labels and tags.
 - 1. Deliver sod to job within 24 hours after being cut; place sod within 36 hours after being cut.
 - 2. Prior to and after delivery during wet weather, allow sod to dry to the extent that will prevent tearing during handling and laying. During dry weather, water sod to ensure its vitality and prevent dropping of the soil in handling.
- E. Topsoil: During hauling operations, keep walkway and roadway surfaces clean. Promptly remove fallen material.

1.05 JOB CONDITIONS:

- A. Conduct seeding and sodding only under favorable seasonal conditions throughout the period of the Contract as determined by the Engineer. Install no work during adverse weather or during periods when soil conditions are unfavorable as determined by the Engineer. Do not plant or lay sod during freezing weather, when planting area is muddy or frozen, nor when sod is frozen.
- B. Protection: During progress of operations, protect walls, walks, curbs, benches, established lawn areas, plant material, and other site improvements by adequate means acceptable to the Engineer.
 - 1. Weight Restrictions: Do not overload entrance paving, sidewalks and curbs.
 - 2. Pollution: Take necessary and adequate measures to prevent soil erosion, air pollution and water pollution by the materials and equipment used during construction.
 - 3. Repairs: If damage by the Contractor should occur, it is the Contractor's responsibility to repair or replace per the Engineer's direction, as acceptable to concerned parties, and at no additional cost to the Authority. Perform work so that damaged areas make smooth, satisfactory, and imperceptible transitions to existing adjacent work. Use materials and methods conforming to current standards for the area damaged, matching adjacent materials in appearance, and meeting approval of jurisdictional authorities and the Engineer.
- C. If, at any time, the Engineer determines that work is unsatisfactory or being conducted in an unsafe manner, immediately cease such work activities upon notification.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Seed: Free of quack grass, timothy, bentgrass, clover, dock, annual bluegrass, cheat, chess, chickweed, crabgrass, plantain, black medic and, except where specified in Table 02920-2, Canada Bluegrass. Kentucky Bluegrass and red fescue free of tall fescue.
 - 1. Grass Seed: Dated material from last available crop, with date of test not more than nine months before date of sowing; listed as Proven Cultivars in the latest Agronomy Mimeo #77 (Turfgrass Cultivar Recommendations for Maryland), *published by UMPC*; and as specified in Table 02920-2 below.
 - 2. Crownvetch Seed: Dated material from last available crop, with date of test not more than nine months before date of sowing. Germination portion consisting of minimum 35-percent normal sprouts, maximum 35-percent hard seed and as specified in Table

02920-4.

3. Appalow Sericea Lespedeza Seed: Germination portion consisting of minimum 35-percent normal sprouts, maximum 35-percent hard seed and as specified in Table 02920-5.

B. Inoculant: Adaptable culture of live nitrogen-fixing bacteria true to legume strain used.

C. Sod:

1. Well-rooted Maryland or Virginia State-Certified sod, at least 18 months old. Varieties, identical to one of the following, or as approved:
 - a. Seed mixture specified in Table 02920-3.
 - b. Proven Cultivars in the latest Agronomy Mimeo #77, published by UMPC, certified 90-percent Turf-type Tall Fescue and 10-percent Kentucky Bluegrass.
2. Sod and attached soil free from noxious weeds such as Bermuda grass, quack grass, garlic, Johnson grass, Canada thistle and other turf weeds.
3. Mowed in production field to height of not more than 2-1/2 inches within five days prior to lifting.
4. Machine cut in sections not less than 2-1/2 feet in length nor less than 12 inches in width and to a depth equal to growth of fibrous roots, uniform soil thickness of 3/4 inch, plus-or-minus 1/4 inch. Measurement for thickness to exclude top growth and thatch.
5. Cut in sections or strips strong enough to support its own weight and retain size and shape when suspended vertically from firm grasp on upper 10 percent of section. Small, irregular or broken pieces of sod are prohibited. Sod on Beck Roll is permitted.

D. Topsoil: Weathered surface soils or natural friable loam obtained from approved sources, free of subsoil, hard fragments and stones larger than one-inch across greatest dimension, objectionable salts, noxious weeds and plants, debris and other materials inferior to surface soils or that would be toxic or harmful to growth; containing not less than 1.5-percent organic matter as determined by Walkley-Black Method; capable of sustaining normal, healthy growth and development of seed and sod scheduled and specified. Seed shall not be placed in topsoil which has been treated with soil sterilants until sufficient time has elapsed to allow for the dissipation of toxic materials.

1. Grading analysis:

Sieve	Minimum Percent Passing
2 inches	100
1/2 inch	90
1/4 inch	80
No. 10	70

2. Test and analysis of proposed topsoil material: Performed by local state agricultural experiment station or agricultural laboratory recommended by the U.S. Department of Agriculture, including recommendations for fertilizer and pH adjustment for target crop, and meeting the following requirements.
 - a. Acidity range: pH 5.5 to pH 7.5, inclusive. When topsoil pH is not within pH 5.5 - pH 7.5, modifications to correct topsoil pH shall be made according to the recommendations of the soil test lab, or the applicable State Cooperative Agricultural Extension Service.

- b. Salinity by electrical-conductivity measurement: 500-ppm soluble salt maximum.
 - c. Fertility: Rated high in natural nutrients in pounds per acre based on the standard soil test in laboratory.
 - d. Texture: Classification consisting of 5-percent to 25-percent clay, 20-percent to 60-percent sand and 15-percent to 45-percent silt as determined by hydrometer or pipette method. Sand, silt and clay as defined by USDA-SCS.
- E. Fertilizer:
- 1. For grass seeded and sodded areas: Commercial fertilizer of standard quality, recommended by approved soil test report; 10-22-22.
 - 2. For crownvetch seeded areas: Use both of the following:
 - a. Commercial fertilizer of standard quality; 0-20-20 or 3-25-25.
 - b. Blue Chip Nitroform, slow-release nitrogen, granular form, of standard quality; 38-0-0.
 - 3. For appalow-sericea-lespedeza seeded areas: Commercial fertilizer of standard quality, recommended by approved soil test report; 10-22-22.
- F. Limestone: ASTM C51, Dolomitic, Agricultural Grade.
- 1. Capable of neutralizing soil acidity and containing not less than 85 percent calcium and magnesium carbonates
 - 2. Sieve analysis: 95-percent passing No. Eight sieve and 40-percent passing a No. 100 sieve. For hydroseeding, use pulverized limestone.
 - 3. Containers labeled to show chemicals.
- G. Acidifying Agent: As approved per soil analysis recommendations and seeding method.
- H. Mulch:
- 1. Wood-cellulose fiber: Containing no growth or germination-inhibiting factors and dyed green.
 - a. Properties:
 - 1) Fiber length: Approximately 3/8 inch.
 - 2) Diameter: Approximately 1/32 inch.
 - 3) Acidity range: pH 4.0 to 8.5, inclusive.
 - 4) Ash content: 1.6-percent maximum.
 - 5) Water-holding capacity: 90-percent minimum.
 - b. Packaging: Furnish fibers air-dry in packages not exceeding 50 pounds gross, with net weight shown on package.
 - c. Source: Conwed Hydro Mulch by Conwed Corp., St. Paul, MN 55101 or equal.
 - 2. Straw: Wheat, barley, oat or rye straw, threshed, air-dried and free from Canada thistle, dock, Johnson grass and other foreign matter.
 - 3. Mulch blanket: Knitted construction of biodegradable yarn with uniform openings, Gulf States Paper Corporation, Tuscaloosa, AL 35401 or equal.
 - a. 150-foot lengths or greater.
 - b. U-shaped staples: As standard with mulch-blanket manufacturer.
- I. Mulch Binders: Non-asphaltic only.
- 1. Synthetic binder for use with the following:
 - a. Wood-cellulose fiber: Terra Tack 1 by Grass Growers, Plainfield, NJ 07061; Soil-Gard by Alco Chemical Company, Philadelphia, PA 1913, or equal.
 - b. Straw: Terra Tack 1 by Grass Growers, Plainfield, NJ 07061 or equal.
 - 2. Biodegradable netting for use with straw: Conwed Erosion Control Netting by Conwed

Corporation, St. Paul, MN 55101 or equal.

- J. Herbicides:
 - 1. Broadleaf weed control: Trimec by P.B.I. Gordon Corporation, Kansas City, KS 66118 or equal.
 - 2. Pre-emergent crabgrass control: Balan by Elanco Products Company, Division of Eli Lilly Corporation, Indianapolis, IN 46206 or equal.
 - 3. Post-emergent crabgrass control: A.M.A., D.S.M.A., M.A.M.A. or Calcium Methyl Arsenate by W.A. Cleary Company, Somerset, NJ 08873 or equal.
 - 4. Perennial bunch-grass control: Round-up by Monsanto Agricultural Products Company, Wilmington, DE 19810 or equal.

- K. Stakes (for pegging sod): Wood or other biodegradable stakes suitable for the purpose, measuring 1/2-inch by one-inch by 12 inches.

- L. Water: Potable.

2.02 SEED MIXTURES:

- A. Grass Seed: Tables 02920-2 and 02920-3.
- B. Crownvetch Seed: Table 02920-4.
- C. Lespedeza Seed: Table 02920-5.
- D. Hydroseeding Crownvetch and Lespedeza Seed: Tables 02920-6 and 02920-7.

2.03 EQUIPMENT:

- A. Dry-Type Seeder: Brillion seeder, drill seeder or other approved mechanical seeder.
- B. Spraying Equipment for Hydroseeding: Use water tank equipped with liquid-level gauge calibrated in increments not larger than 50 gallons over entire range of tank capacity with gauge visible to nozzle operator. Use tank equipped with agitation system capable of maintaining solids in complete suspension until used.

PART 3 - EXECUTION

3.01 PLACING TOPSOIL:

- A. After completion of construction work in the area, prepare surface of subsoil. Finish to lines shown and parallel to proposed finished grade, as approved. Remove rocks and other foreign materials 1-1/2 inches or greater in any dimension. Immediately prior to covering with topsoil, loosen prepared subsoil surface to a minimum depth of four inches. Leave no depressions.
- B. Place and spread topsoil over areas to be seeded and sodded except areas to receive crownvetch or lespedeza (unless Contract Drawings require 2:1 or greater slopes to be sodded or seeded), to depth which will produce four-inch depth after natural settlement and will conform to finish lines, grades and elevations.
- C. When placing topsoil on slopes, work topsoil into subsoil to minimum depth of four inches to

eliminate slip-plane between the two materials. Leave topsoil at surface to ensure germination of seed.

- D. After spreading topsoil, rake up and remove large stiff clods, hard lumps, large rocks, roots, stumps, litter and other foreign matter.
- E. Maintain specified depth of topsoil from time placed until specified seed or sod is established.
- F. If soil or weather conditions are unsuitable, cease topsoil operations. Resume topsoil operations when proper conditions prevail.

3.02 SEEDING GRASS:

- A. Dry Seeding: After placing topsoil, proceed as follows:
 - 1. Seed bed preparation:
 - a. pH adjustment: Adjust topsoil pH to raise it by applying limestone or approved acidifying agent or elemental sulfur to lower the topsoil pH at per-acre rate recommended by approved soil test report so as to obtain a 6.5 pH. Apply separately prior to fertilizing and seeding operations. Work into the top three inches of soil.
 - b. Fertilizing: After acidity adjustment and within 24 hours before seeding, apply fertilizer at per-acre rate recommended by approved soil test report. Use machine spreader and lightly drag or rake fertilizer into top 1/4 inch of soil.
 - 2. Seeding: Clean seeders as approved prior to applying seed. Apply seed mixture directly after fertilizing.
 - a. Sow specified grass seed mixture from March 1 to April 30 and from August 15 to October 15. Extend or reduce specified periods as approved and as required by weather and soil conditions.
 - b. Sow at minimum rate as specified in Table 02920-3.
 - c. Work seed in to depth of 1/4-inch maximum.
 - d. Finish as follows:
 - 1) Lawn areas with slopes up to 3:1: Raked surface.
 - 2) Roadside areas with slopes up to 3:1: Scarified surface.
 - 3) Slopes over 3:1: Leave surface in irregular condition with ridges running parallel to contour of slope to prevent erosion.
 - 3. Rolling: Directly after seeding, roll lawn areas with slopes up to 3:1 using approved lawn roller, weighing 40 to 60 pounds per foot of width, unless intervening precipitation would cause such rolling to be detrimental.
- B. Hydroseeding: After placing topsoil, proceed as follows:
 - 1. Seed bed preparation:
 - a. Clean hydroseeders as approved prior to coming on site.
 - b. pH adjustment: Adjust soil pH by either applying limestone or approved acidifying agent or elemental sulfur at per-acre rate recommended by approved soil test report so as to obtain a 6.5 pH. Apply separately prior to fertilizing and seeding operations.
 - 1) Use only pulverized limestone to raise soil pH.
 - 2) Apply not more than 300 pounds of limestone for each 100 gallons of water.
 - 3) After applied limestone mixture has dried, work into the top three inches of soil.
 - c. Apply elemental sulfur as recommended, and incorporate into top three

- inches of soil.
- d. After pH adjustment, again grade and dress seed beds for lawn areas to raked surface.
- 2. Fertilizing and seeding: After seed bed preparation, apply fertilizer-seed mixture.
 - a. Apply fertilizer at per-acre rate recommended by approved soil test report.
 - b. Apply seed at same rates and times specified for dry seeding. Mix seed and fertilizer together in proportions to meet required application rates.
 - c. If mulching with wood-cellulose fiber on areas with slopes up to 3:1, add mulch to seed and fertilizer mixture.
- 3. Application method:
 - a. Apply mixtures by means of high-pressure spray directed upward into air so that mixtures fall to ground in uniform spray. Do not direct nozzle of hand-held hose toward ground in manner that would produce erosion or runoff.
 - b. Make uniform applications at required rate, with two passes at 90 degrees to each other, to ensure uniformity and prevent misses.
 - c. Agitate mixtures constantly from time mixed until application to seed bed.
 - d. Use mixtures within eight hours after mixing.

3.03 SEEDING CROWN VETCH:

- A. Seed Bed Preparation: After construction work in the area has been completed, proceed as follows:
 - 1. Grading: Rough grade to remove large stones and roots. Remove or break up clods greater than one-foot diameter. Chisel surface to depth of four to six inches. When preparing slopes, chisel parallel to contour of slope.
 - 2. pH adjustment: Adjust soil pH by applying limestone or approved acidifying agent or elemental sulfur at per-acre rate in Table 02920-6, except as recommended by approved soil test report so as to obtain a 6.5 pH. Apply separately prior to fertilizing and seeding operations.
 - a. Apply 2/3 of limestone when seed bed is prepared. Work this into the top six inches of soil.
 - b. Apply remaining 1/3 of limestone with seed mixture.
 - 3. Fertilizing: After acidity adjustment, apply fertilizer at per-acre rate in Table 02920-6, except as recommended by approved soil test report.
 - 4. Hydraulic overseeding: For overseeding existing vegetation, cut existing vegetation to height of three inches and remove resultant refuse prior to overseeding.
- B. Seed Preparation:
 - 1. Inoculate crownvetch seed on day it is used.
 - 2. Reinoculate seeds not sown within 24 hours following inoculation.
- C. Hydroseeding: Clean hydroseeders as approved prior to coming on site.
 - 1. From March 1 to October 15, sow specified crownvetch seed mixture (Table 02920-4) at a rate of 100 pounds per acre.
 - 2. From June 1 to August 15 sow specified crownvetch seed mixture (Table 02920-4) at a rate of 100 pounds per acre, except add an additional three-percent by weight of Loehmans Weeping Lovegrass.
 - 3. Extend or reduce specified periods as approved and as required by weather and soil conditions.
 - 4. Bare areas: Perform application-sequence Stages I and II, specified below.
 - 5. Existing vegetation areas (hydraulic overseeding): Perform only application-sequence Stage I, specified below. Obtain the Engineer's on-site approval on whether to use

- nozzle or hose for hydraulic overseeding.
6. Application method:
 - a. Apply mixtures by means of high-pressure spray directed upward into air so that mixtures fall to ground in uniform spray. Do not direct nozzle of hand-held hose toward ground in manner that would produce erosion or runoff.
 - b. Make uniform applications at required rate, with two passes at 90 degrees to each other, to ensure uniformity and prevent misses.
 - c. Agitate mixtures constantly from time mixed until application to seed bed. Use mixtures within eight hours after mixing.
 - d. Use inoculated crownvetch in slurry with fertilizers within one hour after mixing. Use fresh crownvetch seed and reinoculate seed whenever this requirement cannot be met.
 7. Application sequence:
 - a. Stage I, Table 02920-5: Load materials into water-filled tanks in proportion to tank size; agitate until smooth slurry is formed. Spray on seed bed at rates specified. Follow within two hours with Stage II.
 - b. Stage II, Table 02920-6: Mulch area within two hours after completing Stage I. Use straw mulch for slopes up to 2:1. Use mulch blanket for slopes greater than 2:1. Do not use wood-cellulose fiber.

3.04 SEEDING LESPEDEZA:

- A. Seed Bed Preparation: After construction work in the area has been completed, proceed as follows:
 1. Grading: Rough grade to remove large stones and roots. Remove or break up clods greater than one-foot diameter. Chisel surface to depth of four to six inches. When preparing slopes, chisel parallel to contour of slope.
 2. pH adjustment: Adjust soil pH by applying limestone or approved acidifying agent, or elemental sulfur at per-acre rate in Table 02920-6, except as recommended by approved soil test report so as to obtain a 6.5 pH. Apply separately prior to fertilizing and seeding operations.
 - a. Apply 2/3 of limestone when seed bed is prepared. Work this into the top six inches of soil.
 - b. Apply remaining 1/3 of limestone with seed mixture.
 3. Fertilizing: After acidity adjustment, apply fertilizer at per-acre rate in Table 02920-6, except as recommended by approved soil test report.
 4. Hydraulic overseeding: For overseeding existing vegetation, cut existing vegetation to height of three inches and remove resultant refuse prior to overseeding.
- B. Seed Preparation:
 1. Have lespedeza seed hulled, scarified and inoculated for spring sowing.
 2. Inoculate lespedeza seed on day it is used.
 3. Reinoculate seeds not sown within 24 hours following inoculation.
- C. Hydroseeding: Clean hydroseeders as approved prior to coming on site.
 1. Sow specified lespedeza seed (Table 02920-5) from March 1 to April 30 and August 15 to October 31 at the rate of 90 pounds per acre.
 2. Extend or reduce specified period as approved and as required by weather and soil conditions.
 3. Bare areas: Perform application-sequence Stages I and II, specified below.
 4. Existing vegetation areas (hydraulic overseeding): Perform only application-sequence Stage I, specified below. Obtain the Engineer's on-site approval on whether to use

- nozzle or hose for hydraulic overseeding.
5. Application method:
 - a. Apply mixtures by means of high-pressure spray directed upward into air so that mixtures fall to ground in uniform spray. Do not direct nozzle of hand-held hose toward ground in manner that would produce erosion or runoff.
 - b. Make uniform applications at required rate, with two passes at 90 degrees to each other, to ensure uniformity and prevent misses.
 - c. Agitate mixtures constantly from time mixed until application to seed bed. Use mixtures within eight hours after mixing.
 - d. Use inoculated lespedeza in slurry with fertilizers within one hour after mixing. Use fresh crownvetch seed and reinoculate seed whenever this requirement cannot be met.
 6. Application sequence:
 - a. Stage I, Table 02920-5: Load materials into water-filled tanks in proportion to tank size; agitate until smooth slurry is formed. Spray on seed bed at rates specified. Follow within two hours with Stage II.
 - b. Stage II, Table 02920-6: Mulch area within two hours after completing Stage I. Use straw mulch for slopes up to 2:1. Use mulch blanket for slopes greater than 2:1. Do not use wood-cellulose fiber.

3.05 MULCHING:

- A. General:
 1. Mulch according to the following slope limitations, except as limited for crownvetch and lespedeza.
 2. Mulch within two hours after seeding as follows:
 3. Immediately replace displaced mulching.
- B. Slopes up to 3:1:
 1. Wood-cellulose fiber:
 - a. Apply at a net dry weight 1,500 pounds per acre.
 - b. Apply hydraulically with seed and fertilizer at rate of 50 pounds per 100 gallons of water.
 2. Straw:
 - a. Methods of application:
 - 1) Hand spreading: 4,000 pounds per acre (100 pounds per 1,000 square feet). Cover areas uniformly to depth of not less than two inches of loose material.
 - 2) Blowing: Use of cutters is permitted in blowing equipment if at least 95-percent of mulch is six inches or more in length. For cut mulches applied by blowing method, achieve uniform distribution and loose in-place depth of not less than two inches.
 - 3) Mulch-binder application:
 - a) Synthetic binder: Apply according to manufacturer's instructions.
 - b) Biodegradable netting: Apply according to manufacturer's instructions.
- C. Slopes 2:1 to 3:1: Straw as specified above.
- D. Slopes over 2:1: Mulch blanket, applied and stapled according to manufacturer's instructions.

3.06 SODDING:

- A. Sod Bed Preparation: After placing topsoil, proceed as follows:
1. pH adjustment: Adjust soil pH by applying limestone or approved acidifying agent, or elemental sulfur at per-acre rate recommended by approved soil test report so as to obtain a 6.5 pH. Mix into soil to a depth of four inches minimum.
 2. Fertilizing: After pH adjustment, apply fertilizer at per-acre rate recommended by approved soil test report. Mix into soil to a depth of four inches minimum.
 3. Compact topsoil with lawn roller or tractor roller to three inches of final compacted thickness as approved.
- B. Laying Sod:
1. Lay sod between September 15 and June 1, grown from seed varieties identical to grass seed mixture in Table 02920-3, or sod which is Blue-Tag certified.
 2. Extend or reduce specified period as approved and as required by weather and soil conditions.
 3. When soil surface is hot or dry, wet soil to a depth of two inches, six to eight hours before sodding. Do not accept or lay dried sod.
 4. Place sod by hand with butted joints and no overlapping. When Beck Roll of sod is used, lay also in accordance with the supplier's instructions.
 5. Lay first row of sod in straight line. Place subsequent rows parallel to and tightly against each other. Stagger perpendicular joints to promote more uniform growth and strength. Do not stretch sod. On slopes, lay sod parallel to contour of slope.
 6. Peg sod placed on slopes 2:1 or greater. Peg each strip or section of sod with at least two stakes not more than two feet apart. Drive stakes flush with top of sod so that roots are in contact with topsoil.
 7. Water sod immediately to prevent excessive drying during progress of work. Sod which dries out will be rejected.
 8. Roll entire area as sodding is completed in each section so that sod is without surface irregularities, such as depressions and high spots.
 9. Irrigate immediately after rolling, enough to wet underside of sod and one inch of soil immediately below.

3.07 MAINTENANCE AND REPLACEMENT:

- A. Maintenance: Maintain seeding, sodding and incidental work during seeding and sodding and thereafter for a period of 120 days for work performed in the spring and for 90 days of subsequent growing weather for work performed in the fall. Perform the following and other operations of care appropriate for promotion of healthy growth, so that work is in an approved condition throughout maintenance period; uniform in color, quality and coverage; and free of weeds, insects, diseases, surface damage and other imperfections:
1. Watering:
 - a. First week: Perform watering daily to keep soil and sod pads continuously moist, maintaining moist topsoil to a depth of at least four inches. Water prior to heat of the day as necessary to prevent wilting or as approved.
 - b. Subsequent weeks: Water seeded and sodded areas to maintain moisture in upper four inches of soil for promotion of deep root growth.
 2. Mowing: Mow only when seed or sod has firmly rooted, is securely in place and has grown to height of six inches. Mow to height of three inches at first cutting. Thereafter, do not remove more than 1/3 of grass leaf at any cutting. Maintain Kentucky Bluegrass between height of two and 2-1/2 inches and tall fescue at height of three inches, unless otherwise directed.

3. Edging: Edge walks during alternate mowings.
 4. Rolling: Roll to maintain uniform surface.
 5. Applying herbicides: Apply in spray form. Do not apply when temperature exceeds 80F or during periods of drought. Have workers wear personal protective equipment appropriate for the submitted MSDS.
 6. Clean-up: Remove rubbish and debris caused by this work. Keep site clean during maintenance period.
- B. Replacing Seeding and Sodding: During maintenance period and until Final Acceptance, replace seeded and sodded areas that are dead, unhealthy, unsightly or badly impaired. Replace as soon as possible during the specified planting seasons. Make such replacements in the same manner as required for original seeding and sodding.

3.08 SUBSTANTIAL COMPLETION INSPECTION (SCI):

- A. Substantial Completion Inspection will be held by the Engineer after completion of seeding and sodding to verify that the work was performed as defined in the Contract Documents.
- B. The Contractor will not be held responsible or liable for damage by animals, by malicious or careless human agencies over which the Contractor has no control, by fire or storm, or by vehicular accidents by others that occur after the Substantial Completion Inspection.

3.09 FINAL ACCEPTANCE:

- A. Request inspection for final acceptance at least 10 days before end of maintenance period.
- B. Replace rejected seeded and sodded areas as specified so that repair or replacement plantings are rooted and established prior to final acceptance.
- C. Final acceptance of crownvetch or lespedeza areas requires a minimum of nine vigorous, healthy seedlings evenly distributed per each square yard after 12 weeks of growing weather following germination.

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TABLE 02920-1: MATERIALS SUBMITTAL CHART			
This chart indicates minimum length of time required for the approval process before intended use and by which submittals must be made, as well as the minimum quantity for each sample. Useable samples will be returned.			
ITEM	TIME	QUANTITY	COMMENT
SEED	40 days	10 pounds or 5 kilograms	If seed is purchased as a mixture.
		5 pounds or 3 kilograms	Per component prior to blending if Contractor blends mixture.
INOCULANT	7 days	1 packet	Keep temperature of inoculant below 70F (21C).
SOD	7 days	--	Notification of source.
FERTILIZER	14 days	50 pounds (25 kilograms)	Provide sample of each type of fertilizer used. Unopened container.
LIMESTONE	14 days	50 pounds (25 kilograms)	As specified. Unopened container.
MULCH	7 days	10 pounds (5 kilograms)	Wood-cellulose fiber mulch.
		1 unbroken bale	Straw mulch.
		1 square yard (1 square meter)	Mulch blanket including staples.
MULCH BINDER	14 days	1 quart (1 liter)	Synthetic binder.
		1 square yard (1 square meter)	Biodegradable netting including staples.
TOPSOIL	28 days	25 pounds (15 kilograms)	--
HERBICIDE	7 days	1 quart (1 liter)	Unopened container. Include MSDS
OTHER MATERIAL	7 days	As directed and as approved	--

TABLE 02920-2. GRASS SEED FOR SEED MIXTURES			
SPECIES	MINIMUM GUARANTEED PURITY	MAXIMUM WEED SEED AND OTHER CROP	MINIMUM GUARANTEED GERMINATION
Certified Turf-Type Tall Fescue <i>Festuca elatior arundinacea</i> (Cultivars from current Agronomy Mimeo #77)	98 percent	0.2 percent	85 percent
Certified Kentucky Bluegrass <i>Poa pratensis</i>	95 percent	0.2 percent	85 percent

TABLE 02920-3. GRASS SEED MIXTURES
For areas with slopes up to 2:1, unless otherwise shown.
<p style="text-align: center;">Seed Mixture:</p> <p style="text-align: center;">90-percent Tall Fescue (Maryland Green-label certified cultivars from current Agronomy Mimeo #77)</p> <p style="text-align: center;">10-percent Kentucky Bluegrass (Maryland Yellow-label certified cultivars from current Agronomy Mimeo #77)</p>

TABLE 02920-4: CROWN VETCH SEED MIXTURE				
For areas with slopes 2:1 or greater, unless otherwise shown.				
SPECIES	PROPORTION BY WEIGHT	MINIMUM GUARANTEED PURITY	MAXIMUM WEED SEED & OTHER CROP	MINIMUM GUARANTEED GERMINATION
Certified Penngift Crownvetch Coronilla varia	40 percent	99 percent	0.25 percent	70 percent
Certified Pennfine or Manhattan or Citation Perennial Ryegrass Lolium perenne	60 percent	98 percent	0.25 percent	90 percent
Loehmans Weeping Lovegrass (June 1 to August 15)	3 percent	95 percent	0.20 percent	85 percent

TABLE 02920-5: LESPEDEZA SEED MIXTURE				
For areas with slopes 2:1 or greater, unless otherwise shown.				
SPECIES	PROPORTION BY WEIGHT	MINIMUM GUARANTEED PURITY	MAXIMUM WEED SEED & OTHER CROP	MINIMUM GUARANTEED GERMINATION
Certified Lespedeza Certified Appalow	44 percent	99 percent	0.25 percent	70 percent
Nurse Grass: *Certified Tall Fescue per Maryland Green- label certified cultivars from current Agronomy Mimeo #77	56 percent	98 percent	0.20 percent	85 percent

TABLE 02920-6 MATERIALS FOR HYDROSEEDING CROWN VETCH AND LESPEDEZA STAGE I		
MATERIAL	PER ACRE	PER 1,000 SQUARE FEET
Limestone	**2 ton minimum	**100 pounds
3-25-25 fertilizer or 0-20-20 fertilizer or *10-22-22 fertilizer	600 pounds 800 pounds *1,075 pounds	15 pounds 20 pounds *25 pounds
Blue Chip Nitroform, granular, 38-0-0	200 pounds	4.5 pounds
Nurse Grass: Certified Pennfine, Citation, or Manhattan Perennial Ryegrass Seed or *Certified Tall Fescue per Table 02920-5	60 pounds *50 pounds	1.5 pounds *1.25 pounds
Target Crop: Blue Tag Certified Penngift Crownvetch Seed or *Certified Appalow Sericea Lespedeza	40 pounds *40 pounds	1 pound *1 pound
Bacterial crownvetch or lespedeza inoculant in 5-pound-size packets	Five times manufacturer's recommended rate	Five times manufacturer's recommended rate
Wood-Cellulose Fiber	435 pounds (dry weight)	10 pounds
Mulch Binder (synthetic type)	20 pounds	0.5 pounds

* Lespedeza requirements only.

**Superseded recommendation of approved soil test report

TABLE 02920-7 MATERIALS FOR HYDROSEEDING CROWN VETCH AND LESPEDEZA STAGE II		
MATERIAL	PER ACRE	PER 1,000 SQUARE FEET
Straw	4,000 pounds	100 pounds
Mulch Blanket and Staples	Use according to manufacturer's instructions	Use according to manufacturer's instructions

END OF SECTION

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SECTION 02930

LANDSCAPING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing and maintaining landscape plantings, edge plantings and related accessories. It also specifies existing tree pruning and removal requirements.
- B. Related Work Specified Elsewhere:
- | | |
|---------------|--|
| Section 02320 | Grading, excavating and backfilling |
| Section 02920 | Topsoil, seeding and sodding |
| Section 02205 | Removal and restoration of existing facilities |
- C. Definitions:
1. Landscape Plantings (Outside Reforestation areas and in Median strips): Designed planting of trees and shrubs within lawn or established areas, as shown. Landscape plantings are indicated on the Drawings with a square symbol as shown on the key in the Drawings.
 2. Edge Plantings: Planting of trees and shrubs along edge of reforestation areas, as shown. Edge plantings are indicated on the Drawings with a triangular symbol as shown on the key in the Drawings.
 3. Reforestation: Planting of trees and shrubs within designated reforestation areas. These reforestation areas are outside the limits of existing woodlands and wetlands and of landscape and mow areas, as shown. Reforestation planting areas are indicated on the Drawings with small circles as shown on the key in the Drawings.
 4. Plants or Plant Material: Vegetation, including trees, shrubs, ground cover, vines, and seasonal flowers.
 5. Size: The factor controlled by dimensions representing caliper, height or spread. For standard quality a dimension is given for caliper, height or spread, whichever is a typical characteristic of the plant. For specimen quality, all dimensions may be specified.
 6. Condition: The factor controlled by vitality and ability to survive and thrive and be comparable with normal plants of the same species and variety in the vicinity, at the same season of the year, free from physical damage or adverse condition that would prevent thriving, whether dormant or growing.
 7. Foliage line: Maximum dimension measured from ground to lowest part of body of plant.
 8. Quality: Structure and form as evidenced by density and number of canes and branches, compactness, symmetry and general development, without consideration of size or condition.
 - a. Standard: The least acceptable quality, good average uniform growth, absence of irregularities, typical characteristics of the species and variety, nursery-grown, well-formed, and uniformly branched, sound, healthy, vigorous and free of disease and insects, and having healthy, well-developed root systems, and having the minimum number of canes specified or conforming to minimum quality index. Plant materials below specified standard will be considered unacceptable culls and are not acceptable.

- b. Specimen: An exceptionally heavy, symmetrical, tightly knit plant, trained or favored in its development and appearance so as to be An unquestionably and outstandingly superior in form, of the designated species or cultivar number of branches, compactness and symmetry.
- 9. Spread: Single dimension that represents the minimum acceptable width. Where range is shown between two spread dimensions, the lesser is the minimum acceptable.
- 10. Root Protection Zone (Area): The root protection area is an area equal to a radius of 1.5 feet for each inch of diameter at breast height (dbh) (i.e.; a 10-inch dbh tree will require protection 15 feet from the main trunk in every direction.
- 11. Diameter at Breast Height (DBH): The DBH is the trunk diameter measured at a point 4.5 feet (Maryland State Standard) above the average ground level. If the trunk divides into several smaller trunks at a point lower than 4.5 feet (Maryland State Standard) from the ground, the tree size is the diameter measured at the highest point on the single trunk.
 - a. If a tree falls between sizes as listed in the bid schedule, the tree is placed in the next larger size. For example, a 17-1/2 inch diameter tree is placed in the 18-inch to 23-inch size.
- 12. Tracing: Careful cutting of bark along the line of sap flow to encourage wound closure and to smoothly outline the wound area.
- 13. Girdling Roots: Surface roots whose circular growth around the base of a tree trunk or around other roots applies pressure to the bark thereby restricting the sap flow.
- 14. Stumps: Stumps include the base of the trunk and visible surface roots attached to the trunk no more than three feet high, measured from the average ground level. Stump size is the diameter of the cut wood surface as measured across the narrowest portion.
- 15. B&B: Balled and burlapped.
- 16. NIC: Not in Contract.
- 17. Other Terms: The following in accordance with ANSI Z60.1:
 - a. Height.
 - b. Cane.
 - c. Caliper: Determine caliper measurement by taking the average of two trunk caliper measurements at right angles six inches above the root crown.
 - d. Height of branching.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications: Keep always available at the work site a copy of each of the cited references.
 - 1. Codes and regulations of jurisdictional authorities, including but not limited to NPS, MNCPPC and MDNR.
 - a. Wherever specific reference is made to NPS, MNCPPC and MDNR, it applies to work performed on or affecting the property governed by these agencies.
 - 2. ANSI: Z60.1 (American Standard for Nursery Stock), Z133.1 (Safety Requirements for Pruning, Trimming, Repairing, Maintaining and Removing Trees and Cutting Brush).
 - 3. Bailey's Standard Cyclopedia of Horticulture.
 - 4. American Joint Committee on Horticultural Nomenclature (AJCHN): Standardized Plant Names.
 - 5. Hortus III.
 - 6. USDA-SCS.
 - 7. FS: O-F-241.
 - 8. ASTM: A36, A48, A53, A153, A307, A501, C51, D448, D2729, F593.

- B. Source Quality Control:
1. Verification of availability: Before bidding, verify sources of supply of the plants on the plant schedule, including requirements for size, species, variety and quality shown and specified.
 2. Furnish plant materials certified by state or federal Department of Agriculture to be free from disease or infestation.
 3. Obtain plants climatized to the Project area. Acclimate plants for a minimum of 3 months. Supply plants only from nurseries within U.S.D.A. Plant Hardiness Zone 6 or 7, and not more than 500 miles from the Project site.
 4. Pre-select and tag at the nursery the large plants of quality and number indicated, prior to inspection by the Engineer.
 5. Inspection of plant material:
 - a. Inspection: Have plant material inspected and trees seal-tagged by the Engineer at the nurseries prior to digging. Have representative samples of shrubs and miscellaneous plants sealed.
 - 1) To be approved, remaining plants are to be equal to sealed samples. Obtain approval of plants after delivery and before planting.
 - 2) Inspection and approval of plants at the nursery or at delivery is for quality, size and variety only and will not abolish or abrogate the right of rejection for failure to meet other requirements discovered during the progress of the work.
 - b. Travel expenses: In the bid price, include related Authority-incurred expenses for the Engineer's travel. Allow sufficient time for travel advance to be processed, minimum 2-weeks.
 - 1) Appropriate expenses include the costs associated with meals, lodging and transportation; i.e., airfare, auto rental, parking, tolls, and privately owned vehicles at the rate per mile currently in effect under Federal Travel Regulations. Daily lodging and meal expenses may not exceed the per diem limits allowed under the provisions of the Federal Travel Regulations in effect at the time the expenses are incurred. Air travel is limited to regularly scheduled airline flights, coach class, whenever possible
 - 2) In these costs allow for maximum 8-hour work days, including suitable inspection time and round-trip travel time.
 - 3) No costs are borne by the Contractor for Authority-furnished labor.
 - c. The NPS and MNCPPC, as applicable to the planting location, have the right to inspect, select and tag plants before delivery to the job site. If this inspection is made, it will be at the nursery at no additional cost to the Contractor.
 6. Inspection of topsoil.
 - a. Make arrangements with the Engineer for inspection at the source. Furnish travel expenses as specified for Inspection of Plant Material.
 - b. Obtain representative topsoil samples for submittal as specified in Section 02920.
 - c. Contractor is liable and responsible for any deleterious soil material brought on site, and subsequent pollution abatement clean-up.
- C. Personnel Qualifications:
1. Superintendent: Use a Landscaping Superintendent with previous knowledge and verifiable experience in supervising landscaping work and grounds maintenance of similar size and scope. Have the Superintendent present whenever work is being

performed and have the Superintendent responsible for controlling the quality of work and inspecting completed work to ensure that Contract requirements are met. The Superintendent is the primary contact person with the Engineer regarding landscaping work.

2. **Arborist:** Perform tree pruning and removal work under the direction and general supervision of an Arborist certified by the International Society of Arboriculture, PO Box 908, Urbana, IL 61801, telephone 217/328-2032; or by a Maryland-licensed Tree Expert; who has verifiable experience and technical competence in tree physiology, identification, diagnosis of disorders, and current tree care and safety practices in accordance with accepted industry standards. The Arborist is responsible for controlling the quality of pruning and removal work and for inspecting such completed work.
3. **Tree Crew Supervisor:** Have tree pruning and removal work performed under the full-time supervision of an experienced Tree Crew Supervisor to accompany each tree crew while work is being performed. Ensure that the Tree Crew Supervisor has verifiable work experience as a full time direct supervisor of shade tree pruning and climbing work crews.
4. **Workers:** Have the work performed only by experienced workers, who through related training and verifiable previous on-the-job experience, are familiar with the technical aspects of landscape planting, grounds maintenance, with the hazards of tree pruning and removal work, and with equipment used for each of these operations as applicable. Have each worker abide by the code of ethics or professional conduct established by the Landscape Contractors Association MD-DC-VA, the National Arborist Association and the International Society of Arboriculture.

- D. **Pre-Planting Conference:** Hold a pre-planting conference prior to planting landscaped areas.
1. Set a time, date, and location agreeable to the Engineer and personnel of the Contractor, and jurisdictional agency, including but not limited to, NPS and MNCPPC, who are responsible for the contractual obligations of these parties. Participation of these parties at this conference is mandatory prior to beginning planting.
 2. Have discussion topics include, but not limited to, confirmation of exact plant substitutions previously accepted by the Engineer.
 3. Make notations on plans to document direction received from the jurisdictional agency, including but not limited to, NPS and MNCPPC, and send record copies to attendees.
 4. After conference, notify the Engineer 48 hours prior to beginning landscape planting work. Notify MDNR through the Engineer.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. **Location list:** Within 10 calendar days after receipt of NTP, submit a complete list of locations of plant material subject to inspection. Should plant material be exhausted from these sources, the Contractor is responsible to locate elsewhere, at no additional cost to the Authority.
 2. **Request for Substitutions:** Submit requests for plant material substitutions, if necessary, within 10 days of NTP.
 - a. If a substitute is to be used on and jurisdictional agency, including but not limited to, NPS property, it requires approval by the Engineer and the NPS, or applicable agency.

- b. The Engineer will approve substitutions only after thorough evaluation has been made concerning the need for such a change based upon the unavailability of plant material specified. If size changes are made, the Engineer will require equal total caliper inches for trees as bid, or if limited by space, extra numbers of plants equitable to unit cost bid price; at no additional cost to the Authority.
 - 3. Work routes and details: Submit plans of entire project site clearly marked to show proposed work routes of crews and equipment, turning radii, and locations of temporary protective markers, barriers and storage areas, coordinated with details of methods to distribute concentrated loads so as not to compact soil unacceptably (above 75% maximum density). Do not route through zones designated for planting.
- B. Samples: Samples of each required type of material specified in Table 02930-1. Samples failing to meet specified requirements are unacceptable. Resubmit new samples of satisfactory material until approved.
- C. Certifications:
 - 1. Complete, certified reports attesting that proposed materials comply with specified requirements. Furnish certificates of inspection of plant materials by state or federal agency prior to delivery.
 - a. Topsoil: As specified in Section 02920.
 - b. Antidesiccant: Submit certificate from the antidesiccant manufacturer as evidence that the antidesiccant material can be safely used on both deciduous and evergreen plants. Mandatory use, if any plants installed outside the specified planting period.
 - 2. Copies of each license and certificate necessary for complying with Federal, State, and municipal laws, codes, and regulations prior to delivery.
- D. Documentation:
 - 1. Personnel qualifications: A list of the qualifications and experience of the workers, and qualifications and experience of the Landscaping Superintendent, Arborist and Tree Crew Supervisor, as attested by knowledge and experience in supervising contracts of similar size and scope in the past.
 - 2. Soil Density Tests: Submit soil proctor tests made by a qualified independent soil-testing agency, acceptable to the Engineer, stating soil density. Perform tests where directed by the Engineer. Compaction by rolling or operating heavy equipment is not permitted within planting locations. Maximum density of subgrade in planting locations is 75 percent. Disc or rototill bottom of plant beds to remove hard pan that may exist and remove rocks and debris off site, at no extra cost to the Authority.
 - a. Before beginning work: Furnish one pre-construction soil proctor test to 24-inch depth for each 100 square feet of approved work routes and storage areas.
 - b. After completing work: Furnish one post-construction soil proctor test to 24-inch depth for each 100 square feet of approved work routes and storage areas.
 - c. Perform additional soil proctor tests if correcting soil density is required.
 - 3. Topsoil pH Tests: Submit soil pH tests made by a qualified independent soil-testing agency, acceptable to the Engineer, stating soil pH. Report suitability of pH for growth of target crop in each area. State recommended quantities of soil amendments to be added to produce a satisfactory Ph.
 - a. Furnish one test for each 500 square feet of each planting area, and not less than one test for each area.

- b. After adjusting pH, furnish one test for each 300 square feet of each pH-adjusted areas, and not less than one test for each area.
- c. Confirming orders: Within 10 calendar days after receipt of NTP, submit confirming orders from the nursery for plant material.
- 4. Packing slips: Certified plant materials packing slips with each delivery.
- 5. Reports: Furnish copies of the following reports to the Engineer either on a daily or weekly basis as requested.
 - a. Daily Work Log: Maintain a daily work log recording the quantities of trees and shrubs installed, and their locations.
 - b. Maintenance Reports:
 - 1) Prepare monthly reports describing the work of the previous month and work scheduled for the following month.
 - 2) At the end of maintenance period, submit maintenance schedules and instructions for future maintenance.
- 6. Equipment list: A list of the equipment anticipated for use, including the make and model, year manufactured, tag number if applicable, and date of last inspection. If requested by the Engineer, submit a list of the equipment to be used for each delivery order. Have the listed equipment on the job site when necessary during the execution of the delivery order.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Delivery:

- 1. Notify the Engineer at least 48 hours before each delivery. Describe in writing the method of shipment and include an itemized list of quantity and sizes. Do not deliver plants until the areas for planting are prepared as required, and approved by the Engineer.
- 2. With each delivery, include certified packing slip for the shipment listing types and sizes of plants, types of materials, and quantities of each shipped. Inspect received materials against packing slip promptly upon arrival at the job site.
- 3. Deliver materials and products to the job site in their original unopened containers or wrappings, clearly labeled with the manufacturer's name and address, material components, trademark, chemical analysis, species, age and source. Materials and supplies are subject to inspection and sampling for testing.
- 4. Allow no agronomic materials or supplies on site other than those for the project.
- 5. Protect plants from weather and adequately pack them to provide protection against climate and breakage during transit. When shipment is made by open vehicle, tie and cover plant materials to prevent wind-shipping and dehydration. When shipment is made by closed vehicle, carefully pack and adequately ventilate plants to prevent condensation on or overheating of plants during transit.
- 6. Spray evergreen and deciduous plants in leaf with an anti-transpirant in accordance with manufacturer's instruction to protect from drying.
- 7. Protect roots of bare-root plants with approved nursery packing. Keep damp during delivery and storage. If planting is delayed, heel-in plants in topsoil or wet straw and keep moist.
- 8. Do not expose fertilizer to weather until used. Completely protect fertilizer before use and do not store in direct contact with the ground.

- ##### B. Plant Identification Labels:
- Mark plants with identification before delivery to the site. Make labels durable and legible stating the correct botanical name and size/caliper in weather-resistant ink or embossed letters. Securely attach labels to each plant in a manner

that will not restrict growth. Maintain labels until they are removed by the Contractor at final acceptance or when directed otherwise by the Engineer.

- C. Move plants marked B&B on plant list with root systems as intact solid units and with root balls of earth firmly wrapped.
- D. Exercise care during every handling operation so as to prevent damage to bark, branches, roots and stem, and to preclude cracked root balls. Use platforms under balls whenever hoisting plants. Do not use plants with cracked, broken or loosely wrapped root balls. Handle plants only by root balls. Plants handled by tops will be rejected. Protect plant roots, root balls and tops from sun or drying winds until planted.
- E. Do not stack root balls. This will mean that for a 40-foot flat bed trailer, the number of 1.75-inch to 2-inch B&B plants may not exceed 130.
- F. Do not handle soil in a frozen or muddy condition.

1.05 JOB CONDITIONS:

- A. Conduct planting operations only under favorable seasonal conditions throughout the period of the Contract as determined by the Engineer. Install no plants during adverse weather or during periods when soil conditions are unfavorable as determined by the Engineer. Do not plant when ground is frozen.
- B. Daily Work Log: Coordinate daily work log with work performed, recording numbers of plants planted and their locations.
 - 1. To indicate progress, attach color-coded survey tape in the planting areas, with a different color tape per month and marked with the date of installation in weather-resistant ink, keyed to the Plant Schedule shown.
 - 2. Securely attach tape to each plant in a manner that will not restrict growth. Maintain tape on plants until removal is directed by the Engineer.
- C. Protection: During progress of operations, protect walls, walks, curbs, benches, lawn areas, plant material, and other site improvements by adequate means acceptable to the Engineer.
 - 1. Existing Vegetation: Preserve and protect existing vegetation such as trees, shrubs, and grass on or adjacent to the site which do not reasonably interfere with the construction. Box and protect trees and shrubs that may be subject to construction activities within the root protection area with chain link or wood fencing as directed by the Engineer.
 - 2. Weight Restrictions: Do not overload entrance paving, sidewalks and curbs. These areas are limited to a maximum load of 1,250 pounds per square foot.
 - 3. Existing Utilities and Structures: The existence and location of underground utilities on the plans are not guaranteed. Investigate and verify locations in the field before starting work. The Contractor will be held responsible for damages to, and for maintenance and protection of existing utilities and structures.
 - a. Obtain copies of available as-built utility drawings from the Engineer for reference.
 - b. Contact the local utility companies concerned to inform them of excavation plans.
 - c. To locate utilities in the field, contact Miss Utility at 800/257-7777, 48 hours in advance of work.

- d. Perform excavation in vicinity of existing structures and utilities with great care.
 - 4. Pollution: Take necessary and adequate measures to prevent soil erosion, air pollution and water pollution by the materials and equipment used during construction.
 - 5. Repairs: If damage by the Contractor should occur, it is the Contractor's responsibility to repair or replace per the Engineer's direction, as acceptable to concerned parties, and at no additional cost to the Authority. Perform work so that damaged areas make smooth, satisfactory, and imperceptible transitions to existing adjacent work. Use materials and methods conforming to current standards for the area damaged, matching adjacent materials in appearance, and meeting approval of jurisdictional authorities and the Engineer.
 - a. Replace damaged existing turf areas with approved sod per Section 02920.
- D. Root Protection Zone (Area): Do not permit heavy equipment or vehicles or the stockpiling of materials in the root protection area without advance permission of the Engineer. Where such activity is allowed within the root protection area, provide an ample mitigation plan to prevent the possibility of damage to the tree trunk and roots, or to increase soil compaction.
 - 1. If the Engineer approves construction activities within the root protection area, protect tree trunks and shrubs with chain link fence or wooden fencing as directed, cover the entire root protection area with landscape fabric and weed barrier as approved, and mulch with four inches of mulch prior to construction. Placing metal plates, tree pruning, fertilization, aeration and irrigation may also be required as directed by the Engineer.
 - 2. If damage by the Contractor should occur, it is the Contractor's responsibility to repair or replace per the Engineer's direction, as acceptable to the applicable regional jurisdictions, including, but not limited to NPS, MNCPPC, and at no additional cost to the Authority.
 - 3. For pruning or removal of existing trees, obtain approval by the NPS or the MNCPPC, as applicable, through the Engineer. Tree pruning and removal, except as shown, is NIC. and at no additional cost to the Authority.
- E. If, at any time, the Engineer determines that work is unsatisfactory or being conducted in an unsafe manner, immediately cease such work activities upon notification.

1.06 SCHEDULING AND COORDINATION:

- A. General:
 - 1. Perform planting operations according to Contractor's detailed and updated plan of the work as approved by the Engineer.
 - 2. Schedule and arrange work so as not to interfere with normal activities of the applicable regional jurisdictions including, but not limited to NPS and MNCPPC land and adjacent properties. Advance notice will be given to the Contractor if a conflict is expected. Remove plant debris, personnel and equipment that could interfere with an activity or event prior to the activity.
- B. Planting Seasons: The times of year in which planting is permitted is limited by the planting seasons for plant types as stipulated by the appropriate regional jurisdictional agency. Authority planting seasons are as follows. These time periods also include the time required, after initial planting, for staking, pruning and mulching operations.
 - 1. Evergreen material:
 - a. Fall planting: September 15 through November 30.
 - b. Spring planting: March 1 through May 15.

2. Deciduous material:
 - a. Planting period: October 15 through April 30.
 - b. White and Willow Oaks, Ironwood, dogwoods and other species as specifically directed, may be planted in spring only: March 1 through April 30.
3. Subject to the Engineer's approval, extend or reduce planting season as required by weather and soil conditions. Preparations for planting may begin earlier than the specified seasons if weather permits and if the staking of plant locations has been approved.

1.07 WARRANTY:

- A. Six months in addition to the requirements of the General Provisions for a total of 18 months, commencing the day the landscaping is accepted.
- B. Contractor has the responsibility for plant material locations that may be considered by the Contractor to be affected by adverse conditions, such as undesirable soil pH, water table factors, or poor drainage. Contractor also has responsibility during and following adverse weather conditions such as periods of excessive precipitation, extreme temperatures, wind and drought.
- C. As specified in Part 3, Concurrent Maintenance and Warranty Period, seasonally replace dead plants and plants that have died back beyond normal pruning lines as determined by the Engineer and at no additional cost to the Authority.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Plants and Plant Materials:
 1. Provide plants meeting the requirements of the plant schedule as shown, identified by botanical and common names and in accordance with applicable standards of quality, size, condition and type listed.
 2. Supply only plants free from disease, well-branched, in full foliage when in leaf and with healthy normal root systems. Have plants freshly dug, nursery-grown, and meeting the other specified requirements. Cold storage plants are unacceptable.
 3. Plants in marked cans, pots, or other containers on the plant schedule are to have been grown in the containers for a minimum of three months and a maximum of two years. Ensure that plant roots filling the containers show no evidence of being or having been root-bound.
 4. B&B plants: Use B&B plants that meet the Recommended Baling and Burlapping Specifications of ANSI Z60.1. Specifically: freshly dug by hand or with a mechanical tree digger in good condition, free of hydraulic leaks, with blades aligned and free of damage; roots wrapped firmly with untreated burlap, and bound carefully with untreated sisal or jute twine, cord or ungalvanized wire mesh; in a manner so as not to damage the bark, break branches, or destroy the natural shape.
 5. Root ball: Dig trees so that the root crown is at the top of the root ball. Make diameter and depth of root balls sufficient to encompass fibrous and feeding root systems.
 6. Provide genus, species and cultivar names which agree with the nomenclature of the most current edition of Hortus III by L.H. Bailey, Hortorium, Cornell University.

B. Topsoil:

1. Weathered surface soils or natural friable loam obtained from approved sources, free of subsoil, hard fragments and stones larger than one-half inch across greatest dimension, objectionable salts, noxious weeds and plants, debris and other materials inferior to surface soils or that would be toxic or harmful to growth; containing not less than 1.5-percent organic matter as determined by the Walkley-Black Method; capable of sustaining normal, healthy growth and development of seed and sod scheduled and specified.
2. Grading analysis:
 - a. All material must pass through a two-inch screen. Remove all material larger than two inches from the site.

SIEVE	MINIMUM PERCENT PASSING
2 inches	100
1/2 inch	90
1/4 inch	80
No. 10	70

3. Test and analysis of proposed topsoil material: Performed by local state agricultural experiment station or agricultural laboratory recommended by U.S. Department of Agriculture and meeting the following requirements:
 - a. Soil pH range: Between pH 5.0 and pH 7.6 inclusive.
 - b. Soil salinity by electrical-conductivity measurement: 500-ppm soluble salt maximum.
 - c. Soil fertility: Rated high in natural nutrients in pounds-per-acre based on the standard soil test in laboratory.
 - d. Soil texture: Classification consisting of 5 to 25-percent clay, 20 to 60-percent sand, and 15 to 45-percent silt as determined by hydrometer or pipette method. Sand, silt and clay as defined by USDA-SCS.

C. Fertilizer:

1. Commercial fertilizer: FS O-F-241, Type I, of grade noted, Level B, composite and bearing manufacturer's guaranteed statement of analysis. Unless otherwise shown or specified, use 10-10-10, slow-release, meeting the following minimum requirements:
 - a. Nitrogen content: Ten percent; slow-release, 50-percent organic.
 - b. Available phosphoric acid: Ten percent.
 - c. Potash content: Ten percent.
2. Soluble fertilizer: Standard commercial grade, 15-30-15 or higher analysis, Rapid-Gro or equal.
3. Packet tree and shrub fertilizer, minimum two-year time release: Root-Contact Packet, Sando Products, Inc., Prairie du Chien, Wisconsin 53821; Eeesy Grow, Specialty Fertilizer, Inc., Suffern, New York, 10901; 21 Gram, Planting Tablets, 200-10-5 Agriform International Chemicals, Inc.; or equal.

- D. Stable manure: Well-rotted cow manure. Free from fresh manure, sawdust, wood chips, tanbark, long straw, stones, chemicals used to hasten decomposition artificially, or other substances injurious to plants.

- E. Perlite: Granules, sterile, uniform gradation, insoluble, high water-holding capacity; as available from Pennsylvania Perlite Corporation, Lehigh Valley, Pennsylvania 18001 or equal.
- F. Mulch:
 - 1. Mulch blanket: Knitted construction of bio-degradable yarn with uniform openings, Hold-Gro as manufactured by Gulf States Paper Corporation, Tuscaloosa, Alabama 35401 or equal.
 - a. 150-foot lengths or greater.
 - b. U-shaped staples: As supplied by mulch-blanket manufacturer.
 - 2. Shredded hardwood or shredded pine bark: Sound, nondecomposed bark free from sticks, stones, clay and other foreign and toxic substances, with 50 percent over the minimum size indicated.
 - a. Regular size: 1/2-inch to two inches.
 - b. Extra-Coarse size: One inch to three inches.
 - c. Sources: Cove Dehydrated Products, Martinsburg, Pennsylvania 16662; Weyerhaeuser Garden Bark, Weyerhaeuser Company, Silva Products Department, Takoma, Washington 98401; or equal.
- G. Crushed Stone: ASTM D448, Size 57.
- H. Pea Gravel: Smooth, rounded pieces of gravel, clean and free from objectional materials, such as soft particles, coal and lignite particles, or friable particles, graded from 1/4 to 3/8 inch in size.
- I. Sand: Sharp, common, coarse, wet sand as approved, for use under plants.
- J. Peat Moss: Type 1 sphagnum peat moss (at least 75-percent), finely divided, with a pH of 3.1 to 5.0, moistened prior to and at time of use.
- K. Perforated Plastic Pipe: ASTM D2729.
- L. Landscape Fabric and Weed Barrier: Porous geotextile fabric for water and nutrient exchange; tear-resistant, minimum four ounces per square yard; Typar Landscape Fabric, DeWitt Earthmat, Pro 5, or equal.
- M. Limestone: Agricultural or dolomitic, ASTM C51, capable of neutralizing soil acidity and containing not less than 85 percent of total carbonates. Containers or sacks labeled to show chemical and mechanical analysis.
- N. Plant Hormone: Vitamin powder; Transplantone, American Chemical Paint Co., Ambler, Pennsylvania 19002; Super Thrive, Vitamins Institute, 5409 Satsuma Avenue, North Hollywood, California 91601; or equal.
- O. Antidesiccant for Retarding Excessive Loss of Plant Moisture and Inhibiting Wilt: Sprayable, water-insoluble vinyl-vinylidene complex which will produce a moisture-retarding barrier not removable by rain or snow. Capable of forming a film at temperature commonly encountered out-of-doors during planting season and with the moisture-vapor transmission rate of the resultant film not more than 10 grams per 24 hours at 70-percent humidity; Wilt-Pruf, as manufactured by Wilt-Pruf Nursery Specialty Products, Inc., Greenwich, Connecticut 06830; Vapor Gard as manufactured by Miller Chemical Company, Hanover, Pennsylvania 17331; or equal.

- P. Tree Stakes and Guys:
1. Stakes: Sound No. 2 Douglas fir or rough sawn straight-grain oak of uniform size.
 - a. Type 1: Two-inch square or 2-1/2 inches in diameter, eight feet long, with six-inch point at one end. Paint with two heavy brush coats of dark walnut oil stain before installation. After installation, cut off stakes square to a level two inches above the wires.
 - b. Type 2: Two-inch square by 30 inches long and notched to bold wires.
 2. Metal stakes: Steel angle, zinc-coated, ASTM A153, 1/4-inch thickness, 1-3/4 inches by 1-3/4 inches by 30 inches long.
 3. Pipe: ASTM A53, hot-dip galvanized, 1-1/4 inch OD eight feet long.
 4. Wood flags: 1/2 inch by two inches by ten inches, painted white.
 5. Turnbuckles: Galvanized, ASTM A153, three-inch minimum adjustment and 5/16-inch minimum diameter threaded opening fitted with screw eyes.
 6. Wires: Zinc-coated steel, No. 12 wire.
 7. Wire guards: Sound, two-ply, 5/8-inch inside diameter, round hose of fabric and rubber, black or green color.
 8. Ring bolts: 1/4-inch by three-inch tie-wire anchor HILTI HKT 14, HILTI Fastening Systems, Langley Park, Maryland 20783; or equal.
- Q. Wrapping Material:
1. Tree wrap: Two thicknesses of crinkled paper cemented together with bitumen, waterproof, four inches wide; as manufactured by Bemis Bag Company, Chase Bag Company, Sisalkraft or equal. Use as directed by Engineer or required by jurisdiction, always applicable for plants subject to sun scald.
 2. Twine: Lightly tarred medium or coarse sisal yarn.
- R. Watering Pipe: As shown.
- S. Marker Stakes: Sound No. 2 Douglas fir, or equivalent grades of rough sawn straight-grain oak, rough sawn cypress, hard pine, cedar, or locust; straight, of uniform size, 3/4-inch x 2-inch x 18 inches, pointed at one end.
- T. Tree Grates, Tree Grate Frames and Tree Guards:
1. Round tree grates: As shown, or with five-foot diameter, radial pattern, and expandable, as approved.
 2. Square tree grates: As shown.
 3. Guards: As shown.
 4. Cast iron: ASTM A48.
 5. Steel angles, plates and collars: ASTM A36.
 6. Steel tubing: ASTM A501.
 7. Bolts and washers: ASTM A307, zinc-coated.
 8. Screws: Stainless steel, ASTM F593, Alloy S30400.
 9. Tubing and collars: Shop-painted in accordance with Section 05500; finished as shown.
 10. Steel bars: ASTM A36.
- U. Hedge Guards: PVC-coated chain link fencing and accessories as specified in Section 02820, and as shown; consisting posts, fabric, tension wire and ties.
- V. Water: Potable.
- W. Composted screened leaf mold:

1. Processed leaves aerobically composted, free from litter such as glass, paper, plastic and other foreign substances, as approved.
2. Source: Leaf-Gro as available from Maryland Environmental Services, 2020 Industrial Drive, Annapolis, Maryland 21401 (301) 261-8596, or equal. Do not use composted sewage sludge.

2.02 PLANTING MIXTURES:

- A. Planting Mixture A:
 1. Use: For backfilling plant pits of deciduous and evergreen trees, shrubs, excluding azaleas:
 2. Mixture: Four parts topsoil and one part leaf mold or decomposed cow manure plus five pounds of 10-10-10 fertilizer per cubic yard, mixed on site to an approved consistency.
- B. Planting Mixture B:
 1. For backfilling plant pits of deciduous and evergreen groundcover and vines and all azaleas:
 2. Mixture: Four parts topsoil, one part leaf mold and one part perlite plus five pounds of 10-10-10 slow-release fertilizer per cubic yard, all mixed on site to an approved consistency.

2.03 EQUIPMENT:

- A. Use only equipment that meets federal OSHA, state and local safety requirements and that is properly licensed. This includes but is not limited to equipment such as bucket trucks, aerial lifts, chipper trucks, wood trucks and stump grinders, which may be needed to correctly perform landscaping, maintenance, and tree pruning and removal in accordance with the requirements.
- B. Have the name or logo of the Contractor or subcontractor clearly displayed on trucks used on the job.
- C. Use equipment of sizes that clear access routes, protective markers and barriers by 2 feet or more on each side.
- D. Do not use material storage devices or equipment that could increase compaction of existing, undisturbed soils.

PART 3 - EXECUTION

3.01 PREPARATION FOR PLANTING:

- A. See Article above on Scheduling and Coordination.
- B. Pre-Planting Conference: See Article above, under Quality Assurance.
- C. Locate and mark location of each underground utility.
- D. Mark outlines on the ground for locations of individual trenches and planting beds as approved. Have the Engineer approve marked locations before excavating.
 1. Drive marker stakes with at least eight inches projecting above surrounding ground cover.
 2. Paint top four inches of each stake according to the following color schedule and mark stakes with plant common name and sizes for each location:
 - a. Evergreens: Blue.

- b. Deciduous trees: Red.
 - c. Flowering trees: Yellow.
- E. Do not permit personnel, vehicles, or equipment not directly associated with the work into the planting areas.
 - F. Inspect Plants: Do not plant if plants appear damaged, unhealthy, insect infested, or if the root ball is cracked or broken either before or during planting operation.

3.05 PRESERVATION OF EXISTING PLANTS:

- A. Preserve and protect existing plants in accordance with the existing Plant Schedule as shown and with the requirements of Section 02205.

3.02 EXCAVATION FOR PLANTING:

- A. Exercise care during entire time of excavation and planting work so as to prevent contact with, disturbance of or unearthing of utilities and devices. Hand excavate wherever necessary to ensure this level of care.
- B. Exercise care in excavating tree pits at locations with existing drainage systems so as to prevent contact with, disturbance of or unearthing of drainage systems. Hand excavate wherever necessary to ensure this level of care. Place landscape fabric as shown. Staple per manufacturer's directions.
- C. Plant Locations: Locate plants as shown on the Contract Drawings, from dimensions shown, and as approved by the Engineer after locations are marked per the Preparation for Planting requirements specified above.
- D. Excavate pits, trenches, and beds with vertical sides and flat bottoms, to dimensions shown.
- E. Excavate pits to a minimum depth of 24 inches, measured from finished grades, or as shown.
- F. Make pits for bare-root plants to diameters at least 12 inches larger than the maximum spread of the roots and to minimum depth of at least 12 inches below the roots of the plant as placed.
- G. Make pits for balled or potted plants, with ball or container less than 12 inches in diameter, to diameters at least 16 inches larger and depth to size of ball or container. Alleviate hardpan compaction by rototilling or discing sub-soil beneath plant.
- H. Make pits for balled or potted plants, with ball or container 12 inches or greater in diameter, to diameters at least 24 inches larger and minimum depth to size of ball or container.
- I. Install trench drain for trees on slopes greater than 3:1 in locations as shown. Excavate four to six inches wide. Start bottom of trench at elevation of bottom of plant ball and extend away on low side of plant location until daylighted. Fill bottom twelve inches of trench with pea gravel. Backfill to surface with excavated material from trench. Blend surplus over area next to trench. Cover surface with material to match the surrounding area.
- J. Make beds for ground cover plants to the length and width shown with minimum depth of six inches. Install landscape fabric beneath mulch layer, stapling per manufacturer's directions.

- K. Backfill plant pits that are abandoned due to unsuitable conditions with same excavated material, grade and seed.
- L. Before the close of each working day, barricade open pits. When pits are excavated more than fourteen days in advance of planting, backfill the excavations with the planting mixture specified.
- M. Remove and dispose of rocks, debris and excess excavated material off site. Set aside excavated soil needed for backfill mix and to form saucers.

3.03 PLANTING:

- A. Set plants plumb and straight with allowance for settlement. Set watering pipe as shown.
- B. Place balled plants so that the top of the root ball bears the same relation to finish grade as it bore to previous finish grade in nursery, or 1/8 higher than depth of root ball= approximately two inches higher. Place fertilizer packets or tablets in accordance with manufacturer's recommendations alongside the base of root ball. Backfill with specified planting mixture in 12-inch layers and tamp each layer to fill voids until planting mixture is at grade. Cut and remove burlap and lacing six inches away from trunk, or as approved. Leave remainder of burlap and lacing intact. Soak plant with water containing plant hormone.
- C. Open and remove containers from potted plants. If the growing medium is comprised of 75 percent or more of peat, perlite, sand or like material other than soil, pull visible roots away from container medium leaving the roots partially exposed. Place plants in plant pit or trench and carefully place backfill planting mixture among exposed roots. Continue backfilling and tamping in six-inch layers until finish grade is reached. Soak with water containing plant hormone.
- D. Remove and store existing tree grates and replace when planting is complete.
- E. Placement of bare-root plants: Place in pit or trench, cut off broken or frayed roots, spread root system, backfill with planting mixture in six-inch layers, settle to finish grade with water containing plant hormone.
- F. Create saucer around isolated plants with soil to retain water unless otherwise shown. Bring beds to smooth, even surfaces which will conform to established grade after full settlement has occurred. Plant shrubs as a bed, using weed barrier fabric beneath mulch when shrubs are spaced less than six foot on center (6' O.C.), unless otherwise detailed.
- G. Place specified planting mixture in groundcover bed at six-inch depth or as otherwise shown in contract drawing detail, place landscape weed barrier and then top with a layer of mulch to depth of three inches after compaction.
- H. Remove groundcover plants from pots with root system intact and set in mulched planting beds, cut through weed barrier, in the spacing and arrangement shown. Work soil firmly around each plant and restore the mulching material. Settle to finish grade with water containing plant hormone. On slopes greater than 2:1, after preparing planting beds and mulching, but prior to planting, apply mulch blanket as directed and staple according to manufacturer's instructions.
- I. When pits are dug in wet areas or where subsoil will not permit drainage as shown, set plant higher than normal using extra depth of crushed or crushed stone or sand, up to 12 inches

total depth, to keep ball from settling. Set top of plant root ball up to six inches higher than grade, as directed. Blend the immediate area outside the saucer with suitable soil to meet existing grade.

- J. Topsoil or approved fine, dry subsoil excavated or augered from plant pits may be used to form saucers. If plant pits are augered, break down side of the hole to permit root penetration.
- K. Create soil berm around downhill portion of planting pits on slopes.
- L. Cultivating: Cultivate trenches and shrub beds to the line shown. Cultivate area around isolated plants at least six inches beyond diameter of pit.
- M. Mulching: After planting and cultivating are completed, spread a layer of mulch on finished grade around plants to a depth of three inches after compaction. Lay landscape fabric beneath shrubbery beds, groundcover areas, and in tree pits, stapling as necessary per manufacturer's directions. Spread mulch around isolated plants over an area at least six inches greater than diameter of the pit and extend mulch over berm saucers as shown. Completely cover trenches and shrubbery beds with mulch. In planters and beds, spread a layer of mulch to depth of three inches after compaction.
- N. Pruning: Prune plant material after installation as approved to thin branches and foliage and yet retain species shape and trim hedges as shown. Do not cut leaders.
 - 1. Remove limbs, branches, canes and runners which require trimming with a clean cut flush with trunk or adjacent stem.
 - 2. When pruning lateral branches, cut at the same angle as that at which the buds are growing from the branches. Cut at a distance of 1/8-inch to 1/4-inch beyond the buds to avoid injuring them.
 - 3. Sterilize cutting tools with alcohol before proceeding to next plant after pruning out infected twigs and branches.
- O. Planting in Planters: Install crushed stone, landscape fabric and weed barrier, planting mixture and mulch as shown. Mound planting mix as shown for positive drainage. Do not work soil when frozen.
- P. Flower Beds: Plant flowers as shown, at planting seasons recommended by regional jurisdictions and/or growers.
- Q. Wrapping: Check with Engineer for necessity. For plants prone to sun scald use immediately after planting, spirally wrap trunk and main branches of trees with an overlay of two inches starting at the bottom. Tie wrap securely in place with twine.
- R. Guying: Within three days after planting, guy each tree four-inch caliper or larger as shown. Protect trees at points of contact by use of wire guards. After installation, cut stakes square to a level two inches above the wires.
- S. Staking: Support trees smaller than four-inch caliper within three days after planting by staking at perimeter line of ball as specified and to sufficient depth to hold tree rigid. Drive stakes vertically to achieve uniform height of five feet-six inches above finish grade or as directed. Do not twist or pull. Wire tree with wire guards interlocked to each stake at four inches above finish grade, or as directed.
 - 1. Planting areas: Three stakes, 120-degrees apart.
 - 2. Trees with grates: Four stakes, 90-degrees apart.

- T. Installation of Hedge Guard: Space hedge guard posts at a maximum of eight feet on centers. On curves with radii less than 100 feet, space hedge guard posts at a maximum of four feet on centers. Drive posts plumb to a height of three feet-six inches; protect end of pipe. Install one-cubic foot of concrete around base of end post in each run to serve as pull anchor. Secure fabric to posts with ties spaced 12 inches on centers. Install tension wire two inches below top of fabric. Install permanent caps on posts.
- U. Removal of Seals and Tags: As approved.

3.04 EXISTING TREE PRUNING AND REMOVAL:

- A. Safety:
 - 1. Conduct operations in accordance with national and local fire and safety codes, laws, rules, regulations and ANSI Z133.1 Safety Requirements for Pruning, Trimming, Repairing, Maintaining and Removing Trees and Cutting Brush.
 - 2. Have employees wear reflective, bright orange vests while conducting operations in or adjacent to roadways.
 - 3. Do not permit any one except the operator within six feet of a power saw.
 - 4. Block off the work area to pedestrians, other workers and vehicles.
 - 5. Look for, note and report to the Engineer in writing the presence of the slightest structural weakness, disease conditions, decayed trunk or branches, split crotches or branches, or other hazardous condition that has potential for damage to property or personal injury.
- B. Tree Pruning:
 - 1. Prune and thin trees when in foliage according to the Pruning Standards for Shade Trees (revised 1988) by the National Arborist Association. The classes of pruning are as follows:
 - a. Class I Fine Pruning: Fine pruning consists of removing dead, dying, diseased, interfering, objectionable, obstructing and weak branches, as well as selective thinning to lessen wind resistance. Removal of such branches includes those on the main trunks as well as those within the leaf area. An occasional branch as described above up to ½-inch in diameter may remain within the main leaf area where it is not practical to remove.
 - b. Class II Medium Pruning: Medium pruning consists of removing dead, dying, diseased, interfering, objectionable and weak branches on the main trunk as well as those within the leaf area. An occasional branch up to one inch in diameter may remain within the main leaf area where it is not practical to remove.
 - c. Class III Coarse Pruning: Coarse pruning consists of removing dead, diseased, or obviously weak branches, two inches in diameter or greater.
 - d. Class IV Cutting Back or Drop Crotch Pruning: Cutting back or drop crotch pruning consists of reducing tops, sides, underbranches or individual limbs.
 - 1) Undertake this practice only in cases of utility line interference, or where certain portions of the roots or root systems have been severely damaged, or when there is unusual and rapid tree growth, where it is necessary to reduce the top, sides or underbranches, or for specific topiary training or dwarfing.
 - 2) When cutting back, do not reduce more than 1/3 of the total area as a single operation. When cutting back trees, only drop crotch as

- much as necessary. Make every effort to cut back to a lateral, one-third of the diameter of the cut being made.
- 3) In reducing overall size, give attention to the symmetrical appearance. Keep top higher and sides reduced in order to maintain a tree-like form.
 - 4) Contact the Engineer prior to pruning a tree specified as Class I or Class II pruning if said pruning will reduce the surface area of the tree by more than 25 percent. Report tree structural problems.
2. Cut back dead, diseased and dying wood into healthy wood.
 3. On trees known to be diseased, disinfect tools after use on each tree with methyl alcohol at 70 percent (denatured wood alcohol diluted appropriately with water) or Chlorox bleach solution.
 4. Remove weak crotches, defined as split or rotted wood between two trunks of limbs that may break and fall during high wind.
 5. Where branches cross and rub together or are forming a V-crotch, remove one branch without ruining the appearance of the tree.
 6. Selectively prune trees which are developing more than one dominant leader in order to promote a single dominant leader by sub-dominating the other competitive branches. Make selection of the dominant leader with consideration of the tree's natural form, health, and structure.
 7. Inspect old injuries. Where appropriate, trace those not closing properly and where callus growth is not already completely established.
 8. Remove girdling roots.
 9. Trimming for clearance:
 - a. Trim trees to provide three feet of clearance from adjacent buildings and structures.
 - b. For street trees and trees over walks, trails, and picnic areas over six inches diameter at breast height (dbh), remove lateral limbs and water sprouts from the main trunk of the tree to a height of 12 feet above the ground. For trees over 10 inches dbh, remove lateral limbs and water sprouts from the main trunk of the tree to a height of fourteen feet above the ground.
 - c. Prune trees in the vicinity of electrical or phone lines so as to provide six to eight feet of clearance between lines and the nearest limb.
 10. Remove branches with a slanting cut starting just above a vigorous bud or shoot and running back across the limb at a 45 degree angle. Make cuts sufficiently close to the trunk or parent limb, without cutting into the branch collar or leaving a protruding stub, so that closure can readily start under normal conditions. Make clean cuts.
 11. Precut branches that are too heavy to handle to prevent splitting or peeling the bark. Where damage to other trees, foliage or property is possible, lower branches safely to the ground by ropes or equipment. Under no circumstances drop branches or main trunks freely onto a road, shoulder or paved surface.
 12. Trim salvageable branches by removing smaller branches flush with the surface of the main branch.
 13. Do not remove entire or large portions of healthy, sound limbs in order to facilitate the removal of dead or dying terminals.
 14. Complete required pruning and removals at the site of each tree, including removal of logs and debris, before initiating work on the next tree.
 15. Do not use chain saws or circular power blades to remove branches less than two inches in diameter.
 16. Do not use wounding paint,
 17. Do not use climbing hooks while pruning.

- C. Tree and Stump Removal:
1. Take every reasonable precaution, including but not limited to topping, sectioning and lifting of trees, diagnosing soundness of existing wood, and planning escape routes for workers to prevent damage to other vegetation, property, utility lines and persons and to prevent gouging and erosion of soils as a result of removal operations.
 2. Fell trees only when there is an adequate felling area at least equal in radius to the height of the tree. Top and remove in sections trees that cannot be felled due to proximity of buildings, conductors, adjacent trees, or lack of an adequate felling area.
 3. Properly rope, guy, or anchor trees to be felled that may cause damage to property or existing vegetation.
 4. Climbing hooks may be worn for tree removal work.
 5. Remove stumps to a depth of 12 inches below grade. Backfill and level the stump hole with clean wood-waste material.
 6. Completely remove each tree, including removal of logs and debris, before initiating work on the next tree.
- D. Debris removal:
1. Cut branches over six inches into 18 to 24 inch lengths.
 2. Chip material less than six inches in diameter.
 3. Collect, deliver, and unload wood and chips to a location specified by the Engineer. If approved, chips may be blown into adjacent natural areas.
 4. Remove wood, debris and chips on a daily basis. Sale of wood is not permitted on the project site.

3.05 INTERIM MAINTENANCE (UNTIL SCI):

- A. While planting is in progress, perform interim maintenance and management practices on work completed. During the post-planting period and until the SCI, properly care for plants furnished; performing watering, cultivating, and other maintenance tasks necessary to keep the plants in a live, healthy condition.
- B. Maintain plants and work incidental thereto by performing the following and other operations of care to promote root growth and plant health so that plants are in an approved condition throughout the interim maintenance period. Perform work in a manner which maintains the original intent of the reforestation and landscape design. Submit maintenance reports and schedules as specified.
1. Watering and draining: Water plants as required twice each month, or more frequently if weather conditions require such, as directed.
 2. Weeding: Weed by hand the mulched area around each plant and within bedded areas, at least twice each month during the growing season. Remove weeds from the site immediately. As directed, approved chemical weed killers may be used with precautions to prevent undesired damage resulting from such use. Submit Herbicide spill plan and daily use log , when required by jurisdictional agency.
 3. Pruning: Prune plants to ensure a desired growth habit and to remove dead wood, as directed and approved.
 4. Mulching: Mulch to maintain the depth as indicated or as directed.
 5. Securing stakes: Replace or adjust as necessary to maintain stability.

- C. Periodically inspect plants during the interim maintenance period and notify the Engineer in writing of suspected problems. The Contractor is responsible for insect and disease control on Authority property. Take necessary measures to ensure effectiveness of the treatment and plant survival. Insect and disease control are the responsibility of the NPS and MNCPPC ,unless brought in by Contractor's plant source.

3.06 SOIL DENSITY ADJUSTMENT:

- A. After completion of work and before Substantial Completion Inspection (SCI), have the soil-proctor testing along work routes and storage areas performed as required above under Submittals, Documentation.
- B. Adjust unacceptably compacted soil to a maximum of 75 percent maximum dry density in accordance with the Engineer's directions and at no additional cost to the Authority. In root protection zone, use of decompaction machinery is unacceptable.

3.07 SUBSTANTIAL COMPLETION INSPECTION (SCI):

- A. A Substantial Completion Inspection will be held by the Engineer after completion of planting to verify that the work was performed as defined in the Contract Documents.
- B. Do not remove tags, labels, etc. after SCI. These are needed during Concurrent Maintenance and Warranty period. Remove such identifications only at final acceptance.
- C. SCI commences the Concurrent Maintenance and Warranty Period of the Contract for items accepted as of this inspection.

3.08 CONCURRENT MAINTENANCE AND WARRANTY PERIOD:

- A. See warranty requirements in General Provisions, General Requirements, and specified in Part 1 of this section.
- B. After the Engineer has accepted the completed work in accordance with SCI, perform post-planting maintenance and plant management concurrent with the warranty period. During this period, properly care for plants; performing the following and other beneficial operations of care for promotion of root growth and plant life so that each plant is in an approved condition at the Substantial Completion Inspection and throughout the maintenance period:
 - 1. Watering and draining: Water plants as required twice each month. Every two weeks during the growing season, examine or sound the watering pipe at each plant to determine if too much water is collecting in the plant pit. Remove surplus water by pump or syphon without staining the pavement. Bi-weekly check relative moisture content of soil for typical tree and typical area of shrub or hedge planting; weekly during the months of July and August. Use Peerless Moisture Indicator, Tree-Type; or equal; following manufacturer's recommendations. Provide sufficient water to maintain relative moisture content of 25 to 30 percent. Provide water, fittings, hose, and water tanks as required to perform watering operation.
 - 2. Weeding: As necessary, perform seasonal weeding in the mulched area around each plant and in bedded areas, at least twice each month. Pull roots by hand or use approved chemical weed killers. Submit Herbicide spill plan and daily use log, when required by jurisdictional agency. Correct any damage resulting from such use and no not spray when winds are over. Remove weeds from the site.

3. Controlling insects and diseases: Treat plants year-round with an approved chemical spray or systemic chemical as necessary to prevent insects, disease and fungus. Take necessary measures to ensure effectiveness of the treatment and plant survival. Submit Pesticide spill plan and daily use log, when required by jurisdictional agency. Protect vehicles and construction in the vicinity from damage or staining.
 4. Pruning: Prune plants during each growing season to develop a desired growth habit and to remove dead wood.
 5. Fertilizing: Fertilize trees, shrubs, hedge plants and groundcover once between May 15 and July 1 with 15-30-15 soluble fertilizer, or equal, at the manufacturer's recommended rate.
 6. Edging: At least twice during the growing season, edge around the mulched area of each plant.
 7. Mulching: Mulch to maintain the depth as shown.
 8. Wrapping: Rewrap to maintain protection and a neat appearance. Remove wrapping at end of first winter period after planting as approved. Repair damaged areas previously covered by wrapping.
 9. Securing guys and stakes: Replace or adjust to maintain stabilization. Before end of maintenance period, remove stakes and guys above grade.
- C. Removing and Replacing Plants: After early Spring and early Fall seasonal inspections and written notification by the Engineer of the plant material to be removed and replaced, proceed as follows:
1. Remove or cut off at ground line said plant materials that are dead or in an unhealthy, unsightly or badly impaired condition, within three weeks after notification.
 2. Replace the plant materials during the next specified planting season with healthy plants of the same kinds and sizes as originally specified. Make such replacements in the same manner as specified for the original planting. Notify the Engineer prior to performing the work.
 3. Attach color-coded tag indicating replacement, and mark with the date of replacement in weather-resistant ink, keyed to the Plant Schedule shown. Securely attach tag to each plant in a manner that will not restrict growth. Maintain tag on plants until removal is directed by the Engineer.
 4. Failure to notify Contractor of plant material to be removed or replaced does not relieve the Contractor from warranty obligations.
- D. The Contractor will not be held responsible or liable for damage by animals, by malicious or careless human agencies over which the Contractor has no control, by fire or storm, or by vehicular accidents by others that occur after the Substantial Completion Inspection.
- E. Clean-Up: Leave paved surfaces broom clean and stain free. Remove rubbish and debris caused by this work. Keep site clean during maintenance period.

3.09 FINAL ACCEPTANCE:

- A. Prior to final acceptance, perform final cleanup, including removal of stakes above grade, guys, signs and other items as directed by the Engineer, and for remulching plants and beds to a loose measurement as specified. Place no mulch against a trunk or stem.
- B. Cut off watering pipe projecting above the mulch level.
- C. Replace rejected plants as specified.

- D. Submit maintenance reports and schedules as specified.
- E. Request inspection for final acceptance at least 10 days before the end of the Concurrent Maintenance and Warranty Period.

PART 4 - MEASUREMENT AND PAYMENT

4.01 BASIS:

- A. Compensation for work specified in this section will be made in the following manner for work done satisfactorily based upon the lump sum price for the work of this section:
 1. Installation: 70-percent of lump sum price, pro-rated monthly during planting operations.
 2. Concurrent Maintenance and Warranty: 20-percent of lump sum price, pro-rated monthly or quarterly after planting operations.
 3. Final Acceptance: 10-percent of lump sum price, for satisfying Contract requirements pertaining to Final Acceptance.

TABLE 02930-1. MATERIALS SUBMITTAL CHART This chart indicates the minimum length of time required for the approval process before intended use and by which submittals must be made, as well as the minimum quantity for each sample. Useable samples will be returned.			
ITEM	TIME	QUANTITY	COMMENT
Fertilizer	14 days	50 pounds (25 kilograms)	Sample of each type to be used in unopened container.
Mulch	7 days	10 pounds (5 kilograms)	--
Crushed Stone	7 days	10 pounds (5 kilograms)	--
Sand	7 days	10 pounds (5 kilograms)	--
Plastic Pipe	7 days	3 feet (1 meter)	--
Mulch Blanket	7 days	1 square yard (1 square meter)	Include staples.

ITEM	TIME	QUANTITY	COMMENT
Pea Gravel	7 days	10 pounds (5 kilograms)	--
Plant Hormone	14 days	10 pounds (5 kilograms)	--
Antidessicant	7 days	1 pint (0.5 liter)	--
Tree Stakes and Guys	14 days	1 each	Sample of complete guying system to be used.
Wrapping Material	14 days	1 foot (30 centimeters)	Sample of complete wrapping system to be used.
Landscape Fabric and Weed Barrier	7 days	1 square yard (1 square meter)	--
Marker Stakes	7 days	1 each	--
Tree Grates and Guards	14 days	1 each	Sample of complete system to be used.
Perlite	14 days	10 pounds (5 kilograms)	--
Peat Moss	14 days	10 pounds (5 kilograms)	--

ITEM	TIME	QUANTITY	COMMENT
Limestone	14 days	50 pounds (25 kilograms)	Sample in unopened container.
Hedge Guard	14 days	6 feet (2 meters)	Sample of complete system to be used.
Topsoil	28 days	25 pounds (15 kilograms)	--
Screened Leaf Mold	14 days	50 pounds (25 kilograms)	Sample in unopened container
Herbicide	14 days		Supply MSDS and use directions
Other Material	--	--	As directed.

END OF SECTION

SECTION 02935

SALT DOME

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. The work, shall consist of furnishing all labor, materials, related equipment, tools and supervision necessary for the complete construction of the panelized Salt Dome at Shady Grove Yard only, at the approved location, as herein specified and detailed on the approved manufacturer's drawings.
- B. Related work specified elsewhere:
 - Section 02320 Grading excavation and backfilling
 - Section 02725 Base for pavements
 - Section 02740 Bituminous pavement
 - Section 02920 Seeding
 - Section 03100 Concrete form work
 - Section 03200 Concrete reinforcement

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications.
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. ACI
 - 3. ASTM: A307, C150-74, D-226-68.
 - 4. American Softwood Lumber: PS-1-83, PS-20-74.
 - 5. BOCA.
- B. Testing Laboratory:
 - 1. In accordance with Section 03300.
- C. Design Criteria:
 - 1. Size:
 - a. Capacity: 535 tons of de-icing salt based on the weight of 80 lbs. per cubic foot or 2160 tbs. per cubic yard. Storage of piled salt shall not exceed an angle or repose of 33 degrees.
 - b. Diameter: As shown on the approved drawings.
 - c. Retaining wall height: 4 feet.
 - d. Entrance opening:
 - 1) Minimum width: 15'-0"
 - 2) Minimum height: 16'-0"
 - 2. Snow load: 40 psf. Add coefficients to allow for slope of roof.
 - 3. Wind load: 90 mph. Add coefficients to allow for slope of roof.
 - 4. Roof slope: As shown as shown on the approved drawings.
 - 5. Layout:
 - a. Dome shaped, self-supporting with no internal supports inside to hamper loading and unloading of de-icing material.
 - b. One (1) doorway opening
 - c. One (1) fan dormer.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Samples:
 - 1. Submit proposed materials not less than ten days prior to date of expected first shipment.
- B. Manufacturer's Drawings:
- C. Shop Drawings:
 - 1. Include complete catalog information and shop drawings for material and equipment.
- D. Certification.

1.04 QUALIFICATIONS:

- A. Submit three (3) locations of identical work experience during the past two years. List contact person, firm, address and telephone number for each site.

1.05 WARRANTY:

- A. General: One (1) year
- B. Roof: Five (5) years.
- C. All warranties shall include material and labor.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Wooden Structure:
 - 1. As manufactured by Dome Corporation of North America, Saginaw, Michigan, or approved equal.
 - 2. Framing and sheathing:
 - a. Plywood: 5 ply, 5 layer, douglas fir plywood, exterior grade structural #1, CCX, conforming with PS-1-83.
 - b. Lumber: The outside framing members of the panel shall be SPF species or better, grade #2 or better, kiln dried to a maximum moisture content of 19%. The internal studs shall be southern pine species or better, #2 or better, and be kiln dried to a maximum moisture content of 22%. Conform to American Softwood Lumber Standard PS-20-74.
 - c. Glue: Liquid Resorcinol-Phenolic Formaldehyde Resin, mixed and applied as per manufacturer's instructions, to attach plywood sheathing to framing.
 - 3. Hardware:
 - a. The hardware used to assemble the stress skin panels on site shall be 5/8" dia. hot dip galvanized bolts with 2-3/4" square washers, also hot dip galvanized.
 - b. 3 1/4" galvanized spiral nails to assemble framing.
 - c. 2" spiral nails or 1 3/4" galvanized staples to attach plywood sheathing to framing.
 - 4. Roofing:
 - a. Shingles:
 - 1) Standard, self-sealing, asphalt roofing shingles with either fiberglass or organic mat carrying a minimum manufacturer's warranty of 25 years.
 - 2) Color:
 - b. Roofing Underlayment: Non-perforated, 15 lb. per 100 sq. ft. asphalt saturated felt, 36 or 32 inches in width conforming to ASTM D-226-68 for all

areas with a slope of less than twelve (12) degrees. Not required on steeper portions of the roof.

- c. Ventilation Louver: Gravity shutter, corrosion resistant with a HERESITE VR-500 epoxy coating or an approved equal.

- B. Portland Cement Concrete:
 - 1. Section 3300, Class 4000, air-entrained, except as noted below.
 - 2. Reinforcing Steel: Deformed steel reinforcing bars conforming to ASTM A615, Grade 60, clean and free from loose rust, scale, or coatings that will reduce bond.
 - 3. Anchor Bolts: Unfinished grade ASTM A307 with yield strength $F_y = 36$ ksi. The anchor bolts shall be hot dip galvanized.
 - 4. Metal Accessories: Provide all spacers, chairs, ties and other devices necessary for the proper spacing, supporting and fastening of the reinforcing steel in place.
 - 5. Protective coating: Mixture of 50% mineral spirits and 50% linseed oil.

- C. Foundation Pad: In accordance with Sections 02725 and 02740.

PART 3 - EXECUTION:

3.01 FOUNDATION PAD:

- A. Grade site in accordance with Section 02320.

- B. Construct foundation pad in accordance with Sections 02725 and 02740. The finished pad for dome floor & wall should be completely level at the elevation shown $\pm 1"$.

3.02 STRUCTURE:

- A. Form retaining walls in accordance with Section 03100.

- B. Erect Building structure per manufacturer's recommendations.
 - 1. Assemble framing using 3 1/4" galvanized spiral nails, all joints shall be tight and present a smooth surface for gluing.
 - 2. Attach plywood sheathing to framing using glue and 2" spiral nails or 1 3/4" galvanized staples. Bevel plywood to suit the framework and eliminate sharp edges which may puncture roofing.
 - 3. Roofing:
 - a. Surface to be covered with asphalt shingling shall be smooth and free from defects, dry and clean from dirt, rubbish and other foreign materials before the roofing is started. All projecting nails shall be set flush to the roofing sheathing.
 - b. The roofing shall be installed in accordance with the manufacturer's instructions in the conventional manner after the complete building has been erected. At no time should roofing felt or shingles be stored or applied on the building until all internal bracing has been installed.
 - c. Flashings shall be installed where shown and shall be of .025 mill finish aluminum, non corrosive metal or non-metallic material.
 - d. The roofing felt shall be applied in such a manner that each panel joint is over-lapped to prevent leakage and installed with large head galvanized roofing nails. roofing felt is not required on areas that are steeper than 12 degrees.
 - e. The roofing shingles shall be applied with large head galvanized roofing nails, the number and location of the nails per the manufacturer's recommendations.
 - f. Roof vents and other openings in the roof shall be installed to prevent leakage.
 - 4. Install fan dormer.

- C. Three days after removing forms, apply two coats of protective coating to all exposed interior surfaces. Saturate surface of concrete.
- D. Paint all exposed steel at the structure entrance in accordance with Section 09920.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies formwork for concrete structures and other facilities.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete reinforcement: Section 03200.
- B. Cast-in-place structural concrete: Section 03300.
- C. Structural precast concrete: Section 03400.
- D. Prestressed concrete: Section 03415.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ACI: 347, Publication # 4
 - 3. Western Woods Producers Association : Western Lumber Grading Rules.
 - 4. CE: CRD-C 572.
 - 5. AASHTO: M153.
 - 6. ASTM: D1056, D1149, D1692.
 - 7. APA: HDO Plywood Exterior Grade.
 - 8. U.S. Product Standard : PS 1
- B. Responsibilities:
 - 1. Design and construction of formwork is the responsibility of the Contractor, subject to review by the Engineer.
- C. Design Criteria:
 - 1. Design formwork for vertical loads and lateral pressures in accordance with ACI 347.
 - 2. Design formwork system which is adequately braced and has adequate strength and stability to ensure finished concrete within the specified tolerances.
 - 3. When necessary to maintain the specified tolerances, design camber into the formwork to compensate for anticipated deflection and creep due to the weight and pressure of the fresh concrete, prestressing forces and construction loads.

1.04 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Working Drawings:
 - a. Include details of form types, methods of form construction and erection, design computations and location of form joints and form ties, location and dimensions of blockouts and openings in structure, and embeds.
 - 2. Samples:
 - a. Each type of waterstop proposed for use, each one foot long: Two.

- b. Each type of premolded expansion-joint filler proposed for use, each six inches by 12 inches: Two.
 - c. Proposed dovetail anchor slot, each twelve inches long: Two.
 - d. Snap-off form ties: Two.
3. Certification:
- a. Manufacturer's certificates.
 - b. Certified test reports of specified concrete tests.
4. Documentation:
- a. Calculations: Early form removal calculations as specified certified by a professional engineer registered in the area where the work is to be performed. Submit in advance for obtaining approval prior to form removal.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General:
- 1. Wood forms:
 - a. All framing lumber stress-graded.
 - b. Lumber in direct contact with concrete, dressed on at least the contact side, with dressed or tongue-and-groove edges; other lumber may be dressed or rough.
 - c. Where vertical board finish is shown or specified, use the following:
 - 1) Form board: Tongue-and-groove, Number 1 Common or better, Ponderosa or White pine, in accordance with the Western Lumber Grading Rules book published by WWPA (not the Southern Pine Inspection Bureau grading rules), one-inch nominal thickness, four-inch nominal width, groove S2S milled or beveled one side only and center matched with 45-degree beveled edges to produce sharp V-shaped 3/8-inch wide in concrete. Four-inch tongue-and-groove boards to be toenailed at edge or face-nailed to backer board.
 - 2) Smooth concrete: Tongue-and-groove, square cut unturned edges, Number 1 Common or better, Ponderosa or White pine, in accordance with the Western Lumber Grading Rules book published by WWPA (not the Southern Pine Inspection Bureau grading rules), one-inch nominal thickness, four inches nominal width, S2S and center-matched.
 - 2. Plywood forms:
 - a. APA grade-marked:
 - 1) B-B Plyform Exterior grade Group I or II for unexposed finished concrete.
 - b. APA High-Density Overlay (HDO) plywood;
 - 1) B or better face veneer Exterior grade Group I for exposed to public view finished concrete..
 - c. USPS : PS 1
 - 3. Tubular fiber forms:
 - a. Spirally constructed of laminated plies of fiber.
 - b. Wall thickness as recommended by the manufacturer to meet load requirements of various uses and sizes.
 - c. Outside surface wax-coated for moisture resistance.

- d. Inside surface of column forms coated with bond-breaker compound and fabricated so that finish concrete surfaces are smooth and free of spiral and seam marking.
- 4. Fibrous-glass reinforced plastic forms:
 - a. One-piece dome system forms, fabricated of plastic reinforced with fibrous glass.
 - b. Molded under heat and pressure using matched metal dies.
 - c. Special sizes and cross sections with thickness, reinforcement and surface finish as necessary to form concrete surfaces that are smooth and free of irregularities.
- 5. Steel forms:
 - a. One-piece dome system forms.
 - b. Special sizes and cross sections as shown, with metal gauges, reinforcement, stiffeners and surface finish as necessary to form concrete surfaces that are smooth and free of irregularities and concrete stain.
- 6. Hardboard:
 - a. For concrete not exposed to public view: tempered, smooth-one-side (S1S) panels not less than 3/16-inch thick, in accordance with AHA IS 1.
- 7. Form ties:
 - a. Factory-fabricated, snap-off metal type, of adequate design to minimize form deflection and preclude concrete spalling upon removal.
 - b. Fabricated so that set-back in concrete is such that portion of tie remaining after snap-off and removal of exterior portions is at least 1-1/2 inches below concrete surface.
- 8. Form release agent: Chemically reactive liquid product that will not bond with, stain, or impair concrete surfaces. Follow form panel manufacturers approved product and recommendations for application. Agents containing castor oil are prohibited
- 9. Preformed expansion joint filler: AASHTO M153.
 - a. Type I: Sponge rubber.
 - b. Type II: Cork. Type III: Self-expanding cork.
- 10. Waterstops: PVC, CE CRD-C 572.
- 11. Dovetail-anchor slots: 22-gauge electrogalvanized steel, with removable felt filler.
- 12. Chamfer strips: Except where other sizes are shown, 3/4-inch by 3/4-inch triangular fillets milled from clear, straight-grain pine, surfaced-each-side, or extruded-vinyl tape.
- 13. Miscellaneous preformed strips for reveals, rustications and similar joints: Fabricated of wood, metal, plastic or other approved material formed to cross sections shown.
- 14. Hydraulic-cylinder well casing: Assembly of pipe, coupling and bottom end cap, of thermosetting-polymer vinylester resin reinforced with fibrous glass, with integral waterstop and anchor flange at invert slab as shown and concrete contact area surfaced with alkaline-resistant barrier, with the following additional requirements:
 - a. Properties.
 - 1) Minimum density at 73F: 0.060 pound per cubic inch.
 - 2) Minimum tensile strength at 73F: 12,000 psi.
 - 3) Minimum compressive strength: 18,000 psi.
 - 4) Minimum flexural strength: 20,000 psi.
 - 5) Minimum flexural modulus of elasticity at 73F: 1,500,000 psi.
 - 6) Maximum fire-spread rate: 25.
 - 7) Maximum heat-distortion temperature at 264 psi: 215F.
 - 8) Maximum water absorption in 24 hours at 73F: 0.02 percent.
 - b. Wall thickness: As shown but not less than 3/8 inch.
 - c. Inside diameter: 20 inches.

- d. Pipe furnished with fewest number of joints, watertight, developing full strength of section, made true and straight, with not more than ½-inch deviation from vertical for entire length of pipe.
- 15. Conduit: Schedule 40, black steel pipe, butt-welded as specified in Section 15205.
- 16. Premolded Elastic Filler for elevator hoistways:
 - a. Closed-cell neoprene:
 - 1) ASTM D1056, Grade SCE-45.
 - 2) Water absorption: No increase in weight in excess of two percent when tested in accordance with ASTM D1056 and completely immersed in water for 70 hours at room temperature.
 - 3) Flame resistance: Self-extinguishing when tested in accordance with ASTM D1692.
 - 4) Resistance to ozone cracking: No cracking when tested in accordance with ASTM D1149, after exposure to 100-pphm ozone in air for 100 hours at 100F with specimens under 20-percent strain.
- 17. Bonding adhesive: As recommended by manufacturer of premolded elastic filler.

PART 3 - EXECUTION

3.01 CONSTRUCTION AND WORKMANSHIP:

- A. Concrete finishes and usage locations of various types of forms and form lining: As shown or specified.
- B. Unless otherwise shown for concrete surfaces exposed to public view, use HDO Plywood in largest practicable continuous panels to produce plane, smooth surface free from grain imprint, patchmarks, and discoloration.
- C. Construct adequately braced formwork so that resulting concrete surfaces conform to specified tolerances.
- D. Brace forms, falsework and centering adequately to retain forms in position as shown on approved working drawings.
- E. Provide mortar-tight forms of wood, plywood, fibrous-glass-reinforced plastic, steel or other approved materials which conform to shapes, lines and dimensions shown and produce smooth surface without fins and projections.
- F. Where shown or directed because of lagging or form irregularity, and where concrete surfaces will not be exposed to public view, line inner form surfaces with hardboard as follows:
 - 1. Use widest available width of hardboard.
 - 2. Line areas less than four feet wide with single-width piece of hardboard.
 - 3. Offset lining joints from those in backing.
 - 4. Fasten securely to backing with galvanized or aluminum nails driven flush.
- G. Forms shall be clean of any rust, molds, concrete scale..etc.

3.02 FIELD QUALITY CONTROL:

- A. Allowable Tolerances:
 - 1. Construct elements to meet allowable tolerances of dimensions, elevations and positions shown and specified in Section 03300.

2. Prior to installation, test hydraulic cylinder well casing assembly hydrostatically at 60 psi pressure for two hours in the presence of the Engineer.

3.03 COATING FORMS:

- A. Lightly coat form panels with chemically reactive release agent prior to initial concrete placement and before each subsequent placement.
- B. Do not allow excess coating material to stand in puddles in forms nor to come into contact with concrete against which fresh concrete is to be placed.
- C. Coat with release agent bolts and rods that are to be completely removed or to be free to move

3.04 EMBEDDED ITEMS:

- A. Ensure that items to be embedded in concrete are free from oil and foreign matter that would weaken bond of concrete to such items.
- B. Install in formwork inserts, anchors, sleeves and other items specified elsewhere. Close ends of conduits, piping and sleeves embedded in concrete with caps or plugs.
- C. Install continuous dovetail-anchor slots where shown.
- D. Complete tests on piping and other items before starting concrete placement.
- E. Before depositing concrete, check location and support of piping, electrical conduits and other items which are to be wholly or partially embedded.

3.05 OPENINGS AND RECESSES IN CONCRETE:

- A. Provide openings and recesses; place sleeves furnished by other trades.

3.06 JOINTS:

- A. Unless otherwise directed, make contraction, expansion and construction joints only where shown. Where concrete will be exposed to public view, use largest practicable size sheets to minimize joints.
- B. Form keyways as shown.
- C. Continue reinforcing steel and wire fabric across joints unless they are shown as being free to move.
- D. Make maximum distance between transverse contraction joints 50 feet or as shown, as measured along centerline of track on tangent alignment.
- E. Install premolded joint filler at locations shown. Extend filler from bottom of concrete up flush to finish concrete surface or hold down below finish surface as shown.
- F. Make splices in premolded filler in manner to preclude penetration of concrete between joint faces.

- G. Where premolded joint filler is held below finish concrete face, install in the form a water-soaked wood strip of dimensions shown, to form, after removal, proper size slot to receive sealant compound specified in Section 07900.

3.07 WATERSTOPS:

- A. Install waterstops in construction joints below grade and where shown. Use six-inch minimum width, except use nine-inch minimum width in tunnel structures, or as shown.
- B. Support and protect that portion of waterstop which extends beyond bulkhead, during placing of concrete and subsequent removal of forms.
- C. Position waterstops so as to clear reinforcement. Ensure that the waterstop does not get misaligned or misplaced during concreting.
- D. Make field splices by heat-sealing square cut ends of waterstop using hot metal plate or thermostatically controlled electric-heating iron designed for such purpose. Join ends when material becomes molten, maintaining continuity of ribs and bulbs; allow to cool before stressing.
- E. Make field splices to develop watertightness equal to that of unspliced material and tensile strength of not less than 50 percent of unspliced material. Have 90-degree splices and as many other splices as possible made in the factory.

3.08 REMOVAL OF FORMS, FALSEWORK AND CENTERING:

- A. Maintain forms, falsework and centering in place until the concrete has attained minimum percentage of specified design strength in accordance with Schedule 1:

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Structural Member	Minimum Percentage of Specified Design Strength	
	Schedule 1	Schedule 2
Footings; inverts; sides of beams; slabs and girders; slabs and beams on grade	25	20
Free-standing walls, columns and piers	40	30
Stairways	80	60
Soffits, beams, slabs and girders; clear span between supports,		
under 20 feet	80	60
over 20 feet	90	70
Cantilevers	90	70

- B. Early removal of forms, falsework and centering will not be allowed for concrete strength values below Schedule 2, but will be allowed for concrete strength values between Schedule 1 and Schedule 2 only after:
1. The Engineer has approved calculations showing anticipated concrete strengths at time of proposed early removal based on:
 - a. Ratio of dead load over live load.
 - b. Span, height and shape.
 - c. Ratio of rise over span.
 - d. Reshoring.
 - e. Loads, resultant stresses and deformations to which concrete and reinforcing steel will be subjected at time of removal, subsequent to removal and until concrete has attained design strength.
 - f. Prevailing site conditions.
 2. Concrete strength attained prior to form removal has been determined by analysis of quality-assurance data in accordance with Section 03300.
- C. Do not remove wood board forms within 48 hours of pouring concrete.
- D. Do not alter loading conditions on concrete subsequent to removal of forms if it results in exceeding permissible stresses and deformations at attained concrete strengths.
- E. The Engineer may permit early removal of concrete support without submittal of calculations prior to attainment of specified design strength if he considers such submittals to be unnecessary.

3.09 INSTALLATION OF HYDRAULIC-CYLINDER WELL CASINGS:

- A. Cement bottom end cap to casing pipe with solvent cement prior to installation. Solvent cement, procedures, environmental requirements and instructions for proper cementing as recommended by pipe manufacturer.
- B. Accurately position, plumb and set as shown. Separate casing, including anchor flange, two inches minimum from reinforcing steel and other metallic material.
- C. Except as otherwise specified, perform excavation and backfill as specified in Section 02320. Do not jack or drive casing. Backfill excess excavation around exterior of casing with sand.
- D. Recheck casing for orientation and secure immediately prior to pouring of concrete slabs in which it is to be set.
- E. Deviation of alignment of centerline of casing not more than 1/2 inch from true vertical, end-to-end.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SUMMARY:

- A. This section specifies reinforcement for concrete structures and other facilities.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete formwork: Section 03100.
- B. Cast-in-place structural concrete: Section 03300.
- C. Structural precast concrete: Section 03400.
- D. Prestressed concrete: Section 03415.
- E. Asphalt or bitumen fill in concrete notches at copper bonding: Section 07125.
- F. Additional copper bonding work adjacent to traction power substations: Section 16060.

1.03 DEFINITIONS:

- A. Cover: Thickness of concrete between outside surface of reinforcement and outside face of concrete

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ACI: SP-66, 318.
 - 3. CRSI: Manual of Standard Practice; Placing Reinforcing Bars.
 - 4. AASHTO: Standard Specifications for Highway Bridges.
 - 5. ASTM: A82, A185, A615, A775, A706.
- B. Allowable Tolerances:
 - 1. Cut and bend reinforcing steel to conform to dimensions shown within the following tolerances:
 - a. Sheared length: Plus-or-minus one inch.
 - b. Depth of truss bars: Plus zero or minus 1/2 inch.
 - c. Stirrups, ties and spirals: Plus-or-minus 1/2 inch.
 - d. All other bends: Plus-or-minus one inch.

1.05 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings:
 - a. Detail reinforcing in accordance with ACI SP-66.
 - b. Bar lists showing the individual weight of each bar, total weight of each bar size and total weight of bars on list. Base calculated weights on theoretical unit weights shown in ASTM A615, Table 1.
 - c. Details showing bonding of reinforcement for stray current and cathodic protection.

2. Certification:
 - a. Manufacturer's certificates.
 - b. Mill tests on each heat showing chemical and physical analyses performed in accordance with ASTM A615, as modified by ACI 318.
 - c. Record of mill tests traceable to individual reinforcement bars supplied to the project.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship reinforcing steel in bundles limited to one size and length.
- B. Tag each bundle at mill with waterproof tag showing name of mill, heat number, grade and size of bars and identifying number.
- C. Protect reinforcing steel and wire fabric from damage; foreign matter such as dirt, oil and grease; and rust-causing conditions.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Reinforcing Steel Bars:
 1. ASTM A615, Grade 60, modified in accordance with ACI 318.
 2. ASTM A706, for all welding reinforcing bars, except for electrical bonding.
 3. Epoxy Coating: ASTM A775, as shown.
- B. Spiral Reinforcement: ASTM A82 or ASTM A615, Grade 60.
- C. Welded Steel-Wire Fabric: ASTM A185.
- D. Metal Accessories: As recommended by CRSI Manual of Standard Practice. Where concrete surfaces will be exposed to public view in finish structure, use supports with plastic-protected legs or stainless steel legs.

PART 3 - EXECUTION

3.01 CUTTING AND BENDING:

- A. Perform cutting and bending in the shop. Bend steel cold. Do not bend or straighten bars so as to damage material.
- B. Do not bend bars in the field except to correct minor errors and damage occurring during shipping and handling.

3.02 BAR SUPPORTS AND SPACERS:

- A. Support bars by means of bolsters or chairs with no less than minimum required by ACI SP-66.
- B. Reinforcing steel in bottom of slabs resting on earth may be supported by concrete brick or mortar blocks.
- C. In walls, columns, piers and abutments hold reinforcing steel in position by means of mortar blocks, bar supports or spacers wired to reinforcing steel.

- D. Do not use stones, clay bricks, wood blocks or pieces of broken concrete to support reinforcing steel.
- E. Do not place bars or fabricated mats on layers of fresh concrete as work progresses.

3.03 PLACING AND FASTENING:

- A. Arrange and place reinforcing steel as shown.
- B. Secure reinforcement positively against displacement during placing of concrete.
- C. Wire or clip bars together as recommended in CRSI Placing Reinforcing Bars.
- D. Maintain reinforcing steel accurately in locations shown in tops of inverts to permit arrangements of anchor bolts for rail-tie plates.
- E. Before placement, ensure that reinforcement is free from dirt, mill scale, rust scale, oil, grease and other foreign matter.

3.04 SPLICING:

- A. Furnish reinforcing bars in full lengths as shown on the Contract Drawings and approved shop drawings.
- B. Do not splice bars unless approved in writing.
- C. Make splices when authorized, in accordance with ACI 318, except make all butt splices by welding with a capacity of not less than 125 percent of minimum yield strength of bar. Mechanical connections for tensile splice shall be by Cadweld only. However, mechanical connection for precast prestressed structures and parking garages, when the splice is located inside the precast member, may be made by NMB Splices instead of the Cadweld, with prior approval of the Authority.

3.05 ELECTRICAL BONDING:

- A. Weld steel straps to transverse end reinforcing bars and longitudinal reinforcing bars adjacent to joints between pour sections at locations shown.
- B. No electrical bonding is required for epoxy coated rebars.
- C. Thermit weld or Cadweld stranded, bare-copper conductors to adjacent steel strips at specified end locations. Likewise, weld copper conductors to lapped, welded-wire fabric at joints in slabs at locations shown.
- D. Additional copper bonding work adjacent to traction power substations: Section 16060.
- E. Asphalt or bitumen fill in concrete notches at copper bonding: Section 07125.

3.06 STUDS:

- A. Install welded studs in track invert slabs on top of transverse bars 10 feet on center and on first transverse bar at each end of units. Expose tops of studs and set flush with top surface of slab.

3.07 INSPECTION:

- A. Placement of concrete prior to approval of reinforcement and electrical bonding work is prohibited.

3.08 CONCRETE PROTECTION FOR REINFORCEMENT (COVER):

- A. Underground Box Section Structures:
 - 1. Invert slab:
 - a. Top steel: Two inches.
 - b. Bottom steel: Three inches.
 - 2. Roof slab:
 - a. Top steel: Two inches.
 - b. Bottom steel: 1-1/2 inches.
 - 3. Exterior walls:
 - a. Outer-face steel: Three inches.
 - b. Inner-face steel: 1-1/2 inches.
 - 4. Center walls: 1-1/2 inches.
 - 5. Beams, girders and columns: 1-1/2 inches.
 - 6. Intermediate floors, platform slabs and stairs: 3/4 inches.
- B. Retaining Walls:
 - 1. Footing:
 - a. Top steel: Two inches.
 - b. Bottom steel: Three inches.
 - 2. Wall:
 - a. Outer-face steel: Three inches.
 - b. Inner-face steel: Two inches.
- C. Other Underground Structures:
 - 1. Outer-face steel: Three inches.
 - 2. Inner-face steel: Two inches.
 - 3. Drainage slot: Two inches.
 - 4. Safety walk: 1-1/2 inches.
 - 5. Beams, girders and columns: 1-1/2 inches.
 - 6. Intermediate floors, platform and slabs and stairs: 3/4 inch.
- D. Above-Ground Structures:
 - 1. Prestressed concrete bearing highway or transit loads: In accordance with AASHTO Standard Specifications for Highway Bridges.
 - 2. Ancillary structures including precast prestressed structures: : ACI 318.

3.09 EPOXY COATING:

- A. Preparation of surface: Perform the following in order given:
 - 1. Clean surface contaminated with oil and grease using naphtha or xylol.
 - 2. Remove weld slag, rust and mill scale from surfaces by wire brushing.
 - 3. Coat surfaces immediately with methyl-methacrylate primer.
 - 4. Apply coating only to surfaces which are dry and free of contaminants.

END OF SECTION

SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 - GENERAL

1.01 SUMMARY:

- A. This section specifies providing portland-cement cast-in-place concrete.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete pavement: Section 02750.
- B. Curbs, gutters and walks: Section 02772.
- C. Chemical grout: Section 2415.
- D. Concrete formwork: Section 03100.
- E. Concrete reinforcement: Section 03200.
- F. Structural precast concrete: Section 03400.
- G. Prestressed concrete: Section 03415.
- H. Asphalt or bitumen fill: Section 07125.
- I. Copper bonding work: Section 16060.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ACI: 201.2R, 211.1, 304, 309, 318, 318.1.
 - 3. AASHTO: M182, T26.
 - 4. NBS: Handbook 44.
 - 5. USBR: Concrete Manual.
 - 6. FS: A-A-341A, HH-I-521, K-P-146.
 - 7. ASTM: A43, A47, A48, C31, C33, C39, C40, C42, C87, C88, C94, C131, C150, C171, C172, C260, C295, C309, C311, C330, C494, C535, C586, C595, C618, C665, C685, C881, C989, C1107, C1260, D98, E328.
 - 8. CPMB (Concrete Plant Manufacturer's Bureau): Concrete Plant Standards.
- B. Testing Laboratory:
 - 1. Furnish the services of an independent testing laboratory. Employment of an independent laboratory does not relieve the Contractor of the obligation to perform the work in accordance with requirements of the Specifications and Drawings. Submit certified results of the tests performed.
 - 2. Furnish proof that the laboratory satisfies the requirements of the American Council of Independent Laboratories' Recommended Requirements for Independent Laboratory Qualification. Laboratory need not be a member of the American Council of Independent Laboratories.
 - 3. Certify that testing equipment has been calibrated by an accredited calibration agency at not more than 12-month intervals using devices of accuracy traceable to the National Institute of Standards and Technology (NIST) or accepted values of material physical constants

C. Properties of Concrete:

1. General:

- a. Design mixes to produce concrete of proper workability, durability, strength, maximum density, minimum shrinkage and permeability.
- b. Design mixes to have minimum water content per cubic yard of concrete, cement content corresponding to appropriate water-cement ratio, largest permissible maximum size specified of coarse aggregate available and optimum percentage of fine aggregate.
- c. Use maximum size of coarse aggregate in accordance with ACI 211.1.
- d. Use same brand from same source throughout the work.
- e. Use aggregates from same source throughout the work.
- f. Use ground-iron blast-furnace slag and fly ash from the same sources respectively throughout the work.

2. Durability:

- a. Maximum water cementitious materials ratio as per ACI 318, Chapter 4 and ACI 201.2R.
- b. Use a suitable combination of approved air-entraining admixture and water reducer to reduce water content and permeability of the concrete, provided such admixtures do not adversely affect other specified properties of concrete.

3. Workability:

- a. Use approved chemical admixtures as needed for workability so that concrete can be placed, consolidated, and finished without segregation or excessive bleeding.

4. Strength:

- a. Design mix for each class and type of concrete of each specified strength based on overdesign factor in accordance with ASTM C94. Unless otherwise shown, working-stress method applies to structures.
- b. Design each class of concrete in accordance with the following:
 - 1) Not more than the following percentages of strength tests to have values less than specified strength:
 - 2) Working-stress method: 20 percent.
 - 3) Ultimate-strength method: 10 percent.
 - 4) Prestressed structures: 10 percent.
 - 5) Average of the following numbers of consecutive strength tests to be equal to or greater than specified strength:
 - (a) Working-stress method: Six.
 - (b) Ultimate-strength method: Three.
 - (c) Prestressed structures: Three.
- c. When number of tests totals six or less, average to be in accordance with Note 21 of ASTM C94.

5. Appearance:

- a. Cured concrete exposed to public view shall be uniform in color, texture and finish with no discernible form or patch marks, grain imprint, joint irregularities or discoloration. Use only manufacturer approved chemically reactive release agents on HDO plywood forms.
- b. Final selection and approval for color shall be made by the Engineer.

D. Method of Proportioning:

1. Proportion mixes as described in ACI 211.1.

2. Approximate mixing-water and air-content requirements for mixes of different slumps and nominal maximum sizes of aggregates as specified in ACI 211.1, Table 5.3.3.
3. Do not vary proportions of ingredients of approved mixes without written approval.

E. Ready-Mixed Concrete: ASTM C94.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: Manufacturer's literature completely describing each material, standard, test data, installation instructions and special instructions or safety precautions applicable to the materials.
- B. Samples:
 1. Concrete surface sealer: Two, each one pint.
 - a. Membrane-forming curing compound: Two of each type, each one pint.
 2. Sandblast finish:
 - a. Number 6 sandblast finish as specified, each 12 inches square by two inches: Two.
 - b. Seal 1/2 of face of each sample with concrete surface sealer.
 - c. If samples are not approved or if concrete mix is changed, submit additional samples until approved.
 - d. When samples have been approved, submit details of procedures followed to produce approved surface finish including, but not limited to, the following:
 - 1) Size and type of nozzle.
 - 2) Air pressure.
 - 3) Distance of nozzle from surface blasted.
 - 4) Duration of blast.
 3. Concrete panels of each type of concrete used in the work: Two each, 18 inches square by two inches thick.
- C. Certification:
 1. Ingredients:
 - a. Submit with mix design, laboratory test reports and mill or manufacturer's certificates verifying that ingredients conform to specified requirements. Use ingredients in design mix which are representative samples of materials to be used in the work.
 - 1) Submit test results whenever the aggregates, cement or other additives to be used in the concrete come from a different lot, source, other area of the quarry, different quarry or from other than the representative stockpile or batch from which the original material was tested and approved.
 - b. In case the source, brand or characteristic properties of ingredients need to be varied during the term of the Contract, submit revised laboratory-mix report in accordance with procedures specified for original mix design.
 2. Batch tickets:

- a. Before unloading at the site, submit certification or delivery ticket from concrete supplier with each batch delivered to the site bearing the following information:
 - 1) Name of supplier.
 - 2) Name of batching plant and location.
 - 3) Serial number of ticket.
 - 4) Date.
 - 5) Truck number.
 - 6) Specific job designation: Contract number and location.
 - 7) Volume of concrete in cubic yards.
 - 8) Class and type of concrete.
 - 9) Time loaded.
 - 10) Type and brand of cement.
 - 11) Weight of cement and fly ash or ground-iron blast-furnace slag.
 - 12) Maximum size of aggregates.
 - 13) Weights of coarse and fine aggregates.
 - 14) Maximum amount of water to be added and amount of water added at the site.
 - 15) Kind and amount of admixtures.
- D. Documentation:
- 1. Proposed methods for controlling concrete temperature and plans for placing concrete taking into account sun, heat, wind, ambient air temperature or other limitations of facilities that will prevent proper finishing or curing.
 - 2. Quality control plan for floor treatment. Submit as specified prior to installation.
 - 3. Quality control reports. Submit as specified after installation.
 - 4. Design mixes:
 - a. Prior to placing concrete, submit design mixes for each class and type of concrete, certifying that proposed concrete ingredients and proportions will result in concrete mix meeting specified requirements.
 - b. Include for each class and type of concrete as many mix designs as there are combinations of different ingredients or types of ingredients anticipated to cover requirements of the work.
 - c. Establish mix designs through an approved design laboratory.
 - d. Design concrete mix for protection against alkali-aggregate reactivity.
 - e. The Contractor may present for approval a concrete mix previously approved for Authority work provided such mix is made with proposed ingredients that meet requirements and provided that concrete has complied with compressive-strength requirements based on control record of at least 30 consecutive-strength tests recently obtained.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Aggregates :
 - 1. Transport and stock pile aggregate separately according to sources and gradations. Handle so as to prevent segregation, loss of fines and contamination by earth or other foreign materials.
 - 2. If aggregates show segregation or if different grades become mixed, rescreen before placing in proportioning bins.
 - 3. Do not combine aggregate from different sources or of different gradations except to obtain different gradations.

4. Do not transfer aggregates directly from trucks, railroads cars or barges to proportioning bins when moisture content is such that it will affect accurate proportioning of concrete mixture. In such cases, stockpile aggregate until excess moisture drains off.
- B. Packaged Cement:
1. Deliver to project site in original sealed packages labeled with weight, name of manufacturer, brand and type.
 2. Store packages in watertight building.
 3. Do not use cement which has been reclaimed by cleaning bags.
 4. Do not use cement which has been exposed to moisture or contaminated.
 5. Deliver packages conforming to weight specified.
 6. Packaged cement will be subject to testing.
- C. Bulk Cement:
1. Store bulk cement separately from other cement and protect to prevent exposure to moisture and contamination.
 2. In ready-mix plant, provide facilities to maintain separation of cement meeting specified requirements from other cement.
 3. Provide in cement manufacturer's plant, facilities for sampling cement at weighing hopper or in feed line immediately before entering hopper.
- D. Ready-Mixed Concrete: ASTM C94.
- E. Blast-Furnace Slag or Fly Ash for use with Portland Cement:
1. Transport in covered carriers.
 2. Store in watertight bins or silos to provide protection from dampness and contamination. When compartmented bins are used, conduct periodic, but not less than weekly checks between adjacent bins to avoid contamination of either of the stored materials.
- F. Concrete Additives, Sealers and Corrosion Inhibitor . As required by the manufacturer.

1.05 WARRANTY

- A. Penetrating Concrete Sealer: Provide a minimum effective service life warranty of 10 years for the penetrating concrete sealer.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Cementitious Materials:
1. Portland Cement: ASTM C150, Types I and II. Use Type II only for underground structures.
 - a. Alkali content not to exceed 0.6 percent.
 2. Blended Hydraulic Cement: ASTM C595 Type IS and IP.
- B. Ground-Iron Blast Furnace Slag: ASTM C989, Grade 100 or 120.
- C. Fly Ash: ASTM C311 and ASTM C618, Class F:

1. Loss on ignition not to exceed 4 percent.
2. Maximum available alkalis (for combination of cement and fly ash) not to exceed 0.6 percent based on proportions to be used and alkalinity measurements for cement and fly ash individually or in combination.
 - a. Fly ash used to be qualified for each source.
3. Uniform color when used in concrete exposed to public view.

D. Aggregates:

1. Aggregates for normal concrete and shotcrete: ASTM C33 with the following additional requirements:
 - a. Coarse aggregate: Gravel, crushed gravel or crushed stone.
 - 1) Deleterious substances:

<u>Substance</u>	<u>Maximum Allowable Percentage by Weight</u>
(1) Soft particles:	5.0
(2) Coal and lignite particles:	0.5
(3) Friable particles:	0.25
(4) Material passing Size 200 sieve:	1.0
(5) Thin or elongated pieces:	15.0
(6) Other local deleterious substances:	1.0
 - b) Soft particles: Higher percentage may be approved where concrete is not subject to abrasion, provided concrete strength is achieved without the use of excess cement.
 - c) Crushed aggregates: If material finer than Number 200 sieve consists of dust of fracture essentially free from clay or shale, percentage may be increased to 1.5.
 - d) Thin or elongated pieces: Length of pieces to be greater than five times the smallest dimensions of a circumscribing rectangular prism.
 - 2) Percentage of wear: 45 maximum when tested in accordance with ASTM C131 and ASTM C535.
 - 3) Weighted percentage of loss: 15-percent maximum by weight when subjected to five cycles of magnesium sulphate soundness test in accordance with ASTM C88.
 - 4) Gradation: In accordance with ASTM C33, Table 2, and represented by a smooth gradation curve within required limits.
- b. Fine aggregate:
 - 1) Washed natural sand or washed stone sand. Stone sand may be subject to special gradation requirements as directed.
 - 2) Gradation in accordance with ASTM C33.
 - a) Minimum percentages of material passing Size 50 and Size 100 sieves may be reduced to five and zero, respectively, if aggregate is to be used in concrete with

three percent minimum air entrainment, or in concrete containing more than 517 pounds of cement per cubic yard.

3) Weighted percentage of loss not more than 12 percent by weight when subjected to five cycles of magnesium sulphate soundness test in accordance with ASTM C88.

4) Deleterious Substances:

<u>Substance</u>	<u>Maximum Allowable Percentage by Weight</u>
a) Friable particles:	1.0
b) Coal and lignite:	0.5
c) Material passing the Size 200 sieve:	5.0
d) Other deleterious substances, such as shale, alkali, mica, coated grains, soft and flaky particles:	2.0

5) Free from injurious amounts of inorganic impurities as determined by ASTM C40. Should materials fail to pass test for organic impurities in sand for concrete, retest in accordance with ASTM C87. If fine aggregate shows by colorimetric test a darker color than that of sample originally approved for the work, stop using such aggregate until approved tests have been made to determine whether change in color is indicative of injurious amount of deleterious substances.

c. Evaluate for potential alkali aggregate reactivity:

1) Perform a petrographic examination in accordance with ASTM C295. The petrographic analysis will identify the constituents of the fine and coarse aggregate and will also identify aggregate found to be potentially alkali-carbonate reactive. Fine and coarse aggregate containing more than the following quantities of constituents is unacceptable:

- a) Optically strained, microfractured or microcrystalline quartz exceeding five percent (a common constituent or granite and granite gneiss).
- b) Chert, Metaquartzite, Chalcedony or combination thereof exceeding three percent. However, fine aggregate may contain up to eight percent provided that mortar bar test results are acceptable.
- c) Tridymite or cristobalite exceeding one percent.
- d) Opal exceeding five percent.
- e) Natural volcanic glass in volcanic rocks exceeding three percent.

2) Test aggregate for alkali-silica reactivity in accordance with ASTM C1260. Aggregate sources that exhibit a C1260 mean mortar bar expansion at 16 days greater than 0.08 percent are unacceptable.

3) Aggregate identified by the petrographic analysis to be potentially alkali-carbonate reactive is to be further evaluated in accordance

with ASTM C586. Expansion of test specimen cylinders not to exceed 0.10 percent after 28 day immersion in NaOH solution.

- d. Aggregate which fails the evaluation criteria for potential alkali aggregate reactivity may be reclassified as acceptable if prior field performance demonstrates that the aggregate is nonreactive. Include service records (material records, batch quantities, exposure conditions, and petrographic evaluation) demonstrating the aggregate to be nonreactive in the mix design submittal.
2. Aggregates for Lightweight Structural Concrete: ASTM C330, with the following additional requirements:
 - a. Coarse aggregate:
 - 1) Composition: Expanded shale, clay or slate, predominantly lightweight, cellular and granular.
 - 2) Percentage loss: 10-percent maximum by weight when subjected to five cycles of the magnesium sulphate soundness test in accordance with ASTM C88.
 - 3) Gradation: In accordance with ASTM C330, Table 1.
 - 4) Unit weight: In accordance with ASTM C330, Table 2.
 - b. Fine aggregate:
 - 1) Composition: Particles of expanded shale, clay, slate or ASTM C33 natural sand as necessary to obtain specified compressive strength and comply with specified air-dry unit weight for lightweight structural concrete.
 - 2) Gradation: In accordance with ASTM C330, Table 1.
 - 3) Unit weight: In accordance with ASTM C330, Table 2.
 - 4) Percentage loss: 10 percent maximum by weight when subjected to five cycles of magnesium sulfate soundness test in accordance with ASTM C88.
- E. Water:
1. Natural potable water with no pronounced taste or odor.
 2. Containing no impurities, suspended particles, algae or dissolved natural salts in quantities that will cause:
 - a. Corrosion of reinforcing steel.
 - b. Volume change that will increase shrinkage cracking.
 - c. Efflorescence.
 - d. Excessive air entraining.
 3. pH: Not less than five.
 4. When tested in accordance with AASHTO T26, standard mortar-briquette tests to show no indication of unsoundness, no change in setting time in excess of plus-or-minus 30 minutes and no reduction in strength in excess of 10 percent.
- F. Ready-Mixed Concrete: ASTM C94, Option C.
- G. Admixtures:
1. In accordance with the following:
 - a. Air-entraining admixtures: ASTM C260.
 - b. Chemical admixtures: ASTM C494.
 2. Approved brands: Chlorides may be present in admixtures provided total chloride in mixing water of proposed concrete mixture, including chloride ions contributed by admixture or admixtures, aggregate and mixing water is not in excess of 150 ppm.

3. Meeting requirements of reference standards or documented to have five-year minimum history of demonstrably satisfactory performance for similar structures under equivalent conditions.

H. Aluminum Powder: FS A-A-341A, free of oil, grease, soluble alkalis and organic materials, gradation as approved.

I. Ferrous Aggregate:

1. Cast-iron particles, ASTM A43, ASTM A47, or ASTM A48, free of oil, grease, soluble alkalis and organic materials.
2. Aggregate graded as follows:

<u>Sieve Designation</u> <u>US Standard Square Mesh</u>	<u>Percentage by Weight</u> <u>Passing Individual Sieves</u>
3/8 inch	—
Size 4	100
Size 8	90 - 100
Size 16	75 - 90
Size 30	45 - 60
Size 50	15 - 25
Size 100	10 - 20

3. If recommended by manufacturer and approved, in lieu of the above gradation use lower percentage of aggregate passing Size 100 sieve.

J. Abrasive Aggregate: 60 to 75 percent silicon-carbide abrasive, bonded by vitreous ceramic material, black, graded from 12 to 30.

K. Floor Treatment:

1. Sealer: Zinc or magnesium fluosilicate and wetting agent formulated and mixed with water in concentration recommended by manufacturer.
2. Floor hardener system:
 - a. Floor hardener:
 - 1) Free from non-ferrous metallic particles, filler material, silica sand, natural aggregates, rust and materials which disguise rust.
 - 2) Ready-to-use formulation proportioned, mixed and packaged at factory ready for application.
 - 3) Ingredients proportioned to maintain two parts well-graded iron aggregate to one part consisting of cement, plasticizing agents and other ingredients designed to absorb moisture from floor slab.
 - 4) Color: Per sample, or as selected by the Engineer.
 - 5) Masterplate 200, Master Builders, or equal.
 - b. Floor curing compound:
 - 1) Clear modified-acrylic resin.
 - 2) Moisture retention: In accordance with ASTM C309 when applied at a rate of 400 square feet per gallon.
 - 3) Masterkure, Master Builders, or equal.

L. Penetrating Concrete Sealer:

1. Penetrating silane sealer, which is readily absorbed into concrete substrate and which reacts chemically to provide a hydrophobic barrier that will not wear off when

exposed to sunlight or wheel traffic; which allows concrete to breathe, allowing the escape of water vapor but preventing the absorption of surface water; colorless; not altering the surface texture of the concrete substrate. See Warranty requirements.

2. Provide one of the following:
 - a. Chem-Trete BSM 40, Hüls America, Inc. (1-800-828-0919).
 - b. Penetrating 40, Sonneborn Division Chemrex (1-800-CHEMREX).
 - c. Master Seal SL40, Master Builders Technologies.

M. Curing Materials:

1. Plastic sheeting: Polyethylene, ASTM C171.
 - a. Curing sheet: Type 1.1.1 and 1.1.2.
 - b. Vapor barrier: Clear 10-mils thickness.
2. Burlap sheet: AASHTO M182, Class 3 or 4.
3. Tarpaulin: FS K-P-146.
4. Blanket insulation: FS HH-I-521.
5. Membrane-forming curing compound: ASTM C309, Type 1-D, 100 resin with fugitive dye, and Type 2.

N. Epoxy Mortar:

1. Epoxy: ASTM C881, Type III-C, grey.
2. Sand: Clean, dry, well-graded particles, passing Size 16 sieve, with the following additional requirements:

<u>Individual Sieve Size</u>	<u>Percent by Weight Retained on Sieve</u>
30	26 to 36
50	18 to 28
100	11 to 21
Pan	25 to 35 (range shown is applicable when 60 to 100 percent of pan is retained on Size 200 sieve)

O. Chemical Grout: Section 02415.

P. Paver Tile Setting Bed:

1. Concrete: 4,000 psi.
2. Reinforcement: 4 x 4 - W4.0 x W4.0, Section 03200, furnish in sheets, not rolls

Q. Elastomeric Concrete:

1. Elastomeric Concrete to consist of an aggregate and binder mixture proportioned by the manufacturer.
2. Manufacturer qualifications: Manufacturer to have the following minimum qualifications:
 - a. Ten years experience in the manufacturing of elastomeric concrete materials.
 - b. Qualified personnel, factory trained and certified in the proper installation procedures, are to be available during construction.
3. Manufacturers: The naming of certain manufacturers is intended to establish a standard of quality. Elastomeric Concrete from the following manufacturers is acceptable:

- a. Delcrete Elastomeric Concrete by the DS Brown Company, PO Box 158, North Baltimore, OH 45872, telephone (419)257-3561.
 - b. Wabocrete by Watson Bowman Acme Corporation, 95 Pineview Drive, Amherst, NY 14228, telephone (716)691-7566.
 - 4. Equal Products: Other manufacturers or material suppliers who wish to propose their product as equal to this specification submit product information and a working sample along with independent physical test property verification, and product literature for review and approval.
- R. Waterstop: Section 03100.
- S. Chairs for Reinforcement: Plastic or stainless steel.
- T. Corrosion-inhibitor in concrete. The corrosion-inhibitor shall be calcium nitrite-based admixture DCI or approved equal. Use four (4) gallons per cubic yard of the corrosion inhibitor when the water-cement ratio is 0.40 or less and use three and a half gallons (3-1/2) per cubic yard when water-cement ratio is 0.38 or less. For precast prestressed parking structures/garages use the corrosion-inhibitor in cast-in-place concrete overlay topping over the double tees and the inverted tee beams on top level and for cast-in-place concrete in wash strips and wash areas on all levels.

2.02 SAMPLING:

- A. Sample concrete ingredients prior to use and have them tested by an approved laboratory in accordance with methods specified. Subsequently test materials as often as necessary to verify that materials conform to specified requirements and that quality of product is maintained.
- B. Make arrangements for the Engineer to witness sampling and testing. Submit record of test results.
- C. Ready-Mixed Concrete: ASTM C94.

2.03 GROUT MIXES:

- A. Portland-cement grout:
 - 1. Prepare grout composed of portland cement, sand and water.
 - 2. Use portland-cement grout under bearing plates, in recesses, holes and surfaces under structural members and at other locations shown.
 - 3. Do not use staining ingredients in grout exposed to view.
 - 4. Formulation: Two parts sand and one-part cement measured by volume.
 - 5. Mix grout with sufficient water to permit placing and packing, approximately 45 minutes prior to use.
- B. Nonshrink grout: ASTM C1107.
- C. Shrinkage-compensating grout:
 - 1. Use shrinkage-compensating grout for setting structural members, anchor bolts, embedded items or items of equipment and machinery on hardened concrete.

2. Prepare nonstaining shrinkage-compensating grout with portland cement, sand and aluminum powder and use in accordance with manufacturer's recommendations.
 3. Prepare shrinkage-compensating grout for use up to two inches thick as follows, measured by volume:
 - a. One-part portland cement, Type I or II.
 - b. One-part fine natural-sand aggregate, graded as specified.
 - c. One-part ferrous aggregate, graded as specified, combined with Type-A chemical admixture, oxidation agent and water in sufficient amount to permit placing and packing.
- D. Premixed shrinkage-compensating grout:
1. In lieu of specified shrinkage-compensating grout, use premixed ready-to-use formulation when approved. Approval will be based on manufacturer's certification that:
 - a. Material will perform as specified.
 - b. Composition and proportioning of grout materials is essentially as specified for shrinkage-compensating.
 - c. Formulation has been used successfully in like applications for at least five years.
 2. Proportion ingredients in accordance with the manufacturer's recommendations.
- E. Mixing water:
1. Proportion mixing water in accordance with grout manufacturer's recommendation or to produce flowable mixture without segregation or bleeding.
- F. Curing:
1. After grout has attained initial set, keep damp for 24 hours minimum.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL:

- A. Classes of Concrete:
1. Classes of concrete are designated by numerals corresponding to their specified 28-day compressive strength in pounds per square inch as determined by ASTM C94.
 2. Concrete classes used in this project are specified. Unless otherwise indicated, use Class 4000.
 3. Each class of concrete may comprise one or more mixes determined by maximum size of aggregate, cement factor and types of admixtures used.
 - a. Portland cement may be used alone or mixed with either ground-iron blast-furnace slag or fly ash. Do not use fly ash in architectural concrete exposed to public view.
 - b. Maximum allowable ground-iron blast-furnace slag: 50 percent of the total weight of the portland cement and ground-iron blast-furnace slag mixture.
 - c. Maximum allowable fly ash: 20-percent of the total weight of the portland cement and fly-ash mixture.
 4. Concrete with fly ash or ground-iron blast-furnace slag may be used at locations shown on the drawings.

- B. Types of Concrete:
1. Types of concrete are designated as Concrete Other than Lightweight and Lightweight Structural Concrete.

- C. Minimum Cement Factor:
1. Observe minimum cement factor for various classes of concrete other than lightweight, as follows:

Class of Concrete	Minimum Cement Factor Bags Per Cubic Yard Of Concrete
5,000	6.5
3,500 - 4,000	6.0
2,500 - 3,000	5.0

* one bag of cement = 94lbs. of cement

2. If a mix of portland cement and ground-iron blast-furnace slag or portland cement and fly ash is used, the mix is the basis of determining the bags per cubic yard of concrete.

D. Air Entrainment:

1. Determine air content of concrete in accordance with ASTM C94.

E. Testing of Concrete:

1. General:
 - a. Furnish molds and cast concrete specimens for testing. In addition, furnish necessary testing equipment and tools to perform sampling, slump tests and yield tests. Furnish boxes for shipping samples.
2. Perform strength tests by making not less than one set of standard cylindrical test specimens for each 100 cubic yards of concrete or any portion thereof for each structure.
 - a. For each work shift, when concrete is delivered, make at least one set of specimens. A set of test specimens consists of at least three standard cylinders from a batch.
 - b. Perform slump tests, unit weight and air content tests with no less frequency than that of strength-specimen sets.
3. Concrete strengths:
 - a. Determine strengths from standard test specimens according to ASTM C31 and ASTM C172 and cured and tested in accordance with ASTM C39 by the testing laboratory. Core drilling and testing in accordance with ASTM C42. Consider the effects of corrosion-inhibiting admixture and other admixtures on the strength of the concrete, in the concrete mix design. The corrosion-inhibiting admixture and other admixtures must be present in the concrete used for the test of the proposed mix strength.
 - b. Compute and evaluate in accordance with ASTM C94.

F. Variability of Constituents in Concrete:

1. Take representative samples of concrete mortar.
2. Maximum allowable unit-weight variation of air-free mortar taken from consecutive batches as discharged from mixer:

- a. Average of two mortar weights: 0.8-percent maximum.
- b. Average of six mortar weights: 0.5-percent maximum.
- 3. Maximum allowable weight variation of coarse aggregate per cubic foot of concrete taken from consecutive batches as discharged from mixer.
 - a. Average of two weights: Five-percent maximum.

G. Batching Plant:

- 1. Arrangement:
 - a. Provide separate bins or compartments for each size or classification of aggregate and for bulk portland cement, ground-iron blast-furnace slag or fly ash.
- 2. Compartments:
 - a. Provide compartments of ample size, so constructed that materials will be kept separated under working conditions. Equip batching plant so that flow of each material into its batcher is stopped automatically when designated weight has been reached.
 - b. Weigh aggregates in separate weight batches with individual scales or cumulatively in one batcher on one scale. Weigh bulk cement on separate scale in separate weight batcher. Weigh ground-iron blast-furnace slag or fly ash on the same scale in the same weight batcher containing the bulk cement. Weigh and record bulk cement first; then add to the bulk cement, weigh and record the ground-iron blast-furnace slag or fly ash. Weigh and record the cumulative bulk cement and ground-iron blast-furnace slag or the bulk cement and fly ash.
 - c. Water amount may be measured by weight or volume. If measured by weight, do not weigh cumulatively with other ingredients.
 - d. Interlock batching controls so that charging mechanism cannot be opened until scales have returned to zero. Satisfy these requirements by semi-automatic batching system as defined in the Concrete Plant Standards of the CPMB, with specified interlocking, or by automatic-batching system as defined in the Concrete Plant Standard.
 - e. Arrange plant so as to continuously facilitate inspection of operations. Provide facilities for obtaining representative samples of aggregate from each bin or compartment for test purposes.
 - f. Deliver materials from batching equipment within limits specified in ASTM C94.
 - g. Subject to approval, accomplish batching in accordance with ASTM C685, in lieu of weight batching, provided batching plant complies with requirements of CPMB Concrete Plant Standards.
- 3. Water batcher and admixture dispensers:
 - a. Provide equipment for batching water and air-entraining or other admixtures at batching plant except in cases where mixing is to be performed at jobsite in paving mixers or in truck mixers.
 - b. Provide water-measuring device capable of measuring mixing water within specified requirements for each batch. Provide mechanism for delivering water to mixers so that leakage does not occur when valves are closed.
 - c. Interlock filling and discharge valves for water batcher so that discharge valve cannot be opened before filling valve is fully closed.
 - d. Introduce admixtures in solution form.
 - e. Provide measuring devices for admixtures capable of ready adjustment to permit varying quantity of admixture to be batched. Interlock dispenser for

- admixtures with batching and discharging operations so that batching and discharging of mixture will be automatic.
- f. If noninterlocked dispensers are permitted, check calibration of dispensers at directed intervals. Record results of such calibration for inspection by the Engineer.
4. Moisture control:
 - a. Provide plant capable of ready adjustment to compensate for varying moisture contents of aggregate and to change weights of materials being batched. Provide approved electric moisture meter for measurement of moisture in fine aggregate. Calibrate as often as directed.
 - b. Moisture content of fine aggregate not to exceed eight percent. Arrange sensing element so that measurement is made near batcher.
 5. Scales:
 - a. Provide accurate measurement facilities for and control of each of the materials entering each batch of concrete. Provide accurate weighing equipment in accordance with NBS Handbook 44.
 - b. Include in each weighing unit a visual springless dial to indicate scale load at each stage of weighing operation or include beam scale with beam balance indicator to show scale in balance at zero load and at each beam setting, indicator to have undertravel and overtravel equal to at least five percent of capacity of beam.
 - c. Provide standard test weights and other auxiliary equipment necessary to verify operating performance of each scale or other measuring device.
 - d. Make periodic tests in the presence of the Engineer at directed intervals. Upon completion of each check test and before further use of indicating, recording and control devices, make adjustments, repairs or replacements as necessary to ensure satisfactory performance.
 6. Recorders:
 - a. Provide accurate recorder for producing digital printout of scale readings corresponding to each concrete ingredient of each concrete batch, including zero initial readings; indicate presence of each individual admixture by corresponding code in lieu of weight or volume record.
 - b. Record water in gallons where batched by volume. In addition, on each printout show date and time of batching, identification number identical to that of concrete delivery ticket and codes for mix design and for project section.
 - c. Prepare printout in duplicate and submit one copy with its corresponding concrete ticket at the time and site of concrete placement.
 - d. House each recorder in locked cabinet.
 - e. Place recorders in position convenient for observation by plant operator and the Engineer.
 7. Protection:
 - a. Protect weighing, indicating and control equipment against exposure to dust and weather; isolate against vibration or movement caused by other operating equipment.
 8. Dry batching:
 - a. When bulk cement and aggregates are hauled from central batching plant to mixers, place cement, ground-iron blast-furnace slag or fly ash for each batch in an individual compartment which, during transit, will prevent cement from intermingling with aggregates and will prevent loss of cement.
 - b. Provide bins of batch trucks with suitable covers to protect materials.

- c. Provide batch compartments of sufficient capacity to prevent loss in transit and to prevent spilling and intermingling of batches as compartments are being emptied.
- H. Allowable Concrete Finish Tolerances:
- 1. Finish concrete elements to dimensions, elevations and positions shown within the tolerances specified for each:
 - a. Formed surfaces such as walls, roof soffits, columns, beams and girders: Plus-or-minus 1/4 inch.
 - b. Arches: Plus-or-minus 1/2 inch.
 - c. Bearing-assembly locations of aerial structure piers and abutments: Plus-or-minus 1/16 inch.
 - d. Traction-power substations, tie-breaker stations and ac-switchboard rooms: Plus zero or minus 1/4 inch.
 - e. Safety walks, vertical and horizontal: Plus-or-minus 1/2 inch.
 - f. Station platforms:
 - 1) Vertical: Plus-or-minus 1/4 inch.
 - 2) Horizontal, measured from centerline of track to edge of platform: Plus 1/4 inch or minus zero.
 - g. Invert slabs and floating slabs:
 - 1) Maximum deviation from profile grade: Plus zero or minus 1/2 inch.
 - 2) Maximum deviation from 10-foot steel straightedge: Plus-or-minus 1/8 inch, noncumulative.
 - 3) Verify adequacy of finish for draining by hosing area. Ponding or obstructions to flow toward invert drains constitute defects.
 - h. Invert under floating slabs:
 - 1) Maximum deviation from profile grade: Plus zero, minus 1/2 inch.
 - 2) Maximum deviation from 10-foot steel straightedge: Plus-or-minus 1/8 inch, noncumulative.
- I. Water tightness Criteria:
- 1. Maximum allowable water leakage: No leakage permitted.

3.02 MATERIAL PREPARATION:

- A. Mixing Concrete:
- 1. Operations:
 - a. Provide concrete mixers that discharge concrete of uniform composition and consistency.
 - b. Combine coarse aggregates of different gradation and identical sources, provided corresponding concrete mix has been approved. The use of alternate batches of gravel, crushed gravel or crushed stone of a single size is prohibited.
 - c. Adequacy of mixing will be determined by the Engineer by means of mixer performance tests in accordance with USBR Concrete Manual, Designation 26, Variability of Constituents in Concrete, in the appendix.
 - d. The Engineer may reduce size of batch to be mixed or increase mixing time when charging and mixing operations fail to produce concrete which conforms to specified requirements and which has uniform coloration and consistency.

- e. Add water prior to, during and following mixer-charging operations. Do not overmix or add water to maintain consistency.
- f. Use of concrete to which water in excess of amount permitted by approved design mix has been added to overcome conditions caused by excessive retention in mixer is prohibited.

2. Central-mixed concrete:

- a. Arrange mixers in centralized mixing plant so that mixing action in mixers can be conveniently observed by the Engineer and plant operator.
- b. Do not load mixers in excess of rated capacity. Mix concrete ingredients in batch mixer for not less than period of time specified for various mixer capacities after each ingredient except full amount of water is in mixer. Reduce mixing time if thorough mixing as specified can be obtained in less time and if approved.
- c. Mixing time:

Cubic-Yard Capacity of Mixer	Mixing Time
2 or less	1-1/2 minutes
3	2 minutes
4	2-1/2 minutes
More than 4	To be determined per ASTM C94 tests by the Engineer

- d. Equip each mixer with mechanically operated batch counter and timing and signaling device to indicate completion of mixing period.
3. Truck-mixed concrete: Use equipment and procedures that conform to the requirements of ASTM C94 and ACI 304, Chapter 5, with the following additional requirements:
- a. Introduce materials, including water and mixtures, into the mixing drum only at the central batching plant, or
 - b. Transport aggregates from the central plant to the jobsite in the mixing drum and add measured and recorded cement, admixtures and water into the drum prior to mixing at discharge point.
 - c. When ice is used, add it with the water and counted as part of the water-cement ratio.
 - d. Place concrete within 90 minutes after cement is introduced into the mixing drum.
 - e. Accomplish initial mixing by 70 to 100 revolutions with drum rotating at the manufacturer's recommended speed. 30 revolutions at mixing speed will be required, if the addition of water is permitted. Do not exceed total of 300 mixing and agitating revolutions.
4. Temperature control:

- a. Use preparation methods capable of producing concrete with temperature 85F maximum and 55F minimum at time of placement.
- b. Do not heat concrete ingredients to temperature higher than that necessary to keep temperature of mixed concrete as placed within specified temperatures.
- c. Do not heat water in excess of 140F.

B. Admixtures:

- 1. Introduce admixtures in solution form.
- 2. Air-entraining admixture: Use for concrete exposed to weathering or in contact with rock or moist soil.
- 3. Chemical admixtures:
 - a. Use water-reducing admixtures in concrete areas below grade in contact with rock, earth or fill.
 - b. Employ admixtures without interfering with specified air-content dosage of air-entrained concrete.
 - c. Except as otherwise specified or approved, use of water-reducing, set-retarding or set-accelerating admixtures is prohibited.
 - d. If introduction of certain admixtures to improve concrete strength is approved, do not reduce cement content below minimum amounts specified.

C. Consistency:

- 1. For concrete to be compacted by approved mechanical vibrators, maintain slump range at point of delivery within the following limits:
 - a. Concrete pavement, pavement base, sidewalk and incidental construction: Two to three inches.
 - b. Unreinforced concrete other than pavements: One to three inches.
 - c. Reinforced concrete: Two to four inches.
 - d. Concrete placed by pumping and concrete for filling steel-shell piles: Four to five inches.
 - e. Do not use concrete if slump exceeds maximum by 1/2 inch or more.

D. Lightweight Structural Concrete:

- 1. Prepare lightweight structural concrete with minimum cement content as follows:

Compressive Strength	Cement Content Bags Per Cubic Yard
2,000 psi	4 to 7
3,000 psi	5 to 8
4,000 psi	6 to 9
5,000 psi	7 to 10

- 2. Air-entrainment:
 - a. Use air-entraining admixture in lightweight structural concrete to provide not less than four nor more than six percent of entrained air.
- 3. Dry unit weight:
 - a. Prepare lightweight structural concrete to provide air-dry weight required by design but not less than 90 pounds per cubic foot.

4. Consistency:
 - a. Maintain slump range within two to four inches.

3.03 CONVEYING:

- A. General:
 1. Provide equipment for conveying concrete from mixer with continuous flow of concrete to point of placement without segregation.
 2. Provide arrangement at discharge end of conveyor to prevent segregation.
 3. Design long conveyor runs to discharge concrete into hopper, without segregation, before it is deposited in forms.
 4. Ensure that pumps, pneumatic equipment, pipes, chutes and troughs are cleaned of dirt and concrete before use.
- B. Chutes and Troughs:
 1. Use only ferrous-metal-lined chutes and open troughs. Where steep slopes are unavoidable, equip chutes or troughs with baffles to minimize segregation of aggregates. Keep chutes or open troughs clean of hardened concrete by flushing with water after each use.
 2. Discharge water used for cleaning outside lines of structure. Lay out chutes or open troughs with slope one-foot vertical to two feet horizontal maximum and one-foot vertical to three feet horizontal minimum.
 3. Discharge chutes 20 feet or more in length into hopper before final distribution.
- C. Adjustable Length Pipes (Elephant Trunks):
 1. Use flexible pipes of ferrous metal, rubber or plastic, six inches minimum diameter so as to prevent segregation of concrete.
 2. Position chutes or flexible pipes so that concrete is delivered in continuous flow to points not more than five feet horizontally and five feet vertically from final location. In vicinity of expansion and contraction joints, reduce horizontal distance to three feet maximum.
 3. Clean flexible pipes and elephant trunks after each use.
- D. Buggies:
 1. Construct runways for buggies so they will not come into contact with or be supported by reinforcing steel of structure.
- E. Pumping and Pneumatic Conveying Equipment:
 1. Use pumping and pneumatic conveying equipment, designed to handle without segregation types, classes and volumes of concrete to be conveyed.
 2. Operate pump or pneumatic equipment so that continuous stream of concrete without air pockets is produced. Position discharge end of line as near final position of concrete as possible but in no case more than five feet away.
 3. At conclusion of placement, clean equipment. Discharge debris and flushing water outside of forms.

3.04 PLACEMENT:

- A. General:
 1. Prior to placing concrete, remove debris and extraneous material from interior of forms.

2. Place first lift of concrete on wet surface. Consolidate by dragging vibrator along edges of joints. Make sure there is no free or standing water over the surface.
3. Place concrete continuously and as rapidly as possible after mixing. Do not use vibrators for shifting mass of fresh concrete.
4. Place concrete in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams or planes of weakness. Cover each layer of concrete with fresh concrete within 45 minutes.
5. Do not place concrete which has attained initial set or concrete which has contained mix water for more than 90 minutes.
6. Remove temporary spreaders in forms when concrete has reached elevation which makes them unnecessary.
7. Place column concrete using adjustable-length flexible pipes or elephant trunks to avoid dropping concrete over five feet. In monolithic placements, do not deposit concrete in supported elements such as beams, girders and slabs until concrete previously deposited in columns or walls has completed its settlement shrinkage, but not to the point at which concrete in supporting members will not permit vibrator to sink into its mass of its own weight.
8. Placing will not be permitted when sun, heat, wind or limitations of facilities will prevent finishing and curing.
9. Concrete temperature at time of placement:
 - a. 55F, minimum.
 - b. 85F, maximum.
10. Unless approved, do not continue concreting when descending ambient air temperature falls lower than 40F.
11. Prior to placing fresh concrete against rock or previously placed concrete, take necessary steps, such as flushing with water, to ensure removal of foreign matter which would adversely affect bond.
12. Maintain wire fabric and other reinforcing in proper position on chairs during concrete placement.

B. Underwater Concrete Placement:

1. Place concrete carefully and continuously in compact mass by means of tremie or underwater bottom-dump bucket; do not disturb after depositing. Maintain still water at point of deposit. Use tight forms. In placing concrete, produce approximately horizontal surfaces.
2. Do not perform pumping within area until concrete has set at least 48 hours.
3. Tremie:
 - a. Provide tremie consisting of watertight tube, 10-inch minimum diameter, with hopper at top. Equip tube with device to close discharge end and prevent water from entering tube while charging tube with concrete.
 - b. Support tremie so as to permit free movement of discharge end over entire top surface of work and to permit rapid lowering when necessary to retard or stop flow of concrete.
 - c. Close discharge end at start of work to prevent water entering tube and maintain entirely sealed, except when concrete is being placed. Keep tremie tube full of concrete.
 - d. Maintain continuous flow until work is complete and resulting concrete seal is monolithic and homogenous. Control tremies so that concrete will be effectively compacted into horizontal layers not more than 12 inches thick.
 - e. Space tremies so as to avoid segregation.

- C. Consolidation:
1. Consolidate concrete thoroughly as it is placed in order to secure a dense mass. Work concrete well around reinforcement, embedded items and into the corners of forms. Consolidate concrete in accordance with ACI 309.
 2. Use internal vibrators unless external vibrators are approved.
 3. Use vibrators capable of generating frequencies of not less than 7,000 impulses per minute. Verify that vibrators have power and amplitude factor so as to visibly affect mass of concrete of one-inch slump over radius of at least 18 inches. Prevent formation of laitance and accumulation of excessive water on surface of concrete as it is deposited. Remove excessive water by pumping or other approved means.
 4. When consolidating concrete in haunches, girders, beams or slabs, ensure that vibrator penetrates and revibrates previously placed concrete in top of supporting members.
 5. Do not use vibrators where internal vibration might cause damage to embedded items; in such cases spading is required.

3.05 CURING AND PROTECTING:

- A. General:
1. Protect freshly placed concrete from excessively hot or cold temperatures. Maintain without drying for period of time necessary for hydration of cement and proper hardening of concrete.
 2. Provide sufficient tarpaulins to cover completely or enclose forms and working areas prior to and during placing and finishing operations.
 3. Cure newly placed concrete continuously for seven days at ambient temperature in excess of 55F.
 4. Cure concrete in subway structures by normal curing method specified.
 5. During curing period keep steel and wood forms wet. If forms are removed during curing, use one of the following methods of curing immediately and continue for remainder of the curing period.
- B. Normal Curing and Protection:
1. Use one of the following methods for flat surfaces, weather permitting:
 - a. Use ponding on horizontal surfaces providing surface is continuously submerged for required curing period.
 - b. Apply continuous sprinkling with nozzle or nozzles which, during first 24 hours, atomize flow of water providing a mist and not a spray. Do not apply moisture under pressure directly upon concrete; avoid flowing or washing on surfaces while susceptible to erosion.
 - c. Cover entire surface of concrete with double thickness burlap sheet, laid directly on concrete and kept continuously wet. Maintain in good condition.
 - d. Sprinkle concrete surface as specified for at least 18 hours and immediately cover with waterproof curing sheet, free from holes or tears. Hold in position so that entire surface of concrete is fully and continuously covered.
 - e. Do not damage burlap, waterproof sheet or concrete surfaces.
- C. Membrane-Forming Curing Compound:

1. Use curing compound when approved for circumstances where application of moisture is impracticable and where such compounds will not jeopardize appearance of concrete. Except as otherwise specified, use Type-1 compound, uniformly applied over surface at thickness recommended by manufacturer. Thoroughly mix compound and apply within one hour after mixing.
 2. Where surfaces are subject to sunlight, apply Type-2 compound. Except for surfaces exposed to public view and architectural finished concrete.
 3. Do not apply wax-resin curing compounds to surfaces requiring bond for additional concrete or where bonded surface coating such as paint, tile, dampproofing, waterproofing or roofing is to be applied.
 - a. Do not apply curing compound to floors to be chemically sealed.
 4. Warm or stir curing compound if necessary for satisfactory application in accordance with manufacturer's recommendations. If film of compound is damaged before expiration of curing period, repair immediately with additional compound.
 5. Inside surfaces of tunnels, cut-and-cover boxes and other surfaces specifically approved may be cured with Type-1 membrane curing compound.
 6. Finish surfaces prior to application of curing compound. Do not use curing compound on construction joints.
 7. Apply curing compound in two coats. Apply first coat immediately after stripping of forms and acceptance of concrete finish.
 8. If surface is dry, thoroughly wet concrete with water and apply curing compound just as surface film of water disappears. Apply second coat after first coat has set.
 9. Protect coating against damage for at least 10 days after application. If damage occurs, apply additional coating.
 10. If use of curing compound results in streaked or blotchy appearance, cease operations and use other method of curing until cause of defective appearance is corrected.
- D. Floor Treatment:
1. In accordance with recommendations of manufacturer of floor hardener, apply floor curing compound and curing sheet to surfaces to receive floor hardener.
 2. Where such surfaces are subject to sunlight, protect them by tenting white opaque, polyethylene waterproof sheet.
- E. Protection of Rod Reinforcement:
1. After forms are removed, coat rod reinforcement and dowels extending beyond concrete surfaces with application of neat cement paste.
 2. Remove hardened cement paste and resultant debris immediately prior to extension of reinforcement or installation of formwork.

3.06 COLD WEATHER CONCRETING:

- A. Do not place concrete when ambient temperature is less than 55 ° F and falling. Do not place concrete unless the form temperature at the time of placement is at least 40 ° F.
- B. When ambient temperature is 40 ° F and falling, carry out one of the following procedures to protect placed concrete:

1. Heating:
 - a. Enclose forms or structures and heat to maintain concrete and air within enclosure at not less than 55 ° F for seven days after placement.
 - b. Maintain relative humidity at not less than 40 percent during curing period when heat is applied to enclosures. Arrange stoves, salamanders or heaters so as to provide uniform distribution of heat. Vent combustion gases to outside air. Do not let hot air blow across concrete surfaces.
 - c. After seven-day curing period, reduce temperature within enclosure gradually at maximum rate of 20 ° F per day until outside temperature has been reached.
 - d. Provide continuous and adequate fire protection and watchmen when heating units are in operation.
 2. Form insulation:
 - a. Insulate forms with blanket insulation of approved type and thickness to maintain concrete at 55 ° F minimum for seven days.
 - b. Protect top of placed concrete by tarpaulins or other approved waterproof material over insulation.
- C. Do not allow concrete to freeze in a saturated condition prior to achieving a strength of 4000 psi.

3.07 HOT WEATHER CONCRETING:

- A. When temperature in forms is 75F or above, carry out the following procedures to protect placed concrete:
1. Protect concrete from direct sunlight.
 2. Keep forms moist by means of cool-water sprinkling or application of wet burlap or cotton mats.
 3. At 90F or above cool aggregates with water spray hoses.
 4. Cool truck barrels with water spray system.

3.08 JOINTS:

- A. General:
1. Unless otherwise shown make construction joints bonded joints by roughening surface to expose aggregates. Clean and roughen surface by wet sandblasting, by cutting with high-pressure water jet with a minimum pressure of 2,000 psi or by other approved means. Perform cleaning after concrete has hardened to prevent raveling of surface.
 2. Exercise caution in cleaning concrete to prevent damage to waterstops.
 3. Treat overlays on slabs the same as for rock or other bonded joint.
 4. Place construction joints at locations shown, or at locations approved by the Engineer.
- B. Horizontal Construction Joints:
1. Joints within 18 inches of tops of faces are prohibited.
 2. Trowel top surface of concrete adjacent to forms smooth to minimize visible joints on exposed faces. Remove laitance and other objectionable materials from joint surface to expose sound concrete as soon as concrete is firm enough to retain its form.

3. Immediately after placement of concrete, remove accumulations splashed on exposed reinforcement and surfaces of adjacent forms before concrete attains initial set.
- C. Waterstops:
1. Provide waterstops per Section 03100, Article 3.07.
 2. Rework or replace concrete where waterstop has moved unacceptably.
 3. Support water stop in exact position, do not sink water stops in fresh concrete.

3.09 CONCRETE FINISHING:

- A. When forms are removed, do not remedy voids, stone pockets and other defects until the Engineer has inspected them and given directions.
- B. Finish concrete surfaces as shown and as follows:
1. Number-1 Form Finish:
 - a. Immediately following form removal, remove fins and irregular projections from surfaces exposed to view or those that will receive waterproofing.
 - b. Prepare pointing mortar not more than 30 minutes prior to use.
 - c. Cure mortar patches as specified under curing and protection.
 - d. Leave contraction joints and articulated joints in completed work carefully tooled and free of mortar and concrete.
 - e. Leave joint filler exposed for its full length with clean and true edges.
 - f. Apply this finish to structures, unless otherwise shown.
 2. Number-2 Wet-Rubbed Finish:
 - a. Start rubbing of concrete after removal of forms and as soon as its condition will permit. Keep concrete thoroughly saturated with water before starting this work.
 - b. Allow sufficient time to elapse before wetting down to allow pointing mortar to thoroughly set. Rub surfaces with medium-coarse carborundum stone.
 - c. Continue rubbing until form marks, projections and irregularities have been removed, voids are filled and uniform surface is obtained.
 - d. Leave paste produced by rubbing in place. Obtain final finish by rubbing with fine carborundum stone and water after concrete above surface being treated has been cast. Continue rubbing until entire surface is of smooth texture and uniform color. After final rubbing is completed and surface has dried, rub with burlap to remove loose powder and objectionable marks.
 3. Number-3 Broomed Finish:
 - a. Where floors and other areas are shown to have rough finish, strike-off surface with screeds and wood floats at elevation shown.
 - b. Before concrete has achieved initial set, broom transversely to flow of traffic with stiff, medium-bristle broom especially made for intended purpose to develop corrugations not more than 1/8-inch deep.
 4. Number-4 Steel-Troweled Finish:
 - a. Where floors are shown to have a steel-troweled finish, screed concrete to established grades and compact with wood or power-driven disc float.
 - b. After surface has hardened sufficiently, finish with steel trowel to dense hard finish, free of trowel marks.
 - c. Do not use dry cement or mixture of dry cement and sand to absorb water.
 5. Number-5 Wood-Float Finish:

- a. Screed inverts of subway structure, floors not specified or shown to be finished otherwise, areas below floating slabs and areas to receive dampproofing, waterproofing or roofing to a true and uniform surface conforming to shape and elevations shown.
 - b. Follow with wood-float finish to tolerances specified.
 - c. On slabs and floors, where drainage is shown, maintain accurate slopes for drainage.
 - d. Protect floors and slabs until final acceptance.
6. Number-6 Sandblast-Sealer Finish:
- a. Where concrete surfaces are shown to receive sandblast finish and a sealer prepare sample using sandblast finish on file in the Engineer's office as criterion.
 - b. Prepare samples with degree of sandblasting which will produce uniform texture on surface of concrete. Blast to achieve smooth, sanded surface approximately equivalent to 100-120 grit sandpaper finish.
 - c. Sandblasted surfaces will be inspected before sealing and compared with approved samples.
 - d. Apply concrete surface sealer to sandblast finish in accordance with approved procedures.
7. Number-7 Natural-Board Finish:
- a. After stripping forms, cut back form ties as specified. Touch-up holes created by form ties and damaged or defective finish using grout closely matching surrounding concrete. Accomplish grouting and repairs as specified. Knock-off heavy elongated fins, but do not rub down.
8. Number-8 Abrasive-Aggregate Finish:
- a. After screeding and floating as for Number-4 Finish, apply abrasive aggregate at rate of not less than 0.6 pound per square foot.
 - b. Sprinkle evenly in two applications using one half the amount for each application. Apply second half at right angle to first.
 - c. Follow with wood float; lightly tamp or roll surface to embed aggregate flush with concrete surface.
 - d. Lightly steel trowel to smooth, even finish.
 - e. After curing, rub surface using abrasive brick with water to slightly expose abrasive aggregate.

C. Do not sprinkle water or cement on surfaces to be trowel finished.

3.10 FLOOR TREATMENT:

- A. Sealer:
- 1. Water cure floor surfaces to be sealed for 28 days minimum and ensure that they are completely dry before treatment.
 - 2. Complete overhead work before sealer is applied.
 - 3. Apply liquid floor sealer in three separate coats as recommended by the manufacturer using maximum quantity recommended. Allow to dry between applications.
- B. Floor-Hardener System:
- 1. Areas of application: Concrete floor surfaces as shown.
 - 2. Preparation:

- a. Strike concrete to established grade using wooden strike-off bar. Further level and consolidate concrete with wood bull float or wood darby immediately following strike-off. Complete before free moisture rises to surface.
 - b. Begin floating adjacent to columns, forms and walls where concrete is most likely to stiffen first.
3. Application:
- a. Apply at uniform rate of 1.8 to 2.2 pounds of hardener per square foot of floor surface.
 - b. Apply first shake to floated concrete adjacent to forms, columns, and walls where moisture will be lost first. Apply 2/3 of specified total shake immediately following floating of total area as follows:
 - 1) Distribute evenly.
 - 2) Throwing shake is prohibited.
 - 3) Perform hand floating with wood floats. Magnesium floats are prohibited.
 - c. Use finishing machines with float blades as soon as shake has absorbed moisture as evidenced by darkening of surface. Do not allow float blades to dig into surface. Float sufficiently to bring moisture from base slab through shake.
 - d. Immediately after floating first shake, apply remaining 1/3 of total specified shake in the same manner and machine float as specified. Plan operations to avoid necessity of sprinkling water on surface.
 - e. As surface stiffens as evidenced by loss of sheen, finish by hand steel trowel removing marks and pinholes; leave surface in uniform condition with relatively smooth but nonslip surface.
4. Field service:
- a. During installation, provide services of qualified representative of manufacturer to aid in proper use of product. Notify manufacturer three days minimum prior to initial application of product.
5. Quality control:
- a. Prior to installation, submit for approval detailed quality-control plan describing method of application of floor hardener and listing items to be checked to ensure that materials are placed at proper time and in proper manner to achieve optimum durability of finished floor surface. Prior to submittal, have quality-control plan authenticated by qualified representative of material manufacturer indicating manufacturer's approval.
 - b. Submit quality-control reports authenticated by manufacturer's representative verifying that installation has been made in accordance with approved quality-control plan.

3.11 DEFECTIVE CONCRETE:

- A. Concrete will be considered defective unless it is structurally sound, watertight, properly finished and within specified tolerances.
- B. Concrete in place that is deemed structurally defective will be checked by the Engineer by drilled core specimens. If testing of core specimens shows that strength is less than 85 percent of specified strength, costs incurred in taking and testing of core specimens will be borne by the Contractor.

- C. Replace, strengthen or correct defective concrete as directed.

3.12 PROTECTION FROM AND REMOVAL OF STAINS:

- A. Protect concrete structure from rust staining by structural-steel members or from other substances during the work.
- B. If staining should occur, remove stains and restore concrete to its original color.

3.13 DAMAGED WORK:

- A. Before final acceptance of the work, neatly repair damaged surfaces, corners of concrete and concrete finish.
- B. Where surface repairs are permitted, finish damaged areas to smooth, dense watertight condition.
- C. Replace concrete that is not satisfactorily repaired.

3.14 CORRECTIVE WORK:

- A. Submit corrective action patching procedure.
- B. If correction of defects is approved, remove defective concrete; key area to be repaired, soak surface with water and patch with approved materials. Patch architectural concrete so as to match existing. Use bonding agents applied to the substrate or mixed with patching material only as approved by the Engineer.
- C. Clean surface cavities produced by form ties, other holes, honeycomb spots, broken corners or edges and other defects. Saturate with water and point with mortar paste consisting of cement and fine aggregate mixed in proportions to give same appearance as original concrete.
- D. Prepare pointing mortar not more than 30 minutes prior to use. Cure mortar patches properly. Carefully tool contraction and articulated joints in completed work and keep them free of concrete. Where necessary, leave joint filler exposed for its full length with clean and true edges.
- E. Tolerance deviations and other surface defects may also be corrected, if approved, by grinding high areas and swales. Leaks in station electrical rooms, TPSS and TBS shall be epoxy injected.
- F. Where necessary or when directed, repair leakage in excess of specified maximum allowable, by means of contact grouting, chemical grouting or other approved means.
- G. Where corrective work is unsatisfactory, completely remove such work and replace with new work complying with specified requirements.

3.15 EPOXY MORTAR REPAIRS:

- A. Surface Preparation:
1. Remove defective concrete with chipping hammers or other approved equipment. To prevent removing extra material and causing cracks, saw-cut concrete area to be removed into maximum six-inch square checkerboard pattern 4-1/2 inches deep.
 2. Prepare exposed concrete surface by sandblasting clean and allowing to dry thoroughly. Surface drying may be accomplished by air jet. Ensure that compressed air used in cleaning and drying is free from oil or other contaminating materials.
 3. Maintain concrete surface in sufficient depth at temperature of 65F minimum during first four hours after placement of epoxy bond coat. Preheating may be done with radiant heaters or other approved means. Do not preheat concrete in excess of 200F with final surface temperature below 105F at time of placing epoxy materials.
- B. Application of Epoxy Bonding Agents:
1. Prepare epoxy bonding agent in accordance with manufacturer's recommendations.
 2. Apply epoxy bonding agent to prepared dry concrete surface at coverage of 80 square feet per gallon maximum or as recommended by manufacturer
 3. Epoxy bonding agent may be applied by any convenient and safe method which will yield effective coverage, such as squeegees, brushes or rollers.
 4. During application of epoxy bonding agent, ensure that material is confined to area being bonded; avoid contamination of adjacent surfaces. Extend epoxy bond coat slightly beyond edges of repair area.
- C. Application of Epoxy Mortar:
1. Mix epoxy components in accordance with manufacturer's recommendations.
 2. Proportion: 5-1/2 parts sand by weight to one-part epoxy.
 3. Mix components with slow-speed mechanical device.
 4. Prepare mortar in small batches so that each batch can be completely mixed and placed within approximately 30 minutes.
 5. Do not add thinners or dilutants to mortar mixture.
 6. Immediately after application of epoxy bonding agent, place, tamp, flatten and smooth epoxy mortar.
 7. Work mortar to grade.
 8. Steel-trowel finish. Trowels may be heated to facilitate finishing.
- D. Curing:
1. Cure epoxy mortar repairs immediately after completion at 60F minimum until mortar is hard.
 2. Initiate post-curing of four hours minimum at surface temperature of 90F minimum, 110F maximum.
 3. Heat may be applied by using portable propane heaters, infrared heaters or other approved sources positioned to attain necessary surface temperature.
 4. Do not subject epoxy-bonded epoxy mortar to moisture until after specified post-curing has been completed.

3.16 CONCRETE OVERLAYS AND TILE SETTING BEDS:

- A. General:
1. Water blast (3,000 - 5,000 psi) or sand blast the substrate.
 2. Keep slabs continuously wet for 24 hours prior to concrete placement. Substrate to be air blown just prior to concrete placement.
 3. Place concrete in two pours of equal thickness. Place welded-wire-fabric reinforcement on first pour and then place second pour.
 4. Use a vibratory screed on overlays.
 5. Float slab and apply light broom finish. Cure slabs with water.
 6. Remove laitance by methods in number one above if the overlay requires a bonding surface for tile or other treatments.
 7. Continuously moist cure of overlay (setting bed) for seven (7) days.

END OF SECTION

A. General:

1. Water blast (3,000 - 5,000 psi) or sand blast the substrate.
2. Keep slabs continuously wet for 24 hours prior to concrete placement. Substrate to be air blown just prior to concrete placement.
3. Place concrete in two pours of equal thickness. Place welded-wire-fabric reinforcement on first pour and then place second pour.
4. Use a vibratory screed on overlays.
5. Float slab and apply light broom finish. Cure slabs with water.
6. Remove laitance by methods in number one above if the overlay requires a bonding surface for tile or other treatments.
7. Continuously moist cure of overlay (setting bed) for seven (7) days.

END OF SECTION

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SECTION 03400

STRUCTURAL PRECAST CONCRETE

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. Brentwood Yard
- B. Greenbelt Yard
- C. Shady Grove Yard

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete Formwork: Section 03100.
- B. Concrete Reinforcement: Section 03200.
- C. Cast-in-Place Concrete: Section 03300.
- D. Prestressed Concrete: Section 03415.
- E. Flashing and Reglets: Section 07600.
- F. Quality Control: Section 01428.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ACI: 503.
 - 3. ASTM: A666, C143, C50, C881, C1107.
 - 4. PCI: MNL 116, Plant Certification Program.
- B. Manufacturer's Qualifications: Use only a precast concrete manufacturing plant (or site) certified by PCI Plant Certification Program.
 - 1. Certification is required at time of bidding and throughout construction time.
 - 2. Furnish certification in the following product groups and categories: AI, C3, plus additional certification as appropriate to the visibility and use of precast units required.
 - 3. Furnish name, qualifications and evidence of recent experience on work comparable to that specified.
 - 4. Do not commence work until fabricator has been approved.
- C. Installer qualifications: Use only an experienced, PCI qualified installer who has completed precast concrete work similar in material, design and extent to that indicated for this Project and with a record of successful in-service performance.
- D. Test Units:
 - 1. Prior to production runs of precast elements, cast at least two full-size test units as specified. Perform sampling, testing and frequency of testing in accordance with Section 03300, except as otherwise specified.
 - 2. Mold two cylinders for each casting bed each day it is used or for each 100 cubic yards of concrete or fraction thereof for each precast-concrete structure.

3. Test for compressive strength on twenty-eighth day.
 3. Have tests performed by approved independent testing agency.
 4. The Engineer may test concrete at any time during fabrication operations.
 5. Color, texture, finish and workmanship subject to approval.
- E. Uniformity of Materials:
1. To minimize irregularities in color and texture, use same cement, aggregate and water in delivered production units as that used in approved samples and test units.
- F. Repair of Defective Concrete: Effect epoxy-mortar repairs in accordance with ACI 503.4- 7, except as otherwise specified.

1.04 SUBMITTALS

Submit the following for approval in accordance with the General Conditions and with the additional requirements as specified for each:

- A. Shop Drawings:
1. Have drawings and calculations certified by a registered professional engineer who is licensed to practice in the jurisdiction where the work is to be performed and is experienced in the work to be performed.
 2. Include details of form fabrication, profiles, joints, reinforcing steel, clips, anchors, inserts, reglets, lifting devices, connection to other work and placement and erection sequence.
- B. Samples:
1. Panels representing color, texture and general finish of test units and production panels, each 12 inches square by 1-1/2 inches: Two. Submit prior to fabrication.
 2. Gasket and flashing materials proposed for use, each 12 inches long: Two.
- C. Certification:
1. Certificates from concrete supplier as specified in Section 03300.
 2. Certification or published listing of manufacturer per Quality Assurance paragraph above.
- D. Documentation:
1. Prior to installation of units, submit schedule indicating sequence of installation, joints, support and bracing system and anchoring system.
 2. Design mix. Submit prior to use for test units.
 3. Delivery tickets from concrete supplier in lieu of certification as specified in Section 03300.
- E. Quality Control Plan: Provide production quality control in accordance with the requirements of PC MNL 116.
- F. Keep units under cover and protected until installed.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Concrete: Section 03300, Class 5000 unless otherwise shown; slump of 3-1/2 inches

plus-or-minus 1/2 inch as determined by ASTM C143.

1. Color matching sample on file with the Engineer.
- B. Formwork:
1. One of the following in accordance with Section 03100.
 - a. Fibrous-glass-reinforced plastic forms.
 - b. Steel forms.
 - c. Epoxy-coated concrete forms.
 2. Use largest sizes possible to produce units without visible joints.
- C. Reinforcement Section 03200, welded-wire fabric to be galvanized.
- D. Gaskets:
1. ASTM C509, preformed, expanded closed-cell neoprene sponge, acid-resistant, non-staining, inert to temperature changes, sized to provide constant compression in joint and in pieces as long as practicable to minimize field splices.
 2. Gasket cement Type recommended by gasket manufacturer.
- E. Anchors, Dowels and Accessories Cast Into Precast Units: Steel, hot-dip galvanized.
- F. Joint Connections: Stainless steel, ASTM A666.
- G. Penetrating Concrete Sealer. Silane penetrating sealer as specified in Section 03300.
- H. Sandblasting Sand: One-size silica sand equivalent to Ottawa Sand Grade, graded to pass Size 20 sieve and retained on Size 30 sieve.
- I. Non-shrink Grout Premixed, nonmetallic, non-corrosive, non-staining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107, with fluid consistency and a 30-minute working time.
- J. Epoxy Adhesive: Non-sagging. Consist of epoxy resin bonding material and a hardener. Epoxy shall conform to ASTM C881.
- K. Corrosion Inhibitor Calcium nitrite-based corrosion inhibitor as specified in Section 03300.

PART 3 - EXECUTION

3.01 FABRICATION OF TEST UNITS:

- A. In order to determine materials, proportions and techniques which will result in required color, texture, finish and strength and which will be used in precast concrete production, cast at least two full-size test units, using forms, concrete mix proportions, admixtures and methods proposed for production work.
- B. Design mix to conform to Section 03300 and submit for approval prior to use in test units.
- C. Cast test units as directed to simulate production run, incorporating reinforcing and embedded items as shown.
- D. Maintain complete records of proportions, mixing, consolidation and curing procedures during casting.

- E. Prepare a set of at least four test cylinders during casting of each test unit for compressive tests as specified in Section 03300.
- F. If approved, precast-concrete elements may be cured by accelerated method such as steam treatment. The Engineer may direct that test cylinders be cured in accordance with curing process selected in order to determine satisfactory period of hardening of concrete in the units.
- G. Sandblasting and Sealing:
 - 1. After curing and when so directed, sandblast test units to determine conditions for achieving required texture of concrete surface. Use specified silica sand.
 - 2. Determine required surface texture by varying blasting pressure, size of nozzle, duration of blasting and distance between nozzle and surface. Maintain complete records of sandblasting.
 - 3. After sandblasting test units, seal surface with application of sealing compound as specified.
 - 4. Prior to application of sealer, thoroughly clean surface by application of water or air. Apply sealer as recommended by manufacturer.
 - 5. Keep complete record of each sealer application.
 - 6. Utilize approved procedures and materials on the basis of test applications specified for sandblasting and sealing of surfaces of precast-concrete work.
- H. After test units are approved, fabricate units using mix, ingredients, sandblasting technique and sealer formulation used to prepare test units.
- I. If strength, color, texture, finish or workmanship of test units is rejected, cast additional units until units meet requirements and approval is obtained.

3.02 FABRICATION OF PRODUCTION UNITS:

- A. Fabricate units in number and sizes shown and specified to match approved test units.
- B. Deliver units to site in compliance with erection schedule.

3.03 DEFECTIVE AND DAMAGED CONCRETE UNITS:

- A. Do not install units with surface imperfections such as air bubbles, joint lines, warpage, stains, uneven matrix plane or uneven exposure of aggregate or units which are warped, cracked, broken, spalled, stained or otherwise defective

3.04 ERECTION

- A. Lift, support and erect precast members so as to prevent damage or over stressing. Handle precast members by means of lifting inserts, loops or other approved means.
- B. After erection remove lifting loops, bend them over or cut them flush with the surface of the concrete. If insert material may cause stains to surfaces exposed to view, inset cut and patch concrete.
- C. Set members in position properly leveled, aligned and braced as shown.
- D. Install members so that their erected position does not differ from position shown on approved shop drawings by more than allowable tolerances.
- E. Bring defects detected after erection to the attention of the Engineer who will conduct inspection. Where in his opinion structural adequacy is impaired, replace member.

END OF SECTION

SECTION 03400

STRUCTURAL PRECAST CONCRETE

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. Brentwood Yard
- B. Greenbelt Yard
- C. Shady Grove Yard

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete Formwork: Section 03100.
- B. Concrete Reinforcement: Section 03200.
- C. Cast-in-Place Concrete: Section 03300.
- D. Prestressed Concrete: Section 03415.
- E. Flashing and Reglets: Section 07600.
- F. Quality Control: Section 01428.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ACI: 503.
 - 3. ASTM: A666, C143, C50, C881, C1107.
 - 4. PCI: MNL 116, Plant Certification Program.
- B. Manufacturer's Qualifications: Use only a precast concrete manufacturing plant (or site) certified by PCI Plant Certification Program.
 - 1. Certification is required at time of bidding and throughout construction time.
 - 2. Furnish certification in the following product groups and categories: AI, C3, plus additional certification as appropriate to the visibility and use of precast units required.
 - 3. Furnish name, qualifications and evidence of recent experience on work comparable to that specified.
 - 4. Do not commence work until fabricator has been approved.
- C. Installer qualifications: Use only an experienced, PCI qualified installer who has completed precast concrete work similar in material, design and extent to that indicated for this Project and with a record of successful in-service performance.
- D. Test Units:
 - 1. Prior to production runs of precast elements, cast at least two full-size test units as specified. Perform sampling, testing and frequency of testing in accordance with Section 03300, except as otherwise specified.
 - 2. Mold two cylinders for each casting bed each day it is used or for each 100 cubic yards of concrete or fraction thereof for each precast-concrete structure. Test for compressive strength on twenty-eighth day.
 - 3. Have tests performed by approved independent testing agency.
 - 4. The Engineer may test concrete at any time during fabrication operations.

5. Color, texture, finish and workmanship subject to approval.
- E. Uniformity of Materials:
 1. To minimize irregularities in color and texture, use same cement, aggregate and water in delivered production units as that used in approved samples and test units.
- F. Repair of Defective Concrete: Effect epoxy-mortar repairs in accordance with ACI 503.4- 7, except as otherwise specified.

1.04 SUBMITTALS

Submit the following for approval in accordance with the General Conditions and with the additional requirements as specified for each:

- A. Shop Drawings:
 1. Have drawings and calculations certified by a registered professional engineer who is licensed to practice in the jurisdiction where the work is to be performed and is experienced in the work to be performed.
 2. Include details of form fabrication, profiles, joints, reinforcing steel, clips, anchors, inserts, reglets, lifting devices, connection to other work and placement and erection sequence.
- B. Samples:
 1. Panels representing color, texture and general finish of test units and production panels, each 12 inches square by 1-1/2 inches: Two. Submit prior to fabrication.
 2. Gasket and flashing materials proposed for use, each 12 inches long: Two.
- C. Certification:
 1. Certificates from concrete supplier as specified in Section 03300.
 2. Certification or published listing of manufacturer per Quality Assurance paragraph above.
- D. Documentation:
 1. Prior to installation of units, submit schedule indicating sequence of installation, joints, support and bracing system and anchoring system.
 2. Design mix. Submit prior to use for test units.
 3. Delivery tickets from concrete supplier in lieu of certification as specified in Section 03300.
- E. Quality Control Plan: Provide production quality control in accordance with the requirements of PC MNL 116.
- F. Keep units under cover and protected until installed.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Concrete: Section 03300, Class 5000 unless otherwise shown; slump of 3-1/2 inches plus-or-minus 1/2 inch as determined by ASTM C143.
 1. Color matching sample on file with the Engineer.
- B. Formwork:

1. One of the following in accordance with Section 03100.
 - a. Fibrous-glass-reinforced plastic forms.
 - b. Steel forms.
 - c. Epoxy-coated concrete forms.
 2. Use largest sizes possible to produce units without visible joints.
- C. Reinforcement Section 03200, welded-wire fabric to be galvanized.
- D. Gaskets:
1. ASTM C509, preformed, expanded closed-cell neoprene sponge, acid-resistant, non-staining, inert to temperature changes, sized to provide constant compression in joint and in pieces as long as practicable to minimize field splices.
 2. Gasket cement Type recommended by gasket manufacturer.
- E. Anchors, Dowels and Accessories Cast Into Precast Units: Steel, hot-dip galvanized.
- F. Joint Connections: Stainless steel, ASTM A666.
- G. Penetrating Concrete Sealer. Silane penetrating sealer as specified in Section 03300.
- H. Sandblasting Sand: One-size silica sand equivalent to Ottawa Sand Grade, graded to pass Size 20 sieve and retained on Size 30 sieve.
- I. Non-shrink Grout Premixed, nonmetallic, non-corrosive, non-staining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107, with fluid consistency and a 30-minute working time.
- J. Epoxy Adhesive: Non-sagging. Consist of epoxy resin bonding material and a hardener. Epoxy shall conform to ASTM C881.
- K. Corrosion Inhibitor Calcium nitrite-based corrosion inhibitor as specified in Section 03300.

PART 3 - EXECUTION

3.01 FABRICATION OF TEST UNITS:

- A. In order to determine materials, proportions and techniques which will result in required color, texture, finish and strength and which will be used in precast concrete production, cast at least two full-size test units, using forms, concrete mix proportions, admixtures and methods proposed for production work.
- B. Design mix to conform to Section 03300 and submit for approval prior to use in test units.
- C. Cast test units as directed to simulate production run, incorporating reinforcing and embedded items as shown.
- D. Maintain complete records of proportions, mixing, consolidation and curing procedures during casting.
- E. Prepare a set of at least four test cylinders during casting of each test unit for compressive tests as specified in Section 03300.
- F. If approved, precast-concrete elements may be cured by accelerated method such as steam treatment. The Engineer may direct that test cylinders be cured in accordance with

curing process selected in order to determine satisfactory period of hardening of concrete in the units.

G. Sandblasting and Sealing:

1. After curing and when so directed, sandblast test units to determine conditions for achieving required texture of concrete surface. Use specified silica sand.
2. Determine required surface texture by varying blasting pressure, size of nozzle, duration of blasting and distance between nozzle and surface. Maintain complete records of sandblasting.
3. After sandblasting test units, seal surface with application of sealing compound as specified.
4. Prior to application of sealer, thoroughly clean surface by application of water or air. Apply sealer as recommended by manufacturer.
5. Keep complete record of each sealer application.
6. Utilize approved procedures and materials on the basis of test applications specified for sandblasting and sealing of surfaces of precast-concrete work.

H. After test units are approved, fabricate units using mix, ingredients, sandblasting technique and sealer formulation used to prepare test units.

I. If strength, color, texture, finish or workmanship of test units is rejected, cast additional units until units meet requirements and approval is obtained.

3.02 FABRICATION OF PRODUCTION UNITS:

- A. Fabricate units in number and sizes shown and specified to match approved test units.
- B. Deliver units to site in compliance with erection schedule.

3.03 DEFECTIVE AND DAMAGED CONCRETE UNITS:

- A. Do not install units with surface imperfections such as air bubbles, joint lines, warpage, stains, uneven matrix plane or uneven exposure of aggregate or units which are warped, cracked, broken, spalled, stained or otherwise defective

3.04 ERECTION

- A. Lift, support and erect precast members so as to prevent damage or over stressing. Handle precast members by means of lifting inserts, loops or other approved means.
- B. After erection remove lifting loops, bend them over or cut them flush with the surface of the concrete. If insert material may cause stains to surfaces exposed to view, inset cut and patch concrete.
- C. Set members in position properly leveled, aligned and braced as shown.
- D. Install members so that their erected position does not differ from position shown on approved shop drawings by more than allowable tolerances.
- E. Bring defects detected after erection to the attention of the Engineer who will conduct inspection. Where in his opinion structural adequacy is impaired, replace member.

END OF SECTION

SECTION 03415

PRESTRESSED AND POST-TENSIONED CONCRETE

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. Brentwood Yard: Not applicable
- B. Greenbelt Yard
- C. Shady Grove Yard: Not Applicable..

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete formwork: Section 03100.
- B. Concrete reinforcement: Section 03200.
- C. Cast-in-place structural concrete: Section 03300.
- D. Precast concrete: Section 03400.

1.03 DEFINITIONS:

- 1. Site or job site: Location where members are to be manufactured.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. PCI: MNL 116, Plant Certification Program.
 - 3. ASTM: A416, A421, A722, C109, C404, C618.
- B. Fabricator Qualifications: Use only a prestressed concrete manufacturing plant (or site) certified by PCI Plant Certification Program.
 - 1. Certification is required at time of bidding and throughout construction time.
 - 2. Furnish certification in the following product groups and categories: A1, C3 (if straight strand) or C4 (if draped stand), plus additional certification as appropriate to the visibility and use of prestressed units required.
 - 3. Furnish name, qualifications and evidence of recent experience on work comparable to that specified.
 - 4. Do not commence work until fabricator has been approved.
- C. Installer qualifications: Use only an experienced, PCI qualified installer who has completed prestressed concrete work similar in material, design and extent to that indicated for this Project and with a record of successful in-service performance.
- D. Allowable Tolerances:
 - 1. Fabricate prestressed-concrete members in accordance with dimensional tolerances indicated in referenced PCI standard.
- E. Sampling and Testing:
 - 1. Concrete:

- a. Perform sampling, testing and frequency of testing in accordance with Section 03300, except as otherwise specified.
 - b. Mold three sets of at least two cylinders for each casting bed each day it is used or for each 100 cubic yards of concrete or fraction thereof for each prestressed-concrete structure. In any case, have at least six cylinders cast for each group of members cast from each batch.
 - c. Cure cylinders for stress transfer in same environment as members or structures they represent.
 - d. Test one set for compressive strength at stress transfer and one set on twenty-eighth day.
 - e. Have tests performed by approved independent testing agency.
 - f. The Engineer may test concrete at any time during fabrication operations.
 - g. For major members carrying rapid transit loads or underpinning loads or as directed, perform sampling and testing in accordance with ASTM A416 and ASTM A421.
2. Tendons:
- a. Furnish samples for testing from each size and each heat of prestressing bars, from each manufactured reel of prestressing-steel strand, from each coil of prestressing wire and from each lot of anchorage assemblies and bar couplers to be used. With each sample of prestressing-steel wires, bars or strands furnished for testing, submit certificate stating manufacturer's minimum guaranteed ultimate tensile strength of sample furnished. Prior to installation submit certified test results from each manufacturer for each type of low-relaxation steel.
 - b. Furnish testing materials and equipment.
 - c. Assign individual lot number to bars of each size from each mill heat, wire from each coil, and strand from each manufactured reel to be shipped to site and tag so that each lot can be accurately identified at job site. Likewise, identify each lot of anchorage assemblies and bar couplers to be installed.
 - d. Unidentified prestressing steel, anchorage assemblies or bar couplers received at site will be rejected.
 - e. Submit the following samples of materials and tendons, selected by the Engineer from prestressing steel at plant or jobsite:
 - 1) For wire, strand or bars: One sample of each size from each heat or reel.
 - 2) If prestressing tendon is to be prefabricated, one completely fabricated prestressing tendon five feet in length for each size of tendon, including anchorage assemblies. If the prestressing tendon is to be assembled at jobsite, sufficient wire or strand and end fittings to make up one complete prestressing tendon five feet in length for each size of tendon, including anchorage assemblies.
 - 3) If prestressed tendon is a bar, one five-foot length complete with one end anchorage; if couplers are to be used with the bar, two four-foot lengths of bar equipped with one coupler and fabricated to fit coupler.
 - f. For prefabricated tendons, notify the Engineer at least 10 working days prior to commencing installation of end fittings or heading of wires. The Engineer will inspect end-fitting installations and wire headings while such fabrication is in progress at the plant and will arrange for testing of material to be shipped to the site.
 - g. Do not ship prefabricated tendons to the site until they are released by the Engineer. Tag each tendon before shipment as specified.

- h. Material released by the Engineer will be rejected if subsequently damaged or found defective

1.05 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- 1. Shop Drawings:

- a. Have drawings and calculations for prestressed products certified by a registered professional engineer who is licensed to practice in the jurisdiction where the work is to be performed and who is experienced in the work of this section.
- b. Include the following:
 - 1) Description of equipment to be used and procedure for constructing prestressed-concrete members.
 - 2) Ductwork and method of holding ducts in position, tendon or bar sizes, splicing of bars, unit weights, materials and stress grade, jack clearances and procedures, stressing sequence, initial-tensioning forces, pressure gauge or load cell for determining loads, calculated friction and elastic-shortening losses and tendon or bar elongation, anchorage details and anchorage-slippage losses, bonding and grouting procedures, mild-steel placement, provisions for camber and clearances and concrete dimensions.
 - 3) Details of procedures for yard and site, handling, transporting, storing and erecting. If necessary, furnish design calculations. Show embedded items including, but not limited to, inserts, anchors, couplings, fittings, vent-hole openings and anchorage pockets. Show method of tendon support for post-tensioned systems during tendon-placing operations.
 - 4) Complete details and substantiating calculations of method and materials proposed for use in prestressing operations, including additions or rearrangement of reinforcing steel from that shown. Calculate, detail and show individual tendon layout and anchorage arrangement to satisfy design requirements and to avoid interferences. Coordinate with embedded items. Changes or rearrangement of details shown permitted only with approval. Ensure that spacing of tendon is sufficient for full encasement of each tendon in concrete. Plan sequence of installation to minimize fitting problem of various components embedded in prestressed member. Show camber computations.
 - 5) Stress/strain curve of tendons and bars. Show amount of slip normally expected in seating anchorage devices as opposed to that assumed in design calculations. Show friction-wobble coefficient and friction-curvature coefficient expected from tendons and bars and duct material. Show complete stress diagram for each tendon size or type.
 - 6) Bills of materials, erection diagrams and details of connections to other work.
 - 7) Details and design calculations for size and thickness of anchor plates and corresponding reinforcement necessary for each system

to guarantee safe transfer of forces into end block. Show amount, size and arrangement of such reinforcement to be installed at anchorage zones and along path of tendons to prevent bursting and splitting concrete members when subjected to prestressing forces. Special Anchorage Devices, as defined by the AASHTO Guide Specifications for Design and Construction of Segmental Concrete Bridges, shall be approved based on the results of testing representing actual jobsite conditions.

2. Working Drawings:
 - a. Complete working drawings and necessary calculations for formwork and falsework.
 - b. Include compensation for deflection as necessary to construct structure to lines and grades shown.
 - c. Consider loads, forces and stresses to be imposed during casting and post-tensioning elements of structure.
 3. Samples: As previously specified.
 4. Certification:
 - a. Tendons:
 - 1) Certificates for each five reels or coils or fraction thereof.
 - 2) Submit certificates prior to delivery of tendons to jobsite.
 - 3) Applicable certificates to accompany each shipment of tendons.
 - b. Hydraulic jacks:
 - 1) Certified calibration curves for each hydraulic jack.
 - c. Certified test reports:
 - 1) Concrete tests.
 - 2) Tendons: For each size of strand to be used in the work, submit test certificates showing physical, chemical and stress/strain test properties including modulus of elasticity and stating guaranteed minimum ultimate tensile and yield strength.
 5. Documentation:
 - a. Specified calculations.
 - b. Records of tendon elongation promptly upon completion of post-tensioning of each member.
- B. Quality Control Plan: Provide production quality control in accordance with the requirements of PCI MNL 116.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Prestressing Steel:
 1. Protect prestressing steel against physical damage and rust or other results of corrosion at all times from manufacture to grouting or encasing in concrete. Physically damaged prestressing steel will be rejected. Rust or other corrosion will be cause for rejection.
 2. Package prestressing steel in containers or shipping forms for protection against physical damage and corrosion during shipping and storage. Place corrosion inhibitor

- and rust preventive in package or form or use corrosion-inhibiting carrier-type packaging material. If approved, apply corrosion inhibitor directly to steel.
3. Use corrosion inhibitor which has no deleterious effect on steel, concrete or bond strength of steel to concrete.
 4. Replace or restore to original condition damaged packaging or forms.
 5. Clearly mark shipping package or form with statement that package contains high-strength prestressing steel, and caution that care be used in handling. Show type, kind, amount and placement date of corrosion inhibitor used. Include safety recommendations and instructions for use.
 6. When prestressing steel for post-tensioning is installed in members prior to placing and curing concrete, provide protection against rust or other corrosion, until grouted, by means of corrosion inhibitor placed in ducts or applied to steel in duct.
 7. Do not stress tendons until 28 day compressive strength is verified.

B. Members:

1. Handle, store and transport completed members and member components so as to prevent damage.
2. Maintain beams in upright position.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Concrete:

1. Section 03300: Class 5000, unless otherwise specified.

B. Grout:

1. Materials for grout: Section 03300 and ASTM C404. Pozzolans, if used: ASTM C618.

C. Formwork and Accessories: Section 03100.

D. Reinforcing Steel: Section 03200.

E. Tendons, Anchorage, Couplers and Ducts:

1. Pretensioning tendons:
 - a. Steel strand: ASTM A416, Grade 270, regular or low-relaxation.
 - b. Strand similar to specified steel strand but with different number of wires per strand: As approved.
 - c. Steel wire: ASTM A421.
2. Post-tensioning tendons:
 - a. Strand as specified or shown for pre-tensioning either in single-strand units or in multiple-parallel-strand units, with wedge-type anchorages.
 - b. Button heads to be cold-formed symmetrically about axes of wires so that butt develops minimum guaranteed ultimate tensile strength of wire. Use of cold-forming process that causes indentations in wire is prohibited.
 - c. Prestressing bars:
 - 1) Fabricated and processed in accordance with ASTM A722 and as specified.
 - 2) High-tensile-strength hot-rolled alloy steel, individually cold-stretched and thermally stress-relieved to ensure uniform stress/strain

characteristics and to obtain yield strength not less than 85 percent of required minimum guaranteed ultimate tensile strength.

3)

In accordance with the following minimum requirements:

4)

Properties	Regular Grade	Special Grade
a) Ultimate tensile strength	150,000 psi	160,000 psi
b) Modulus of elasticity at 70 percent of manufacturer's minimum guaranteed ultimate strength	29x10 ⁶ psi	30x10 ⁶ psi

5)

High-strength, thermally stress-relieved, large steel cables with socketed ends fitted with anchorage nuts on peripheries of sockets and meeting required breaking strength, yield strength, elongation, composition and other pertinent requirements may be used if approved. Oil-tempered wires are prohibited.

3. Unbonded tendons are prohibited unless approved.

4. Anchorages and couplers:

a. Steel anchorages and couplers as approved if compatible with particular installation. Anchorage devices to hold prestressing steel at load-producing stress of not less than 95 percent of specified minimum ultimate tensile strength of prestressing steel. Anchorages with cut threads or notches are prohibited on prestressing steel. Fabricate stressing anchorages to provide adjustable-seating loss. Ensure that each anchorage is capable of lift-off, de-tensioning and re-tensioning tendon at any time prior to grouting.

5. Ducts:

a. Galvanized ferrous metal.
 b. Strong enough to retain shape and resist damage during construction.
 c. Capable of preventing entrance of cement paste and water from concrete.
 d. Incapable of causing electrolytic action or deterioration in concrete.
 e. When grouting is necessary, ensure that:
 1) Inside diameter of duct is at least 1/4-inch larger than bar or strand tendons or, in the case of parallel-wire cable tendons, that inside area of duct is at least 100-percent larger than area of tendon.
 2) Ducts have grout holes at each end and at high points.
 3) Ducts have drain holes at low points.
 f. Grout and vent-hole connections to duct made with metallic structural fasteners. Connections to be mortar-tight, taped as necessary. Provide grout holes with means to inject grout. Provide positive shutoff valves.

F. Corrosion Inhibitor: Water-soluble oil; VISCONORUST 84-18, Viscosity Oil Company, or equal.

PART 3 - EXECUTION

3.01 CONCRETE:

- A. Mixing and Placing:
 - 1. Mix concrete in accordance with the requirements of Section 03300, with the following additional requirements:
 - a. Do not use admixtures containing chlorides, fluorides or nitrates.
 - b. Use more than one admixture only if compatible with each other. If used, add separately during batching sequence.
 - 2. Placement of concrete: Section 03300.
- B. Sampling and Testing:
 - 1. Perform sampling and testing as specified.
- C. Concrete Protection for Reinforcement: Section 03200
- D. Compaction of Concrete:
 - 1. Compact concrete by means of internal, external or surface vibrators as approved and as follows:
 - a. Use internal vibrators on sections that are sufficiently large to admit them.
 - b. Use external vibrators on smaller sections and sections produced by extrusion or slip-form method.
 - c. Surface or screed vibrators may be used for flat slabs.
 - 2. Use vibrators having operating frequencies of at least 7,000 impulses per minute and higher frequencies if approved. Use vibrators only for compacting, not for moving concrete along forms.
- E. Patching:
 - 1. Thoroughly clean and hammerpack holes left by tie rods, strand hold-down devices or other temporary inserts with stiff dry mortar made with same type of sand and cement used in concrete. In areas of tensile stress, bond hole patches with approved epoxy resin.
 - 2. Members with honeycombs of such depth as to expose tendons will be examined by the Engineer for structural adequacy. Where in the Engineer's opinion impairment of structural adequacy is apparent, member will be rejected.
 - 3. Where honeycombed areas are to be repaired, remove loose material and cut area back until coarse aggregate breaks under chipping; coat area with layer of epoxy bonding agent and patch with grout matching existing concrete color and strength. Obtain approval of proposed method and materials.
- F. Curing: Section 03300.
- G. Finishes:
 - 1. Types of concrete finishing: As shown and specified.

3.02 FORMS:

- A. Ensure that joints are smooth and tight to prevent leakage of mortar. Maintain accurate alignment of forms during casting operations. Check form alignment and grade for each casting.

- B. Make provisions in form-anchorage system for anticipated differential movement of beds and forms during casting and curing operations. In details of forms, ties, inserts, bulkheads and other accessories, detail forms and anchor them so that differential movement cannot occur or loosen them so that movement can occur without damage to member or forms. Ensure that bearing devices supporting prestressed members are free to rotate and that expansion bearings are free to translate during post-tensioning operation.
- C. Clean beds and forms thoroughly before casting. Do not allow coatings used for bond breakers to accumulate in bottoms of forms. For members to be cured by artificial heat, provide for ventilation of void forms.
- D. In areas subject to freezing and thawing, make provisions for draining voids.
- E. Treat surfaces in contact with concrete with effective bond breaker.
- F. Prevent contamination of tendons by bond breaker, mud, grease or other detrimental substances.
- G. Provide bolting fittings and welding plates for embedment in prestressed members to allow later attachment of conduits, pipes, boxes and similar items.

3.03 JACKS:

- A. Equip each jack used to stress tendons with pressure gauge or load cell to determine jacking stress.
- B. If pressure gauge is used, provide accurate, easily readable dial at least six inches in diameter. Calibrate each jack and its gauge as a unit with cylinder extension in approximate position in which it will be at final jacking force. Provide certified calibration chart as specified.
- C. If inconsistencies occur between measured elongation and jack gauge reading, recalibrate gauge. If further discrepancies occur, determine cause and report to the Engineer. Agreement within seven percent will be satisfactory.
- D. If load cell is used, calibrate and provide with indicator by means of which prestressing force in tendon may be determined. Ensure that range of load cell is such that lower 10 percent of manufacturer's-rated capacity will not be used in determining jacking stress.

3.04 TENDONS:

- A. Placement and Tensioning of Tendons for Prestressing:
 1. Prior to stringing tendons, inspect bottom of forms for cleanliness and accuracy of alignment.
 2. String tendons singly or in multiples.
 3. Splicing of wires or strands is prohibited.
 4. Cut length of each tendon between tendon vise and coil or reel.
 5. Do not string tendons incorporating points previously gripped by tendon vises or wedges within lengths to be stressed. Do not use notched, nicked, pitted, rusted or otherwise damaged tendons.
 6. Provide tendon vises or wedges capable of anchoring stressing loads positively with a minimum of differential slippage. Have vises or wedges cleaned, lubricated and inspected between each use.

7. Discard grips which become visibly worn or distorted or which allow excessive slippage. Furnish full set of cleaned and inspected tendon vises or wedges before commencing each stressing operation. Ensure that vises and wedges are free of rust and physical damage.
8. Position tendons to conform to tensioning detail dimensions shown. Prevent sagging and kinking of tendons. Support tendons as necessary to maintain proper position and prevent vertical movement during pouring of concrete. Permissible deviations from profile shown on approved shop drawings as follows:

	Depth of Member	Permissible Deviation
a)	Less than 10 inches	Plus-or-minus 1/8 inch
b)	Ten inches or more	Plus-or-minus 1/4 inch

9. After straight wire tendons have been positioned, apply initial force to each tendon to eliminate slack and to provide uniform initial-stress condition in all tendons prior to final stressing. Initial force may be applied only by pressure jacks equipped with proper gauging system for measuring initial force.
10. Do not weld or make grounds for welding equipment on forms or on steel in member after prestressing steel has been installed.
11. Maintain records of elongation of each tendon and tension applied to each tendon.
12. Use load cells to calibrate load-measuring devices and to check initial force on at least 10 percent of tendons.
13. Regardless of method used, measure initial load within tolerance of plus-or-minus 50 pounds or two percent, whichever is larger.
14. Do not use elongation measurements as measure of initial stress.
15. Perform final stressing as shown on approved shop drawings.
16. If prestressing bars less than 30 feet long are used, measure elongation by means of dial indicators.

B. Tendon Vises for Pretensioning:

1. Use tendon vises for pretensioning capable of anchoring tendon positively without slippage after seating.
2. Have steel cases for tendon vises proof-tested by manufacturer to at least 95 percent of guaranteed minimum tensile stress of prestressing steel.
3. Maintain chucks in serviceable condition. Discard chucks that become visibly worn or show evidence of allowing post-seating slippage of tendon.

C. Post-Tensioning:

1. Perform sequence and staging of post-tensioning in accordance with approved shop drawings. Perform special techniques, such as overjacking with following reduction of load or jacking from both ends of the tendon, in accordance with approved shop drawings.
2. Stress post-tensioned prestressing steel by means of hydraulic jacks equipped with accurately calibrated, easily readable hydraulic pressure gauges or load cells to permit reading stress in prestressing steel throughout stressing operation.

3. Keep records of tension and elongation of each tendon at all stages and submit records as specified. Make readings of elongations to within plus-or-minus 1/32 inch when dial indicators are used, reading accuracy to be accordingly higher.
4. At the time of stressing first member of each type, check stresses in individual tendons and verify calculated frictional losses and seating losses to establish post-tensioning procedure and ensure uniform results.
5. Recheck may be directed if it appears that stress shown is not being obtained.
6. If the measured elongation is within seven percent, and the jacking force as measured by the pressure gauge is within five percent of theoretical, tendons may be cut and sealed for grouting. If an elongation or force is outside of these limits, obtain written approval before cutting and capping post-tensioned anchorage.
7. If friction losses in post-tensioned tendon exceed calculated friction losses shown, relieve tendons of stress, lubricate with water-soluble oil or graphite spray and retension.
8. Anchor prestressing steel at initial stresses (transfer) calculated to result in final force shown. Initial stress not to exceed 70 percent of minimum ultimate tensile strength of prestressing steel at any point of tendon.
9. During jacking of prestressing steel, do not exceed 80 percent of the minimum guaranteed ultimate tensile strength of tendon.
10. Make accurate measurements of anchorage slippage losses at time of anchoring first tendon of each type of member and compare with assumed slippage losses. In case of deviation, de-tension tendon; repeat tensioning in accordance with special approved procedure or by shimming as necessary for particular system.
11. When necessary and approved, make adjustments to post-tensioning procedure to obtain required stresses.
12. Submit for approval proposed remedy for inconsistencies which occur between measured elongation and jack-gauge readings and which cannot be corrected by specified recalibration of gauge nor by lubrication of tendons. Replace tendon, if necessary.
13. Immediately after concreting, check ducts for obstructions by drawing cleaning device through them, by blowing through or by movement of tendon. Immediately prior to installation of tendons in ducts, demonstrate that ducts are free of water, debris and other obstructions.

3.05 GROUTING:

- A. Immediately prior to grouting, clean ducts of foreign materials and remove corrosion inhibitor by thoroughly flushing duct with water and dry by blowing. Unless prestressing steel is adequately protected from corrosion, complete grouting operation within 28 days after concrete is placed around ducts but not later than 10 days after stressing.
- B. Mix grout as recommended by manufacturer, as tested and approved or for 1-1/2 minutes in high-speed mechanical mixer; pass through strainer into pumping equipment which has provision for recirculation. Begin pumping grout as soon as possible after mixing. Pumping may be continued as long as grout retains proper consistency.
- C. Use grout consisting mainly of cement and water unless gross inside area of duct exceeds five times tendon area, in which case fine sand may be added.
- D. When approved, add aluminum powder of proper fineness or other approved material in quantity sufficient to obtain a maximum of 10-percent expansion of grout when measured unconfined.

- E. Base proportions of materials on results of tests made on grout to achieve the following:
 - 1. Water content: Minimum necessary for proper placement.
 - 2. Water-cement ratio: Limited to maximum of 0.45 by weight.
 - 3. Minimum seven-day compressive strength: 2,500 psi for two-inch cubes molded, cured and tested in accordance with ASTM C109.
- F. Do not retemper grout.
- G. Inject grout into ducts and anchorage fittings. Continue flow until grout of consistency equivalent to that injected, flows from vent openings without presence of air in bubbles. Ensure that there is enough grout in supply bin to prevent suction of air.
- H. Close vent openings progressively in direction of flow. After vent openings are closed, raise grouting pressure to 100-psi minimum and plug injection hole. Keep accurate records of progress of grouting operations.
- I. In the event of blockage or interruption of grouting, remove grout from duct by flushing with water. Provide water pump in standby condition.
- J. Prevent water trapped in ungrouted ducts from freezing.
- K. Maintain temperature of concrete around grouted tendons at 45F or higher for at least three days after grouting.

3.06 STRESS TRANSFER:

- A. Perform stress transfer to pretensioned or post-tensioned members only after concrete strength, as demonstrated by test cylinders, is in accordance with the transfer strength specified or shown.
- B. Minimum transfer strengths of concrete:
 - 1. Centrally stressed members: 3,000 psi.
 - 2. Eccentrically stressed members: 3,500 psi.
 - 3. Bridge beams or other members in which camber must be minimized: 4,000 psi.
 - 4. Post-tensioned members: 4,000 psi or as shown.
- C. If precast concrete has been moist-heat cured, perform de-tensioning immediately following curing period while concrete is still warm and moist.
- D. In de-tensioning operations, release tension so as to minimize eccentricity between resultant of prestressing forces and the vertical centroidal axis of member and so as to minimize sudden or shock loading. Limit maximum eccentricity about vertical centroidal axis to one strand.
- E. Prior to detensioning, remove or loosen forms, ties, inserts, holddowns or other devices that would restrict longitudinal movement of members along bed.

END OF SECTION

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SECTION 03450

PLANT - ARCHITECTURAL PRECAST CONCRETE

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing precast architectural concrete units and thin-brick-faced, precast architectural concrete units.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete Unit Masonry: Section 04220.
- B. Flashing and Sheet Metal: Section 07600.
- C. Seals and Sealants: Section 07900.

1.03 PERFORMANCE REQUIREMENTS:

- A. Structural Performance: Provide precast architectural concrete units and connections capable of withstanding design loads within limits and under conditions indicated.
- B. Structural Performance: Provide precast architectural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:
 - 1. Dead Loads: <Insert applicable dead loads.>
 - 2. Live Loads: <Insert applicable live loads.>
 - 3. Wind Loads: <Insert applicable wind loads or wind-loading criteria including basic wind speed, importance factor, and exposure category.>
 - 4. Earthquake Loads: <Insert applicable earthquake design data including seismic coefficient and importance factor.>
 - 5. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 1/2 inch.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements specified for each:

- A. Product Data: For each type of product indicated.
- B. Design Mixes: For each concrete mix.
- C. Shop Drawings: Detail fabrication and installation of precast architectural concrete units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, limits of each finish, and types of reinforcement, including special reinforcement.
 - 1. Indicate separate face and backup mix locations and thicknesses.
 - 2. Indicate locations and extent and treatment of dry joints if two-stage casting is proposed.
 - 3. Indicate welded connections by AWS standard symbols. Detail loose and cast-in

- hardware, inserts, connections, and joints, including accessories.
 - 4. Indicate locations and details of anchorage devices to be embedded in other construction.
 - 5. Indicate locations and details of thin brick units and joint treatment.
 - 6. Comprehensive engineering analysis signed and sealed by the qualified professional engineer responsible for its preparation.
- D. Samples: For each type of finish indicated on exposed surfaces of precast architectural concrete units, in sets of 3, illustrating full range of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.
- E. Samples for each thin brick unit required, including special shapes, showing the full range of colors, textures, and dimensions expected.
- 1. Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing the manufacturer's full range of colors.
- F. Welding Certificates: Copies of certificates for welding procedures and personnel.
- G. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- H. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
- 1. Concrete materials.
 - 2. Reinforcing materials and prestressing tendons.
 - 3. Admixtures.
 - 4. Bearing pads.
 - 5. Water-absorption test reports.
 - 6. Thin brick units and accessories.

1.05 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
- 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AASHTO: M251
 - 3. ACI: 211.1, 211.2, 216/TMS 0216.1, 305R, 306.1, 318.
 - 4. AISI: 1018-1020.
 - 5. ANSI: A118.6, 108.10.
 - 6. APA: Architectural Precast Concrete-Color and Texture Selection Guide.
 - 7. ASTM: A27, A36, A47, A82, A108, A123A, A184, A185, A276, A283, A307, A416, A496, A497, A500, A572, A615, A618, A666, A675, A706, A767, A775, A884, C33, C42, C67, C144, C150, C260, C330, C494, C567, C618, C979, C1088, C1017, C1107, C1240, D412, F593.
 - 8. AWS: D1.1, D1.4.
 - 9. CRSI: Manual of Standard Practice.
 - 10. DOD: P-21035A.
 - 11. FS: TT-P-664.
 - 12. PCI: MNL 117, MNL 120, MNL 124.
 - 13. SSPC: PA 1, Paint 20, Paint 25, SP 3.
- B. Installer Qualifications: An experienced installer who has completed precast architectural

concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

- C. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast architectural concrete units similar to those indicated for this Project and with a record of successful in-service performance.
1. Assumes responsibility for engineering precast architectural concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
 2. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of precast architectural concrete that are similar to those indicated for this Project in material, design, and extent.
 3. Participates in PCI's Plant Certification program and is designated a PCI-certified plant for Group A, Category A1-Architectural Cladding and Load Bearing Units [or in APA's Plant Certification Program for Production of Architectural Precast Concrete Products and is designated an APA-certified plant].
 4. Has sufficient production capacity to produce required units without delaying the work.
 5. Is registered with and approved by authorities having jurisdiction.
- D. Design Standards: Comply with ACI 318 and the design recommendations of PCI MNL 120, "PCI Design Handbook-Precast and Prestressed Concrete."
- E. Quality Control Standard: For manufacturing procedures and testing requirements, quality control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
- F. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel"; and AWS D1.4, "Structural Welding Code-Reinforcing Steel."
- G. Calculated Fire-Test-Response Characteristics: Where indicated, provide precast architectural concrete units whose fire resistance has been calculated according to [PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete,"] [ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies,"] and is acceptable to authorities having jurisdiction.
- H. Sample Panels: Before fabricating precast architectural concrete units, produce sample panels to establish the approved range of selections made under sample Submittals. Produce a minimum of 3 sets of full-scale sample panels, approximately 48 inches long by 48 inches high, to demonstrate the expected range of finish, color, and texture variations.
1. Locate panels where directed by the Engineer.
 2. In presence of the Engineer damage part of an exposed-face surface for each finish, color, and texture, and demonstrate materials and techniques proposed for repair of surface blemishes to match adjacent undamaged surfaces.
 3. Maintain sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 4. Demolish and remove sample panels when directed

- I. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings."

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. Deliver precast architectural concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so markings are visible.
- B. Lift and support units only at designated lifting and supporting points as shown on Shop Drawings.

1.07 SEQUENCING:

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.01 MOLD MATERIALS:

- A. Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood, or another material that is nonreactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes
- B. Form Liners: Units of face design, texture, arrangement, and configuration indicated.

2.02 REINFORCING MATERIALS:

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending, as follows:
 - 1. Steel Reinforcement: [ASTM A 615/A 615M, Grade 60] [ASTM A 706/A 706M], deformed.
- D. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M, as follows:
 - 1. Steel Reinforcement: [ASTM A 615/A 615M, Grade 60] [ASTM A 706/A 706M], deformed.
- E. Steel Bar Mats: ASTM A 184/A 184M, assembled with clips, as follows:
 - 1. Steel Reinforcement: [ASTM A 615/A 615M, Grade 60] [ASTM A 706/A 706M], deformed bars.
- F. Plain-Steel Wire: ASTM A 82, [as drawn] [galvanized].
- G. Deformed-Steel Wire: ASTM A 496.

- H. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, [plain] [deformed].
- I. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from [as-drawn] [galvanized] steel wire into flat sheets.
- J. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.
- K. Epoxy-Coated-Steel Welded Wire Fabric: ASTM A 884/A 884M, Class A coated, [plain] [deformed].
- L. Supports: Manufacturer's bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place according to CRSI's "Manual of Standard Practice," PCI MNL 117, and as follows:
 - 1. For uncoated reinforcement, use [all-plastic] [CRSI Class 1 plastic-protected] [CRSI Class 2 stainless-steel] bar supports.
 - 2. For epoxy-coated reinforcement, use [CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire] [all-plastic] bar supports
 - 3. For zinc-coated reinforcement, use [galvanized wire or dielectric-polymer-coated wire] [all-plastic] bar supports.

2.03 PRESTRESSING TENDONS:

- A. Prestressing Strand: ASTM A 416/A 416M, Grade 250 or 270, uncoated, 7-wire, low-relaxation strand.

2.04 CONCRETE MATERIALS:

- A. Portland Cement: ASTM C 150, Type I or Type III, [gray] [and] [white], of same type, brand, and source.
 - 1. Standard gray portland cement may be used for nonexposed backup concrete.
- B. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S.
 - 1. Face-Mix Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining.
 - a. Gradation: [Uniformly graded] [Gap graded] [To match design reference sample].
 - 2. Face-Mix Fine Aggregates: Selected, natural or manufactured sand of the same material as coarse aggregate, unless otherwise approved by the Engineer.
- C. Lightweight Aggregates: ASTM C 330.
- D. Coloring Admixture: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.
- E. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
- F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- G. Water-Reducing Admixture: ASTM C 494, Type A.

- H. Retarding Admixture: ASTM C 494, Type B.
- I. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- J. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- K. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
- L. Plasticizing Admixture: ASTM C 1017.
- M. Fly Ash Admixture: ASTM C 618, Class C or F.
- N. Metakaolin Admixture: ASTM C 618, Class N.
- O. Silica Fume Admixture: ASTM C 1240.

2.05 STEEL CONNECTION MATERIALS:

- A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Carbon-Steel Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished; AWS D1.1, Type A or B, with arc shields.
- C. Carbon-Steel Plate: ASTM A 283/A 283M.
- D. Malleable Steel Castings: ASTM A 47.
- E. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30.
- F. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
- G. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.
- H. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65.
- I. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
- J. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.
- K. Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by [hot-dip process according to ASTM A 123/A 123M, after fabrication, and ASTM A 153/A 153M, as applicable] [electrodeposition according to ASTM B 633, SC 3].
 - 1. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.
 - 2. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply [lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in FS TT-P-664] [SSPC-Paint 25] according to SSPC-PA 1.

- L. Reglets: [PVC extrusions.] [Stainless steel.] [Copper.] [Reglets are specified in Section 07600, Flashing and Sheet Metal.]
- M. Welding Electrodes: Comply with AWS standards.
- N. Accessories: Provide clips, hangers, plastic shims, and other accessories required to install precast architectural concrete units.

2.06 STAINLESS-STEEL CONNECTION MATERIALS:

- A. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
- B. Stainless-Steel Bolts and Studs: ASTM F 593, alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers.
- C. Stainless-Steel Headed Studs: ASTM A 276.

2.07 BEARING PADS:

- A. Provide bearing pads for precast architectural concrete units as follow
 - 1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore A durometer, minimum tensile strength 2250 psi per ASTM D 412.
 - 2. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer.
 - 3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer.
 - 4. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to mild-steel plate, of type required for in-service stress.
 - 5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

2.08 GROUT MATERIALS:

- A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application.

2.09 THIN BRICK UNITS AND ACCESSORIES:

- A. Thin Brick Units: ASTM C 1088, Grade Exterior, Type TBX, [not less than 1/2 inch] [3/4 inch] [1 inch] thick, and as follows:
 - 1. Face Size: Standard, 2-1/4 inches high by 8 inches long.
 - 2. Face Size: Modular, 2-1/4 inches high by 7-1/2 to 7-5/8 inches long.
 - 3. Face Size: Engineer modular, 2-3/4 to 2-13/16 inches high by 7-1/2 to 7-5/8 inches long

4. Face Size: Closure modular, 3-1/2 to 3-5/8 inches high by 7-1/2 to 7-5/8 inches long.
 5. Face Size: Utility, 3-1/2 to 3-5/8 inches high by 11-1/2 to 11-5/8 inches long.
 6. Where shown to "match existing," provide face brick matching color, texture, and face size of existing adjacent brickwork.
 7. Special Shapes: Include corners, edge corners, and end edge corners.
 8. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
 9. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 10. Surface Coloring: Brick with surface coloring, other than flashed or sand-finished brick, shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet
 11. Face Color and Texture: [Match Architect's samples] [Medium brown, wire cut] [Full-range red, sand molded] [Gray, velour].
 12. Back Surface Texture: Scored, combed, wire roughened, or ribbed.
- B. Setting Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.
- C. Latex-Portland Cement Pointing Grout: ANSI A118.6 and as follows: Select one or both types of grout from first two subparagraphs below.
1. Dry-grout mixture, factory prepared, of portland cement, graded aggregate, and dry, redispersible, ethylene-vinyl-acetate additive for mixing with water; uniformly colored
 2. Commercial portland cement grout, factory prepared, with liquid styrene-butadiene rubber or acrylic-resin latex additive; uniformly colored.
 3. Colors: [As indicated by manufacturer's designations] [Match Engineer's samples] [As selected by Engineer from manufacturer's full range].

2.10 CONCRETE MIXES:

- A. Prepare design mixes for each type of concrete required. Delete subparagraph below if fly ash or silica fume is not permitted. Revise percentage to suit Project.
1. Limit use of fly ash and silica fume to not exceed, in aggregate, 25 percent of portland cement by weight.
- B. Design mixes may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast architectural concrete fabricator's option.
- C. Limit water-soluble chloride ions to the maximum percentage by weight of cement permitted by ACI 318.
- D. Normal-Weight Concrete Face and Backup Mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
1. Compressive Strength (28 Days): 5000 psi or greater
 2. Maximum Water-Cementitious Materials Ratio: 0.45.
- E. Water Absorption: 12 to 14 percent by volume, tested according to PCI MNL 117.
- F. Lightweight Concrete Backup Mixes: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide

lightweight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi or greater.
 2. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft., plus or minus 3 lb/cu. ft., according to ASTM C 567.
- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
- H. When included in design mixes, add other admixtures to concrete mixes according to manufacturer's written instructions.

2.11 MOLD FABRICATION:

- A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing operation
1. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concreting. Coat form liner with form-release agent.
- B. Maintain molds to provide completed precast architectural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
1. Edge and Corner Treatment: Uniformly [chamfered] [radiused].

2.12 THIN BRICK FACINGS:

- A. Place form liner templates accurately to provide grid for thin brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concreting.
- B. Securely place thin brick units face down into form liner pockets.
- C. Completely fill joint cavities between thin brick units with sand-cement mortar, and place precast concrete backing mix while sand-cement mortar is still fluid enough to ensure bond
1. Mix and install grout according to ANSI 108.10. Completely fill joint cavities between thin brick units with grout, and compress into place without spreading grout onto faces of thin brick units. Remove excess grout immediately to prevent staining of brick.
 2. Tool joints to a [slightly concave] [grapevine] [V-]shape when pointing grout is thumbprint hard.
- D. Clean faces and joints of brick facing.

2.13 FABRICATION:

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
- B. Furnish loose steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast architectural concrete units to supporting and

adjacent construction.

- C. Cast-in reglets, slots, holes, and other accessories in precast architectural concrete units to receive windows, cramps, dowels, reglets, waterstops, flashings, and other similar work as indicated.
- D. Cast-in openings larger than 10 inches in any dimension.
- E. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" and PCI MNL 117 for fabricating, placing, and supporting reinforcement.
 - 1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
 - 2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
 - 3. Place reinforcement to maintain at least 3/4-inch minimum coverage. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
 - 4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Reinforce precast architectural concrete units to resist handling, transportation, and erection stresses.
- G. Prestress tendons for precast architectural concrete units by either pretensioning or posttensioning methods. Comply with PCI MNL 117.
 - 1. Delay detensioning or posttensioning of precast, prestressed architectural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under the same conditions as concrete.
- H. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.
- I. Place face mix to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover.
- J. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units. Comply with requirements in PCI MNL 117 for measuring, mixing, transporting, and placing concrete.
 - 1. Place backup concrete to ensure bond with face mix concrete.
- K. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with PCI MNL 117.
- L. Comply with ACI 306.1 procedures for cold-weather concrete placement.
- M. Comply with ACI 305R recommendations for hot-weather concrete placement.
- N. Identify pickup points of precast architectural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or

permanently mark casting date on each precast architectural concrete unit on a surface that will not show in finished structure.

- O. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.
- P. Discard precast architectural concrete units that are warped, cracked, broken, spalled, stained, or otherwise defective unless repairs are approved by the Engineer.

2.14 FABRICATION TOLERANCES:

- A. Fabricate precast architectural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with the following product tolerances:
 - 1. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:
 - a. 10 feet or under, plus or minus 1/8 inch.
 - b. 10 to 20 feet, plus 1/8 inch, minus 3/16 inch.
 - c. 20 to 40 feet, plus or minus 1/4 inch.
 - d. Each additional 10 feet, plus or minus 1/16 inch.
 - 2. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:
 - a. 10 feet or under, plus or minus 1/4 inch.
 - b. 10 to 20 feet, plus 1/4 inch, minus 3/8 inch.
 - c. 20 to 40 feet, plus or minus 3/8 inch.
 - d. Each additional 10 feet, plus or minus 1/8 inch.
 - 3. Total Thickness or Flange Thickness: Plus 1/4 inch, minus 1/8 inch.
 - 4. Rib Thickness: Plus or minus 1/8 inch.
 - 5. Rib to Edge of Flange: Plus or minus 1/8 inch.
 - 6. Distance between Ribs: Plus or minus 1/8 inch
 - 7. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches or 1/2 inch total, whichever is greater.
 - 8. Length and Width of Block-outs and Openings within One Unit: Plus or minus 1/4 inch.
 - 9. Location and Dimension of Block-outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or minus 3/4 inch.
 - 10. Dimensions of Haunches: Plus or minus 1/4 inch.
 - 11. Haunch Bearing Surface Deviation from Specified Plane: Plus or minus 1/8 inch.
 - 12. Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or minus 1/4 inch.
 - 13. Bowing: Plus or minus L/360, maximum 1 inch.
 - 14. Local Smoothness: 1/4 inch per 10 feet.
 - 15. Variation between Adjacent Thin-Brick-Facing Products: 1/16 inch.
 - 16. Warping: 1/16 inch per 12 inches of distance from the nearest adjacent corner.
 - 17. Tipping and Flushness of Plates: Plus or minus 1/4 inch.
 - 18. Dimensions of Architectural Features and Rustications: Plus or minus 1/8 inch.
- B. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.
 - 1. Weld Plates: Plus or minus 1 inch.
 - 2. Inserts: Plus or minus 1/2 inch.

3. Handling Devices: Plus or minus 3 inches
4. Reinforcing Steel and Welded Wire Fabric: Plus or minus 1/4 inch where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch.
5. Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch of plan dimensions.
6. Tendons: Plus or minus 1/4 inch, vertical; plus or minus 1 inch, horizontal
7. Location of Rustication Joints: Plus or minus 1/8 inch.
8. Location of Opening within Panel: Plus or minus 1/4 inch.
9. Flashing Reglets: Plus or minus 1/4 inch.
10. Flashing Reglets at Edge of Panel: Plus or minus 1/8 inch.
11. Reglets for Glazing Gaskets: Plus or minus 1/8 inch.
12. Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch.
13. Haunches: Plus or minus 1/4 inch.
14. Allowable Rotation of Plate, Channel Inserts, Electrical Boxes: 2-degree rotation or 1/4 inch maximum over the full dimension of the unit.

2.15 FINISHES:

- A. Finish exposed-face surfaces of precast architectural concrete units to match approved design reference sample and as follows:
 1. Design Reference Sample: <Insert description and identify fabricator and code number of sample.>
 2. PCI and APA's "Architectural Precast Concrete-Color and Texture Selection Guide," of plate numbers indicated.
 3. Smooth-Surface Finish: Provide surfaces free of pockets, sand streaks, and honeycombs, with uniform color and texture.
 4. Textured-Surface Finish: Impart by form liners or inserts to provide surfaces free of pockets, streaks, and honeycombs, with uniform color and texture.
 5. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
 6. Retarded Finish: Use chemical retarding agents applied to concrete forms and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
 7. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
 8. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
 9. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
 10. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
 11. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.
 12. Finish exposed [top] [bottom] [and back] surfaces of precast architectural concrete units to match face-surface finish.
- B. Finish exposed [top] [bottom] [and back] surfaces of precast architectural concrete units by smooth, steel-trowel finish.
- C. Finish unexposed surfaces of precast architectural concrete units by float finish.

2.16 SOURCE QUALITY CONTROL:

- A. The Authority will employ an independent testing agency to evaluate precast architectural concrete fabricator's quality-control and testing methods.
 - 1. Allow the Authority's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with the Authority's testing agency and provide samples of materials and concrete mixes as may be requested for additional testing and evaluation.
- B. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements.
- C. Strength of precast concrete units will be considered deficient if units fail to comply with ACI 318 requirements.
- D. Testing: If there is evidence that the strength of precast concrete units may be deficient or may not comply with ACI 318 requirements, the Authority will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.
 - 1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by the Engineer.
 - 2. Cores will be tested in an air-dry condition.
 - 3. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is equal to at least 85 percent of the 28-day design compressive strength and no single core is less than 75 percent of the 28-day design compressive strength.
 - 4. Test results will be made in writing on the same day that tests are performed, with copies to the Engineer, Contractor, and precast concrete fabricator. Test reports will include the following:
 - a. Project identification name and number.
 - b. Date when tests were performed.
 - c. Name of precast concrete fabricator.
 - d. Name of concrete testing agency.
 - e. Identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
- E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mix that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- F. Defective Work: Precast architectural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Do not install precast concrete units until supporting concrete has attained minimum design compressive strength.

3.02 INSTALLATION

- A. Install clips, hangers, and other accessories required for connecting precast architectural concrete units to supporting members and backup materials.
- B. Install precast architectural concrete. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently connected.
 - 1. Install bearing pads as precast concrete units are being erected.
 - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 - 3. Remove projecting hoisting devices and use sand-cement grout to fill voids within recessed hoisting devices flush with surface of concrete.
- C. Anchor precast architectural concrete units in position by bolting, welding, grouting, or as otherwise indicated. Remove temporary shims, wedges, and spacers as soon as possible after anchoring and grouting are completed.
- D. Welding: Perform welding in compliance with AWS D1.1 and AWS D1.4, with qualified welders.
 - 1. Protect precast architectural concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
 - 2. Repair damaged steel surfaces by cleaning and applying a coat of galvanizing repair paint to galvanized surfaces.
 - 3. Repair damaged steel surfaces by cleaning and repriming damaged painted surfaces.
- E. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.
- F. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

3.03 ERECTION TOLERANCES:

- A. Install precast architectural concrete units level, plumb, square, and true, without exceeding the following noncumulative erection tolerance
 - 1. Plan Location from Building Grid Datum: Plus or minus 1/2 inch.
 - 2. Plan Location from Centerline of Steel: Plus or minus 1/2 inch.
 - 3. Top Elevation from Nominal Top Elevation: As follows:
 - a. Exposed Individual Panel: Plus or minus 1/4 inch.
 - b. Nonexposed Individual Panel: Plus or minus 1/2 inch.
 - c. Exposed Panel Relative to Adjacent Panel: 1/4 inch.
 - d. Nonexposed Panel Relative to Adjacent Panel: 1/2 inch.
 - 4. Support Elevation from Nominal Support Elevation: As follows:

- a. Maximum Low: 1/2 inch.
- b. Maximum High: 1/4 inch.
- 5. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet: 1 inch.
- 6. Plumb in Any 10 Feet of Element Height: 1/4 inch.
- 7. Maximum Jog in Alignment of Matching Edges: 1/4 inch.
- 8. Joint Width (Governs over Joint Taper): Plus or minus 1/4 inch.
- 9. Maximum Joint Taper: 3/8 inch.
- 10. Joint Taper in 10 Feet: 1/4 inch.
- 11. Maximum Jog in Alignment of Matching Faces: 1/4 inch.
- 12. Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 1/4 inch.

3.04 FIELD QUALITY CONTROL:

- A. Testing: The Authority will engage a qualified independent testing and inspecting agency to perform field tests and inspections
- B. Field welds and connections using high-strength bolts will be subject to tests and inspections.
- C. Testing agency will report test results promptly and in writing to Contractor and the Engineer.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 REPAIRS:

- A. Repair exposed exterior surfaces of precast architectural concrete units to match color, texture, and uniformity of surrounding precast architectural concrete if permitted by the Engineer.
- B. Remove and replace damaged precast architectural concrete units if repairs do not comply with requirements.

3.06 CLEANING:

- A. Clean exposed surfaces of precast concrete units after erection to remove weld marks, other markings, dirt, and stains.
 - 1. Wash and rinse according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

END OF SECTION

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SECTION 04050

MORTAR, GROUT AND MASONRY ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This section specifies furnishing mortar, grout, and accessories for masonry work, including brick masonry, concrete unit masonry, granite and other stone masonry. The installation of such material is specified in the various masonry sections.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Brick masonry: Section 04215.
- B. Concrete unit masonry: Section 04220.
- C. Precast concrete panels: Section 03415.
- D. Seals and sealants: Section 07900.
- E. Flashing and sheetmetal: Section 07600.
- F. Miscellaneous metals: Section 05500.
- G. Concrete formwork: Section 03100.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings:
 - a. Manufacturer's data: Recommendations for use of materials, preparation of substrate, limitations and special instructions for materials necessary to the work.
 - b. Granite: Section 04415.
 - 2. Samples:
 - a. Three of each type of the following products used in the work:
 - 1) Mortars: Cured samples showing color of each type.
 - 2) Accessories: Representative samples of each type.
 - 3) Certification.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM: A36, A82, A153, A276, A666, A775, C114, C144, C150, C207, C270, C476, C665, C780, C881, C1019, D570, D638, D695, D1525, D2000, D2240, F593, F594.
 - 3. FS: HH-I-521.
- B. Source Quality Control:
 - 1. Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to job site in their original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type and class as applicable.
- B. Store products so as to prevent water intrusion, dampness and deterioration. Store loose materials sand and aggregates so as to prevent intrusion of foreign materials.
- C. Handle products so as to prevent breakage of containers and damage to products.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. Do not use materials or aggregates that are covered with frost. Do not mix mortar when the temperature is below that specified for masonry work.
 - 2. Provide protective covering and heat as specified for masonry work.
 - 3. Perform work under environmental conditions consistent with manufacturer's recommendations for materials being used in the work.

PART 2 - PRODUCTS

2.01 MORTAR AND GROUT MATERIALS:

- A. Cement:
 - 1. ASTM C150, Type I, portland cement, packaged in one-cubic-foot waterproof bags.
 - a. For exterior walls, use low alkali cement; maximum 0.60 percent total alkali when tested according to ASTM C114.
 - b. For below grade use type II cement and lime.
 - 2. Cement for brick masonry:
 - a. Factory-prepared, color-blended with nonstaining, inorganic coloring pigment.
 - b. Pigments not to exceed 10 percent of weight of cement.
 - c. Pigment blended in such quantity to produce cured mortar color matching face brick when mixed with hydrated lime and fine aggregate.
- B. Hydrated Lime:
 - 1. ASTM C207, Type S.
 - 2. Uniform color for similar work.
- C. Fine Aggregate: Clean, sharp, masonry sand, ASTM C144. For joints less than 1/4 inch, grade aggregate with 100 percent passing the Number 16 sieve.
- D. Water: Potable.
- E. Pigment: As necessary to produce colored mortar matching color of brick unless otherwise indicated.
- F. Admixtures: Do not add admixtures including air-entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

2.02 MORTAR AND GROUT MIXES:

- A. Mortar Mixes for Brick Masonry: ASTM C270, types as follows:
 - 1. Type S: For exterior loadbearing masonry and for masonry in contact with earth, proportioned by volume as follows:
 - a. Portland cement: One part.
 - b. Hydrated lime: 1/4 to 1/2 part.
 - c. Fine aggregate: Not less than 2-1/2 nor more than three times sum of volumes of cement and lime.
 - d. Pigment: As necessary to produce colored mortar matching color of brick unless otherwise indicated.
 - 2. Type N: For interior non loadbearing masonry, proportioned by volume as specified for Type S, except 1/2 to 1-1/4 parts hydrated lime.
 - 3. Color: As shown or as selected by the Engineer.
- B. Mortar Mixes for Concrete Unit Masonry: As specified for brick masonry, except pigment not required.
- C. Grout: For setting steel lintels and similar items, grouting mortar composed of one-part portland cement and two parts fine aggregate with sufficient lime putty added to obtain quick set.
- D. Preshrunk Mortar: Dry, premixed, ready-to-use formulation.

2.03 ACCESSORIES:

- A. Continuous joint reinforcement:
 - 1. Accessories for Brick and Concrete Unit Masonry:
 - a. Prefabricated continuous-reinforcing tie system fabricated of wire conforming to ASTM A82. Flush-welded cross ties, nine-gauge wire, hot-dip galvanized after fabrication in accordance with ASTM A153, Class B2, 1.50 ounces for side and cross rods.
 - b. Fabricate joint reinforcement in straight lengths of not less than 10 feet of truss design with continuous diagonal cross ties spaced maximum 16 inches o.c.
 - 1) Make width of unit 1-1/2 inches to two inches less than thickness of wall.
 - 2) For multi-wythe wall, provide one side rod for each face shell of masonry more than four inches in width; plus one side rod for each wythe of masonry four inches or less in width.
 - 3) At cavity walls, provide integral drips on cross rods. Where horizontal joints of outer wythe does not align with back-up joints, provide adjustable two-piece tab design to engage the outer wythe by at least 1-1/2 inches.
 - c. Corner reinforcement: Prefabricated, shop-welded corner-L and intersection-T units matching the continuous wall units.
 - d. Spacing: See related work sections.
 - 2. Dovetail anchors:
 - a. Flexible, adjustable or corrugated 1-inch wide dovetail anchors of 12 gauge galvanized steel. Place anchors every 16 inches in height of wall at intersections of masonry walls and concrete, and for masonry furring of concrete. Dovetail slots are specified in Section 03100, by same manufacturer of anchors.
 - 3. Wall plugs:
 - a. Galvanized 26-gauge corrugated metal, approximately three inches long and of standard manufacture, where necessary for attaching other work.

4. Z-type rigid-steel anchors: Steel, ASTM A36, 1/4-inch thick by 1-1/2 inches wide by 28 inches long, galvanized; with one two-inch opposing 90-degree bend at each end.
5. Corrugated-steel anchors: 14 gauge by 1-1/4 inches by 20 inches with one two-inch 90-degree bend, with 18 inches of corrugation.
6. Steel framing anchors: Fabricated of 3/16-inch galvanized wire tie and galvanized flat-steel strap one-inch wide by 22 gauge or 3/4-inch wide by 12 gauge.
7. Weep-hole tubes: 3/8-inch OD, medium density, nonstaining, polyethylene tubes of lengths ensuring complete panel penetration and unobstructed flow. Fire-resistant compressible filler: Inorganic, non-asbestos mineral fiber safing insulation, with foil facing to impede smoke passage; moisture resistant, mildew-proof and vermin-proof, noncorrosive and nondeteriorating; UL-listed; meeting ASTM C665 and FS HH-I-521 Type III, except for identification marking.
8. Control joint gasket: Solid styrene-butadiene-rubber compound per ASTM D2000, 2AA-805, factory extruded into shapes for use with standard sashblock to provide stability to masonry walls at expansion and control joints; minimum shear strength 540 psi, durometer hardness 80 (plus or minus 5) per ASTM D2240. Provide T-shape and X-shape for vertical joints as appropriate, flat shape beneath load-relieving angles.
9. Cavity Drainage System: 1 inch thick by 10 inches high by 5 feet long section of high density polyethylene or nylon mesh designed to allow moisture to flow downward in cavity joint.
10. Masonry Cell Insulation: Molded polystyrene Insulation Units - Rigid, cellular thermal insulation formed by the expansion of polystyrene - resin beads or granules in a closed mold to comply with ASTM 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.

B. Steel lintels: Section 05500.

C. Masonry lintels: Section 04220.

D. Flashing: Section 07600.

PART 3 - EXECUTION

3.01 MIXING OF MORTAR:

- A. Mix mortar materials in an approved clean mechanical mixer for at least three minutes and not more than five minutes with a minimum amount of water to produce workable consistency.
- B. Mortar which has stiffened because of evaporation of water may be retempered by adding water as needed to restore necessary consistency. Use mortar within 2-1/2 hours of initial mixing.
- C. Use an approved method of measuring materials and mortar that will control and accurately maintain specified proportions throughout the work. Shovel measure is prohibited. Measure sand in damp, loose condition.
- D. Apply pre-shrunk mortar in accordance with the manufacturer's instructions.
- E. For alteration and restoration work, tint or modify mix to match mortar of existing masonry.
- F. The Engineer may direct a test of the mortar in accordance with ASTM C780 and a test of the grout for compressive strength per ASTM C1019 to establish compliance with specified requirements.

END OF SECTION

SECTION 04215
BRICK MASONRY

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing brick masonry.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Mortar, grout and masonry accessories: Section 04050.
- B. Miscellaneous metal: Section 05500.
- C. Seals and sealants: Section 07900.
- D. Demolition: Section 02220.
- E. Concrete Unit Masonry: Section 04220.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Samples:
 - 1. Three sets of each type of the following products used in the work:
 - a. Face brick: Assemble each set to show the complete variation and percentage proportion of color, texture and other variable properties of appearance.
 - 1) Size and shape for general use.
 - 2) Special shapes and sizes used in the work.
 - b. Common brick.
 - 2. Brick panels:
 - a. Construct sample masonry panels of exposed brick masonry, of size not less than four feet square by eight inches thick incorporating reinforcement, flashing, face brick and backup units. Construct sample panel on site, with face brick facing same direction as major facade of the work.
 - b. If necessary to produce an acceptable standard of appearance and workmanship, construct additional panels until approved.
 - c. Use types of material, color variation, mortar, bond, thickness and tooling of joints, method of laying and workmanship typical and standard for the installation. Clean sample panel as specified for finished work.
 - d. Maintain panels in good condition and protect from moisture penetration until completion of masonry work and removal is directed.
- B. Certification.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.

2. BIA: Technical Notes on Brick Construction No. 7B.
 3. ASTM: C62, C216.
- B. Source Quality Control:
1. All brick used in the work to be from the same run.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to the job site in good condition.
- B. Keep products dry. Prevent contact with soil.
- C. Handle products so as to prevent chipping and breaking.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
1. The following are prohibited:
 - a. Use of products that are covered with frost.
 - b. Erection of masonry when temperature is below 40F or tending to fall below 40F, unless suitable fireproof protective covering and heat are provided to maintain work and materials above 40F.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General:
1. For alteration and restoration work:
 - a. Provide bricks of same size, type, grade and appearance as existing brick work.
 - b. Brick salvaged under Section 02220 may be used if approved.
- B. Face Brick:
1. ASTM C216, Type FBS, Grade SW, wire-cut.
 2. Size 2-1/4 inches by 3-5/8 inches by 7-5/8 inches.
 3. Color: To match existing
 4. Special shapes: 100-percent solid for the following locations:
 - a. Flat header wall caps.
 - b. End units on rowlock header wall caps.
 - c. Corners of soldier courses.
 - d. Corbels.
 - e. Pierced screen walls.
 - f. Where construction would result in exposed cores.
 - g. Where shown.
- C. Common Brick:
1. ASTM C62, wire-cut; Grade SW.
 2. First quality, hard grade, standard size.
- D. Cleaning Solution:
1. Formulated for cleaning new brick work, containing no acid.

2. Type which will not stain, discolor or otherwise adversely affect surfaces with which it comes into contact.
- E. Asphalt-Coated Copper Flashing: 5-oz./sq/ft. (2-kg/sq/m) copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.
1. Available Products:
 - a. Advanced Building Products Inc.; Cop-R-Cote
 - b. AFCO Products, Inc.; Cop-R-Cote
 - c. Hohmann & Barnard, Inc.; H & B C-Coat Flashing.
 - d. Phoenix Building Products; Type ACC-Asphalt Bituminous Coated.
 - e. Polytite manufacturing Corp.; Coated Copper Flashing.
 - f. Sandell manufacturing Co., Inc.; Coated Copper Flashing.
 - g. York Manufacturing, Inc.; Copperseal.
- F. Accessories: Section 04050.
- G. Steel Lintels and Shelf Angles: Section 05500.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Remove dirt, debris, oil, grease and other foreign matter from surfaces to receive brick masonry.
- B. Built-In Work:
 1. Verify and coordinate locations of chases and openings for pipes, conduit, ducts and locations of flashing and weep holes.
 2. Establish layout lines and verify proper setting of bucks and frames.

3.02 ERECTION:

- A. Construct masonry as recommended in BIA Technical Notes on Brick Construction Number 7B, Water Resistance of Brick Masonry Construction and Workmanship Part III of III.
- B. Erect new masonry to conform to approved sample panels. For alteration and restoration work, match existing masonry.
- C. Erect adjoining walls simultaneously. Do not erect walls more than five feet above adjoining walls. Toothing is prohibited. Cover and protect tops of unfinished walls. Protect cavities from mortar and debris.
- D. Plumb piers and walls. Level brick courses using uniform joint thickness. Use power-driven, masonry saws for cutting material. Build external corners square, unless otherwise shown.
- E. Provide structural and pattern bonding as shown or as specified.
- F. Place reinforcement and build in openings for pipes, conduits, ducts, chases and other work as shown.

- G. Grout and set in place steel lintels furnished by other trades for openings in masonry walls.
- H. Install flashing, reglets and weep holes over lintels and where shown. Lap joints in flashing four inches minimum and bond with mastic. Install through-wall flashing to within ½ inch of inside and outside faces of wall. Set flashing in full bed of mortar and trowel full bed of mortar to ensure complete contact.
- I. Use facing brick for exposed brickwork. Select face brick from various stock piles so that they may be integrated to prevent segregating color ranges and bricks from different runs. Use same color mortar proportions throughout work.
- J. Prior to laying face brick, lay out work so that bond and design are maintained plumb and level and joints are of uniform width throughout the work.
- K. Do not use segments of bricks less than one half in size at corners or at openings. Use same sizes of bricks or same sizes of brick segments in same course at each side of jambs of openings or piers. Where cutting of units is necessary, use motor driven masonry saw.
- L. Thoroughly drench brick with water just before laying. Cover brick uniformly with mortar, shove and press into place, with no voids in wall joints, at window frames or at door frames.
- M. Where dovetail anchors are required, provide anchors vertically at each slot, maximum 16 inches on center and solidly fill in joints against concrete with mortar. Ensure that joints at anchors and bond courses are filled.
- N. Unless otherwise shown, use 3/8-inch concave joints, carefully tooled to form smooth, dense surface. Avoid burrs at intersections and mortar discoloration.
- O. Lay face brick from exterior with bed joints, head joints and collar joints full and level, faces plumb, joints uniform and bonds accurate.
- P. For alteration and restoration work, provide beds, coursing and face joints to match existing brick masonry precisely.
- Q. Place continuous joint reinforcement in courses 16 inches on center as shown. Use specially fabricated sections at corners and intersections.
- R. Provide expansion and control joints in masonry walls as shown. Ensure that joints are straight, uniform and of thickness shown. Ensure that clear joints are free of water, mortar and other obstructions. Leave continuous open joint for caulking and sealing in accordance with Section 07900. Provide cavity drainage system on top of the flashing inside the cavity. Drainage system shall be continuous at cell cavity flashing.
- S. Masonry anchors and accessories: In accordance with Sections 04050 and 04220.
- T. Accessories: Section 04050.
- U. Fill jambs of hollow metal frames solid with grout, as laying of brick progresses.
- V. As the work progresses, clean masonry with stiff brush before mortar sets.
- W. Install steel lintels where shown on Contract Documents or approved shop drawings.

3.03 REPAIRING, POINTING AND CLEANING:

A. Repairing:

1. Remove and replace units that are loose, chipped, broken, stained or otherwise damaged; or if units do not blend properly with adjoining units. Install item units to match adjoining units and in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing:

1. When approved, point holes in joints of exposed brick masonry surfaces by completely filling with preshrunk mortar.
 - a. Pre-wet joint and holes before pointing.
 - b. Tool to match adjacent joints. Protect from premature drying.
2. Correct defective joints by cutting out mortar and solidly refilling with new mortar.
3. Point exposed raked joints of brick masonry with mortar and tool to match approved sample panel.
4. Pre-wet holes and joints before pointing. Protect masonry from premature drying.

C. Cleaning:

1. After pointing, wet exposed brick-masonry surfaces and clean with soap-and-water solution applied with stiff-fiber brushes leaving masonry clean, free of mortar daubs and with tight mortar joints throughout. The use of acid is prohibited.
2. Allow masonry walls to cure at least three weeks in summer and five weeks in winter before final cleaning.
3. Test clean methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain approval of sample cleaning before proceeding with cleaning of masonry.
4. Begin cleaning at top and work down.
 - a. Remove as much mortar from brick as is possible with scrapers or wire brushes; taking care not to discolor mortar or brick.
 - b. Dampen walls thoroughly with water to prevent loose materials from being drawn into pores of dry brick below and to prevent build-up of dry detergents.
5. Clean surfaces thoroughly with specified cleaning solution. Rinse and flush with clean water immediately after cleaning.
6. Leave work in first class condition, free from mortar stain or other defacement.

3.04 CONTROL AND EXPANSIONS JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for inplane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow control in ends of concrete masonry units on one side of control joint. Gill resultant core with grout and rake out joints in exposed faces for application fo sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

- C. Form expansion joints in brick masonry as follows:
1. Build flanges of metal expansion strips into masonry. Lap each joint 1 inch (100mm) in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 3. Build in compressible joint fillers.
 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch (10mm) for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 7 Section "Joint Sealants," but not less than 3/8 inch (10 mm).
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

END OF SECTION

SECTION 04220

CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing concrete unit masonry and glazed concrete masonry.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Mortar, grout and masonry accessories: Section 04050.
- B. Brick masonry: Section 04215.
- C. Miscellaneous metal: Section 05500.
- D. Flashing and sheet metal: Section 07600.
- E. Seals and sealants: Section 07900.
- F. Concrete reinforcement: Section 03200.
- G. Cast-in-place structural concrete: Section 03300.
- H. Structural precast concrete: Section 03400.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Samples for Initial Selection: Samples in small-scale form showing the full range of colors and textures available for each different exposed masonry unit required.
- B. Samples:
 - 1. Three sets of each type of the following products used in the work.
 - a. Concrete masonry units (CMU):
 - 1) Lightweight.
 - 2) Normal weight.
 - 3) Special shapes.
 - 4) Glazed.
 - b. Precast lintels.
 - c. CMU lintels.
 - 2. Concrete masonry panels:
 - a. Construct sample panels for exposed work only. Build panels not less than four feet square by eight inches thick, incorporating reinforcement and concrete masonry units. See Section 04215 for brick panels. Construct one panel of concrete glazed and unglazed masonry units.
 - b. Use types of material, color variation, mortar, bond, tooling of joints, method of laying and workmanship shown or specified.
 - c. Maintain panels in good condition and protect from moisture penetration until completion of masonry work and removal is directed.
 - d. Approval of mock ups is for color, texture and blending of masonry unit; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - e. Maintain panel in good condition and protect from moisture penetration until completion of masonry work. Panel may remain as part of finished work after approval.

- C. Shop Drawings: Show fabrication and installation details for the following:
 - 1. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
- D. Certification.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NCMA: TEK Manual for Concrete Masonry Design and Construction.
 - 3. ASTM: A615, C33, C55, C90, C129, C150, C744, E119.
 - 4. ACI: 315, 530.1-99.
 - 5. UL: Fire Resistance Directory.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- C. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to jobsite in good condition.
- B. Keep products clean and dry. Prevent contact with soil.
- C. Handle products so as to prevent chipping and breakage.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. The following are prohibited:
 - a. Use of products that are covered with frost.
 - b. Erection of masonry when the temperature is below 40F or tending to fall below 40F, unless suitable fireproof protection covering and heat are provided to maintain work and materials above 40F.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. CMU:
 - 1. General:
 - a. Nominal dimensions:
 - 1) Face size: 7-5/8 inches by 15-5/8 inches.
 - 2) Thickness: As shown.
 - b. For exposed work, units of uniform medium texture, free from defects and of uniform dimensions. Furnish special units as necessary.
 - c. Units having UL Fire Resistance Directory ratings to achieve fire ratings for walls as required by local building codes and as shown.

- d. Units free from iron and other substances that will stain plaster or paint.
 - 2. Lightweight CMU:
 - a. Hollow, lightweight loadbearing concrete units: ASTM C90, Type I.
 - b. Solid, lightweight loadbearing concrete units: ASTM C90, Type I.
 - c. Lightweight concrete brick: ASTM C55, Type I, Grade N.
 - d. Aggregate: Limited to expanded shale or slate.
 - e. Hollow, light-weight non-load bearing concrete units: ASTM C129, Type 1
 - 3. Normal-weight CMU:
 - a. Solid loadbearing units: ASTM C90, Type I.
 - b. Exposed alteration and restoration work: Units of same type, grade, size, color variation, texture and appearance as existing masonry work.
 - 4. Concrete fill for CMU bond beams and reinforced masonry unit cores: Class 3500; maximum aggregate size, 3/4 inch, and in accordance with Section 03300.
- B. Glazed CMU:
- 1. Prefaced or glazed concrete masonry units shall conform to the requirements specified above for C90 concrete masonry units, and the facing to the following requirements:
 - a. Glazing (Facing): ASTM C744.
- C. Lintels:
- 1. General:
 - a. Provide lintels of same height and width, texture and density as CMU and 16 inches longer than width of opening, free of cracks and chipped and broken edges.
 - b. Concrete:
 - 1) Portland cement in accordance with Section 03300: ASTM C150, Type I.
 - 2) Reinforcing steel bars in accordance with Section 03200: ASTM A615, Grade 60.
 - 3) Aggregate: ASTM C33, graded from 1/8 inch to 3/8 inch.
 - 2. Precast lintels: Class 3500 concrete in accordance with Section 03400, reinforced full length with No. 5 reinforcing bars in accordance with Section 03200, one at top and one at bottom for each four inches nominal width, and No. 2 ties at eight inches on center at each end, unless otherwise shown.
 - a. CMU lintels:
 - b. Lightweight loadbearing lintel-type CMU complying with specified requirements.
 - c. Filled with Class-3000 concrete minimum in accordance with Section 03300 and reinforced in accordance with Section 03200 for width and span as specified for precast lintels, unless otherwise shown.
 - 3. Steel Lintels: Section 05500.
- D. Masonry Accessories: Section 04050.
- E. Cleaning Solution: Section 04215.
- F. Mortar and Grout: Sections 04050 and 03300.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Clean foreign substances which would affect bond of mortar from surfaces to receive CMU.

- B. Built-In Work.
 - 1. Verify locations of chases and openings for pipes, conduits and ducts.
 - 2. Establish locations for walls and partitions; verify that door frames and other built-in work provided by others are or can be properly located.

3.02 ERECTION:

- A. Erect exposed CMU masonry work to conform to approved sample panel.
- B. Use of loadbearing and non-loadbearing units shall be governed by locations and purposes to be served. Except as otherwise shown, follow these general uses:
 - 1. Loadbearing: Backup loadbearing masonry walls and for bearing partitions.
 - 2. Non-loadbearing: Furring, non-bearing partitions and backup non-loadbearing masonry walls.
 - 3. Solid: Where specifically required by drawings, for fireproofing structural steel and for partitions with fire ratings.
- C. Erect adjoining walls simultaneously. Do not erect walls more than five feet above adjoining walls. Tothing is prohibited. Cover and protect the tops of unfinished walls.
- D. Plumb piers, walls and partitions. Level courses using uniform joint thickness for interior work, build external corners with bullnose units.
- E. Place reinforcement and build in openings for pipes, conduits, ducts, chases, frames and other work as shown.
- F. Grout in accordance with Sections 04050 and 03300 and set in place miscellaneous steel lintels furnished by other trades for openings in masonry walls in accordance with Section 05500. Provide eight-inch minimum bearing on adjacent masonry unless otherwise indicated.
- G. As the work progresses, keep masonry clean by stiff brushing with fiber brush. Do not wet units before laying up. Unless otherwise shown, lay units in running bond.
 - 1. Set cored units with cells vertical, unless manufactured with horizontal cores. Open ends not permitted.
 - 2. Lay out so that at jambs and internal and external angles, the headers in alternate courses are at least 2 inches long. Use "Z shapes if necessary , especially with glazed masonry units.
 - 3. Lay units out so that no cut piece is less than 5 inches long; not less that 2 inches high
 - 4. Lay concrete units up suitable for painting. See finish schedules.
- H. Prevent smearing mortar on surface of exposed units. If mortar smears occur, remove while soft.
- I. Carefully cut faces of units for electrical or other outlets and cut-out backs for conduit and other piping. Where possible, use full-size units. Do not use portions of units shorter than four inches. Perform cutting with power-driven masonry saws.
- J. Build partitions straight, plumb, true to line and uniform in thickness unless shown otherwise. Anchor partitions at junctions with CMU exterior walls using Z-type steel anchors, rigid or corrugated, Z-bar anchors vertically 24 inches on center maximum unless otherwise shown. Use dovetail anchors spaced not over 16 inches on vertical centers where partitions abut concrete walls or concrete columns and steel framing anchors where partitions abut steel

columns. Start partitions on concrete slabs and extend to structure above, except where shown to be erected only to ceiling.

- K. Use CMU or precast lintels except where steel lintels are shown. Use precast lintels for four-inch CMU partitions. For other CMU partitions and walls, use lintels fabricated at plant or at jobsite from concrete-masonry lintel units. Provide eight-inch minimum bearing on adjacent masonry unless otherwise indicated.
- L. Fill cells of CMU with mortar in accordance with Section 04050, adjacent to openings and around built-in and embedded items.
- M. Place prefabricated continuous joint reinforcement in alternate horizontal joints above grade and each horizontal joint below grade. Terminate each side of expansion joints. Use specially fabricated sections at corners and intersections.
- N. Fill cells solid with grout in accordance with Sections 04050 and 03300 where vertical reinforcement is installed within CMU walls.
- O. Fill heads and jambs of hollow metal frames solid with mortar in accordance with Section 04050, as laying of units progresses.
- P. Tooling joints:
 - 1. After mortar has attained initial set, finish and compact with non-staining metal jointing tool, forcing mortar tight against masonry units and closing all hair line cracks and crevices.
 - 2. All interior and exterior joints tooled concave type, except as stated below or noted otherwise.
 - a. At wall faces to receive other facing materials having mortar backing, strike joints flush.
 - b. At concealed joints and joints on cavity side of cavity walls, strike flush.
- Q. Mortar Bedding in accordance with Section 04050:
 - 1. Hollow units shall be laid with full mortar coverage on horizontal and vertical face shells, except that webs shall also be bedded in all courses of piers, columns, and pilasters, and in the starting course of footings and solid foundation walls, and where adjacent to cells or cavities to be reinforced and/or filled with mortar or grout.
 - 2. Solid units laid with full head and bed joints.
 - 3. Masonry units:
 - a. Laid in beds of mortar of such plasticity and fullness and spread with trowel so that pressing and shoving units will obviate dashing or slushing joints after units are laid. Mortar shall not be "furrowed".
 - b. In cavity walls, mortar shall be beveled on cavity side to prevent protruding mortar fins and subsequent dropping of mortar into cavity.
 - c. For interior and exterior faces of walls, prior to placing units, one end of each stretcher shall be fully covered with mortar.
 - d. For any wall thickness, leave no voids whatever, except space in cavity walls.
- R. Top of Non-Loadbearing Partitions: Build non-loadbearing interior partitions full height of story to underside of solid floor or roof structure above, unless shown otherwise. Build as follows depending on the movement requirements of floor or structure above, and as shown:
 - 1. Install fire resistant compressible filler in joint between top of partition and underside of structure above.
 - 2. Fill top joint with mortar in accordance with Section 04050, after dead-load deflection of structure above approaches final position.

- S. Installation of Masonry Accessories:
1. Wall anchors:
 - a. Space Z-type rigid-steel anchors at intersections of loadbearing CMU walls and control joints.
 - b. Space corrugated-steel anchors 16 inches on centers vertically at control joints located not more than two feet from intersections of CMU walls.
 2. Steel framing anchors: Install anchors to attach CMU walls to structural steel building frame at 16 inches on centers horizontally and vertically. Weld anchors to structural steel so as to achieve full strength of anchor system.
 3. Soldier-course anchors: Install corrugated-steel anchors in horizontal mortar joints of soldier coursing, except where continuous wall reinforcement is used. Space anchors 24 inches on centers horizontally.
 4. Flashing: Install flashing to provide positive keying to mortar.
 5. Weep holes: Install at two feet on centers at terminations of through-wall flashing, base flashings, lintels, or relief angles, and as shown.
 6. Control joint gasket: Install in sash-type CMU and between wythes in accordance with manufacturer's instructions and as shown. Seal weather side of control joints with sealant and backup rod as specified in Section 07900.
- T. Bond Beams:
1. Provide bond beams in walls where shown.
 2. Construct similar to CMU lintels, except beams to be continuous, except at control joints.

3.03 POINTING AND CLEANING:

- A. Pointing:
1. When approved, point holes in joints of exposed CMU masonry surfaces by completely filling with preshrunk mortar.
 2. Point exposed raked joints of CMU masonry with mortar and tool to match approved samples panels.
- B. Cleaning:
1. After pointing, wet and clean exposed CMU masonry surfaces with soap-and-water solution, applied with stiff-fiber brushes leaving masonry clean, free of mortar daubs and with tight mortar joints throughout. The use of acid is prohibited.
 2. Allow masonry walls to cure at least three weeks in summer and five weeks in winter before cleaning.
 3. Begin cleaning at top and work down.
 4. Remove as much mortar from masonry as is possible by hand with wooden paddles and nonmetallic scraper hoes or chisels or stiff bristle brushes taking care not to deface masonry units.
 5. Remove specific stains by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain present on exposed surfaces.
 6. Clean surfaces thoroughly and carefully with specified cleaning solution.
 7. Rinse and flush with clean water immediately after cleaning.
 8. Leave work in clean condition, free from mortar stain or other defacement.

END OF SECTION

SECTION 05091

RAIL WELDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. The work specified in this section shall include the fabrication of continuous welded rail (CWR) strings by electric flash-butt welding, including testing, inspection, and qualification of welding and welders.
- B. The work specified in this section shall also include movement of rail from the manufacturer to the Design-Builder's welding plant, from the welding plant to the welded string storage location and from the storage location to the final placement in track location.

1.02 RELATED SECTIONS

Section 05651- General Track Construction
Section 05652 - Ballasted Track Construction
Section 05656 - Running Rail

1.03 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering, Vol. I, Chapter 4, Specification for Fabrication of Continuous Welded Rail
- B. ASTM E18
- C. ASTM E109
- D. ASTM E142
- E. ASTM E164
- F. ASTM E709
- G. AWS D1.1
- H. USNRC Rules and Regulations, Title 10, Atomic Energy, Part 20.
- I. ASNT SNT-TC-1A Recommended Guidelines for Qualification and Certification of Non-Destructive Testing Personnel.

1.04 SUBMITTALS

- A. The Design-Builder shall submit procedures and documentation in accordance with the Section 01330 and as follows.
- B. Approval of the following items shall be obtained prior to production welding
 - 1. Identification of welding plant with internal shear and major items of equipment to be used.
 - 2. Standards of welding machine performance as recommended by the manufacturer.

3. Oscillograph record of each qualification weld showing number and duration of preheat impulses, flashing time, upset current time, platen travel during flashing, and platen travel distance for upset cycle.
 4. Report of test results of each qualification weld.
 5. Schedule showing string number, length, proposed stockpile location and installation location.
- C. Production weld approval shall be based on these items:
1. Oscillograph records of production welds.
 2. Production welding record.
- D. Deliver five each taper gauges graduated in hundredths of an inch, with cases, to the Authority Representative. Taper gauges shall become Authority property.
- E. Deliver four each 36 inch steel straight edges, as manufactured by L. S. Starrett Company of Athol, Massachusetts, or approved equal, to the Authority Representative. Straight edges shall become Authority property.

1.05 QUALITY ASSURANCE

Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.

- A. The Design-Builder shall inspect rail for straightness at the manufacturer's plant.
- B. Plant Qualification
- C. General
1. Using the welding plant, personnel and procedures proposed for production welding, make six qualification welds, three for each type of rail.
 2. The qualification welds shall be made in the presence of the Authority Representative.
 3. Weld tests shall provide sufficient detail to establish capability of the welding apparatus and procedures to meet specified welding requirements with the rail supplied.
- D. Qualification Weld Testing - The six qualification welds shall be tested by radiography, hardness testing, metallurgical testing and ultrasonic testing in the following manner:
1. Radiography:
 - a. Radiography shall be conducted in accordance with ASTM E142 using short wave length radiation. The use of nuclear by products for radiography shall be in accordance with USNRC Rules and Regulations, Title 10, Atomic Energy, Part 20. The transportation, handling and storage of hazardous materials used in the examination of welds shall be performed only by or under the supervision of a person of proven experience and ability, operating under a proper license.
 - b. Film shall be capable of producing sharp images, and be free of processing and mechanical defects. High speed, coarse-grained film is prohibited. Fine films shall be used covering head, web and each side of base as shown on **Exhibit 05091-A**. Identify each film by contract number, rail identification, date of test, name of testing agency and the view.

- c. Acceptance of the weld shall be based on the weld having full penetration, complete fusion and being free of flaws. A letter shall accompany each film plate bearing information given on the film, certifying compliance with ASTM E142 and stating whether or not the weld satisfies specified requirements.
 - d. Radiograph plates shall be compared to ultrasonic scans to determine the ability of ultrasonic equipment to identify inclusions or other weld defects. If necessary, compare radiograph plates with ultrasonic scans using the ultrasonic reference blocks. Results of this comparison shall be made in a separate report and include recommended ultrasonic equipment to be used and sensitivity requirements.
2. Hardness testing:
- a. Hardness testing shall be in accordance with current AREMA "Specification for Fabrication of Continuous Welded Rail" and "Specification for the Quality Assurance of Electric Flash-butt Welding of Rail."
 - b. The hardness test shall be performed in accordance with ASTM E18, using a 150kgf diamond sphere conical penetrator. Hardness and location shall be recorded.
3. Metallurgical Tests:
- a. A one foot specimen of each weld shall be sectioned longitudinally through the centerline of the rail. Each specimen shall be etched to enable observation of the hardness pattern, metallurgical properties and the heat affected zone.
 - b. An acceptable weld as determined by the metallurgical test shall meet the following criteria:
 - 1) Steel shall consist of fine-grained pearlite structure with small interlamellar spacing.
 - 2) The hardness pattern in the etched section shall have a uniform distribution.
 - 3) The heat affected zone shall be parallel and fully extended on both sides of the weld.
 - 4) The weld joint shall be planar.
 - 5) Uniform zone of plastic deformation resulting from upset operation shall extend equally on both sides of the weld point.
 - c. An 8x10 black and white photograph and a description of the metallurgical properties including grain structure and distribution shall be submitted.
4. Ultrasonic test, slow bend test and magnetic particle test in accordance with the AREMA Manual.
5. All test samples are to be permanently marked for identification and returned to the Authority Representative at the completion of testing.

1.06 DELIVERY, STORAGE AND HANDLING

- A. It shall be the Design-Builder's responsibility to make all arrangements for shipment and handling of the rail. The Design-Builder shall:
 - 1. Coordinate unwelded rail stick movement from the manufacturer's plant to the welding site by rail and truck as necessary.
 - 2. Obtain any required permits from state, regional or local jurisdictions.
 - 3. Make arrangements for loading, unloading and stacking rail sticks.
- B. Handle and store rail so that it is not damaged either before or after welding.
 - 1. Stacking of sticks shall be as approved by the Authority Representative and layers shall be separated by wood lathing.
 - 2. Rail shall be handled in a manner that prevents damage to fasteners, rail and structures.

3. Rail shall not be dropped or dragged on the trackbed. The use of rollers is required.

PART 2 - PRODUCTS

2.01 RAIL FOR CONTINUOUS WELDED RAIL

Rail for the Work shall be furnished by the Design-Builder in accordance with the Standard Specification Section 05656, Running Rail.

PART 3 - EXECUTION

3.01 PREPARATION FOR WELDING

- A. The welding plant may be set up on Authority property as approved by the Authority Representative.
- B. Rail welding shall be in accordance with the current AREMA Manual "Specification for Fabrication of Continuous Welded Rail", "Specification for the Quality Assurance of Electric Flash-butt Welding of Rail" and as specified herein.
- C. Rail for installation in this Contract shall be welded in accordance with a string schedule approved by the Authority Representative. Strings shall be designed in order to minimize field connections and to the maximum length practical for fabrication and handling. The schedule shall show the following for each string.
 1. The string designation.
 2. The track name where the string will be placed.
 3. The begin and end track station where the string will be located.
 4. Whether the string will be in the left or right rail when facing up station.
 5. The rail type in the string or for each portion of a string.
 6. Where there is more than one rail type in a string, the track station where rail types join in a string.
 7. The end of the string where welding will begin.The track names and stationing systems shown on the Track Alignment Plan and Profile drawings shall be used in the string schedule.
- D. The string designation shall be a unique code identification for each string that indicates
 1. The track
 2. Left or right rail
 3. A consecutive sequential number or letter system that increases with increasing track station.
- E. Rails shall be welded using an electric flash butt welding plant equivalent to the Chessie System plant at Russell, KY or Amtrak Plant at New Haven, CT. An equivalent portable plant may be set up within the contract area.
- F. Rails shall be stacked and fed into the welder so that when the resulting rail string is stored and subsequently placed in track, rail brands for both rails will face to the right when looking up stationing.
- G. Rail Inspection Prior to Welding
 1. Inspect each rail end prior to welding for deviations from lateral line in either direction and for upsweep, downsweep or droop.

2. Rail with upsweep, downsweep or droop and rail failing to comply with the tolerances shown on **Exhibit 05091-B** shall be cut back a sufficient distance to achieve the required alignment. Rails shall be cut clean and within 1/32 inch of square by means of rail saws or abrasive cutting discs.
 3. Torch cutting of rail is prohibited. Cutting shall be done at no additional cost to the Authority.
- H. Rail End Preparation for Welding: Immediately prior to welding, all rail ends shall be wire brushed to remove mill scale or other dirt which might hinder the flow of electric current.
- I. Alignment in Weld Machine:
1. Alignment of the rail in the welding machine shall be done on the head of the rail.
 2. Vertical alignment shall provide for a flat running surface within 0.01 inch between the abutting rail ends.
 3. Horizontal alignment shall distribute head width differences evenly between each side of the head. No horizontal offset shall exceed 0.03 inch on either side of the head. No horizontal offset shall exceed 0.10 inch on either side of the base of the rail.

3.02 WELDING OF RAILS

- A. All welding procedures shall be approved prior to use and as a minimum shall be in accordance with the following:
1. Forge welds to point of no further plastic deformation with upset of 5/8 inch minimum.
 2. Each weld to achieve full penetration, complete fusion, and be free of flaws and inclusions.
- B. Record welding machine performance with an oscillograph recorder or computer printout.
1. Record platen movement and current impulses.
 2. The oscillograph record shall be compared with the approved procedure record from the qualification welds. If the record indicates performance which is not in conformance with the approved procedure, the weld will be rejected.
 3. The recorder shall be calibrated each day.
- C. If flashing is interrupted with less than 1/2 inch of flashing distance remaining before upsetting, the rails shall be reclamped and flashing initiated again.
- D. Grinding shall be done immediately following welding at an elevated temperature.
- E. Welds shall be ground to meet the following finishing tolerances:
1. A finished deviation of not more than plus or minus 0.005 inch of the parent section of the rail head shall be allowed.
 2. The weld at the top and sides of the rail head shall be finished to plus or minus 0.010 inch of the parent section.
 3. The bottom and sides of rail base shall be finished to within plus or minus 0.010 inch of the parent section.
 4. The web zone, underside of head, web, top of base, both fillet each side, shall be finished to within 1/8 inch of parent contour or closer but shall not be deeper than parent section.
 5. Finishing shall eliminate all cracks visible to the unaided eye.
 6. All notches created by offset conditions or twisted rails shall be eliminated by grinding to blend the variations on both sides of the head and base for a distance of 18 inches.
 7. All fins on the weld due to grinding and/or shear drag shall be removed prior to final inspection.

3.03 WELD QUALITY

- A. Inspection of Welds: Each weld shall be examined by the magnetic particles method, ultrasonic examination method and by the visual method as follows:
1. Magnetic Particle Examination:
 - a. Magnetic particle inspection shall be performed using the dry powder method in accordance with ASTM E709, with the rail at a temperature of less than 800 deg. F.
 - b. To be acceptable the particles shall form a regular longitudinal pattern indicating homogeneity of the weld and freedom from defects, surface irregularities and internal discontinuities.
 2. Ultrasonic Examination:
 - a. Ultrasonic examination shall be performed by an independent testing agency under contract to the Authority who will perform ultrasonic examination to the following standards:
 - b. Subsequent to the magnetic particle inspection, all welds will be ultrasonically inspected in accordance with ASTM E164.
 - c. Ultrasonic test equipment will be capable of detecting a 3/64 inch discontinuity, 6-1/2 inches below the top rail. The sensitivity and resolutions of the proposed equipment shall use appropriate area amplitude and distance amplitude reference blocks made of material similar to the rail steels being tested.
 - d. All equipment will be equipped with a distance amplitude correction feature. The equipment will be calibrated daily using an 11W calibration block made of rail steel.
 - e. All welds giving fault indication in ultrasonic testing shall be cut out and the rails rewelded according to these specifications.
 - f. The Design-Builder shall provide a weather resistant enclosure with adequate ventilation and light for ultrasonic inspection.
 3. Visual Inspection for Final Alignment of Finished Welds:
 - a. The combined vertical offset and crown camber at ambient temperature shall not exceed 0.060 inches as shown on **Exhibit 05091-C, Fig. 1.**
 - b. No dip camber shall be allowed as shown on **Exhibit 05091-C, Fig. 2.**
 - c. Combined horizontal offer and horizontal kink camber at ambient temperature shall not exceed 0.060 inches as shown on **Exhibit 05091-C, Fig. 3.**
 - d. Welds shall be free of cracks, fins, and sharp edges.
- B. Correction of Defective Welds: Each production weld failing to meet all acceptance criteria will be considered defective. This shall include welds considered defective by the Authority contracted Ultrasonic Inspector.
1. Defective welds shall be cut out by means of rail saw or abrasive disc.
 2. Use extra initial flash to burn off cut surface, reclamp, and reweld.
 3. Rewelds shall be inspected as specified for initial welds.
- C. Submit Production Welding Records to the Authority Representative at the end of each days production.
1. Oscillograph record of each weld and reweld.
 2. Production welding record in accordance with **Exhibit 05091-D and 05091-E.**
- D. Marking of Rail Strings:
1. Mark each end and on both sides of the rail web every 100 feet of each rail string with a paint suitable for application to steel and which is weather resistant for a period of two years.
 2. High strength rail shall be marked with orange paint.
 3. Standard rail shall be marked with white paint.

4. Each string shall be marked on both ends with its string designation code and the respective beginning and ending station shown on the string schedule.
 - a. When two or more strings are welded into one longer string, then, where the ends of two strings join, the strings shall be marked with their string designation codes and the respective beginning and ending station shown on the string schedule.
5. The end of the string where welding began shall be marked to show that is the end where welding began. The welding shall begin on the end shown on the string schedule. The string designation code and the beginning of welding mark shall be coordinated to permit correlation of each weld with the Production Welding Record.

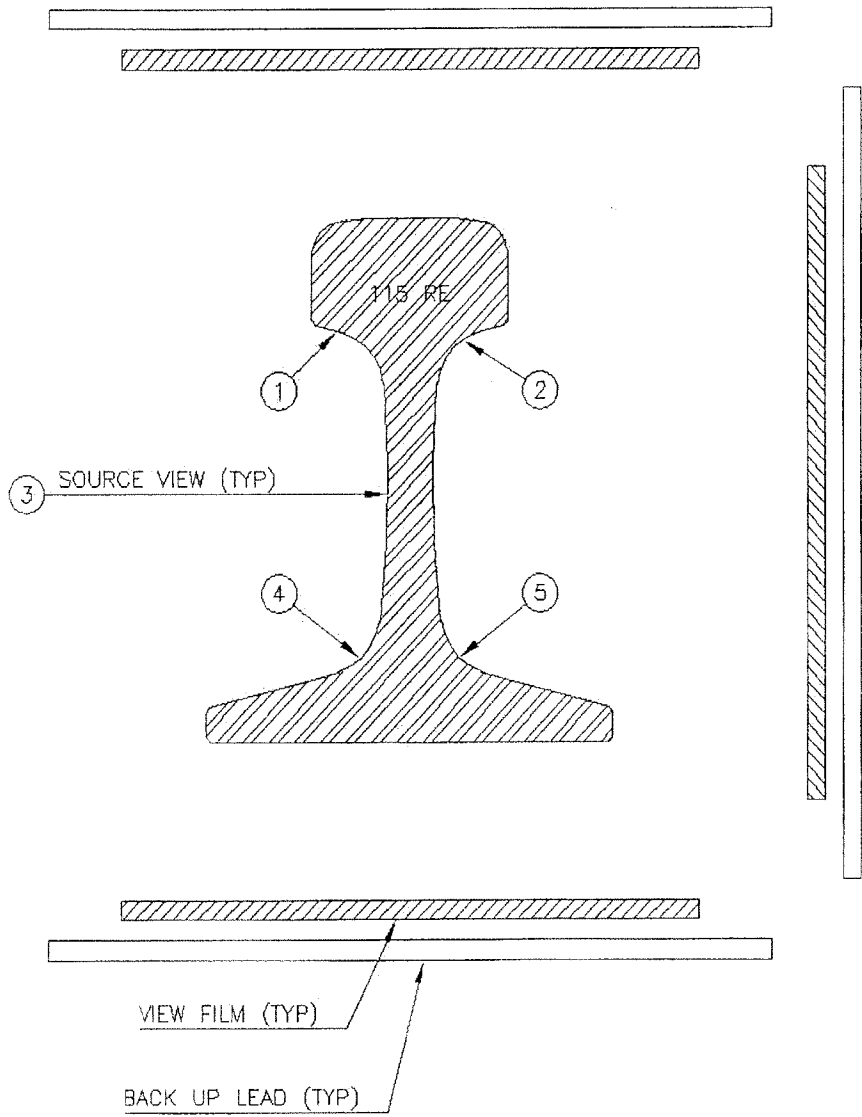
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

No separate measurement of work specified in this Section will be made.

4.02 PAYMENT

Compensation for work specified in this Section will be included in the price of the work of which it is a part.



WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DE LEUW, CATHER & COMPANY
SECTION DESIGNER

RADIOGRAPHY SHOOTING SKETCH
EXHIBIT 05091-A

SCALE: NONE

DATE: JANUARY 2001

05091-8

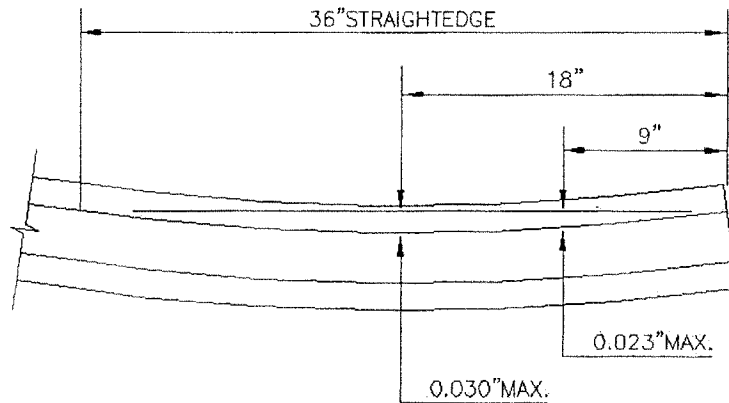


FIGURE 1
TOP VIEW OF RAIL
LATERAL (HORIZONTAL) LINE
TOLERANCE AT RAIL ENDS

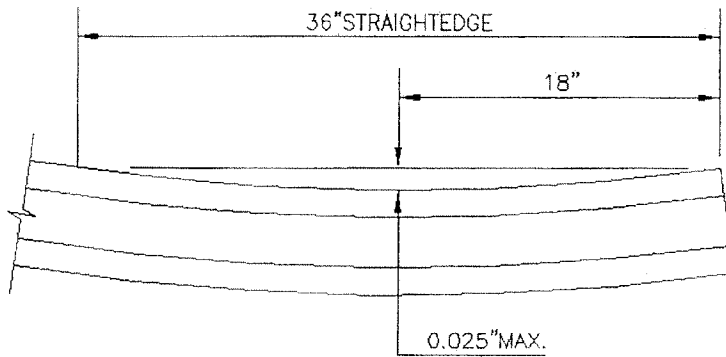


FIGURE 2
SIDE ELEVATION OF RAIL
UNIFORM UPSWEEP
TOLERANCE AT RAIL ENDS

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DE LEUW, CATHER & COMPANY
SECTION DESIGNER

TOLERANCES FOR INSPECTION OF RAIL
EXHIBIT 05091-B

SCALE: NONE

DATE: JANUARY 2001

05091-9

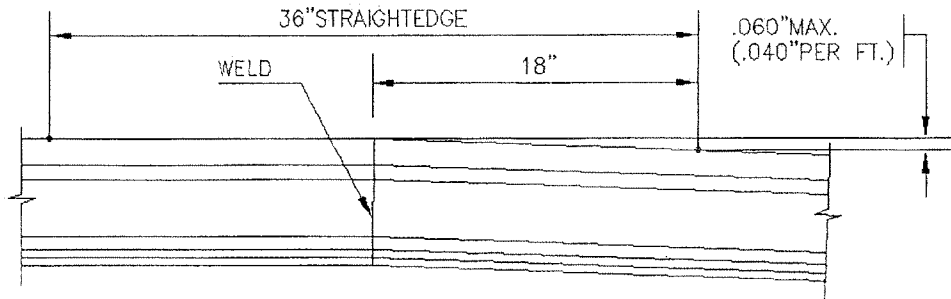


FIGURE 1
ELEVATION OF RAIL SHOWING WELD MISALIGNMENT
TOLERANCE IN VERTICAL ALIGNMENT

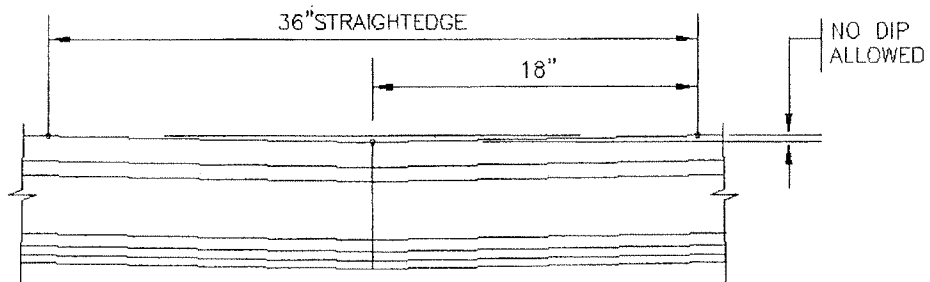


FIGURE 2
ELEVATION OF RAIL SHOWING WELD MISALIGNMENT
TOLERANCE IN VERTICAL ALIGNMENT

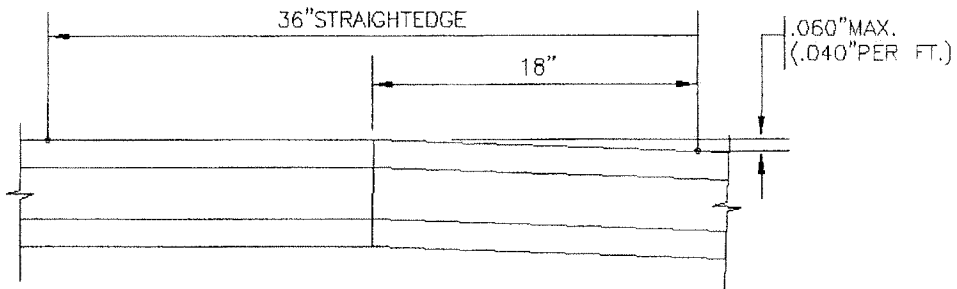


FIGURE 3
PLAN VIEW OF RAIL SHOWING WELD MISALIGNMENT
TOLERANCE IN HORIZONTAL ALIGNMENT

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TOLERANCES FOR INSPECTION
OF WELDED RAIL
EXHIBIT 05091-C

SCALE: NONE

DATE: JANUARY 2001

05091-10

RAIL STRING NUMBER _____

RAIL TYPE: STANDARD _____ HIGH STRENGTH _____ (CHECK ONE)

FINISH STRING LENGTH (NEAREST FOOT) _____

STAMPING ON FIRST AND LAST RAIL IN STRING:

FIRST _____

LAST _____

WELD NO.	WELD MACHINE RECORD IDENTIFIER	MAGNETIC PARTICLE TEST RESULT	VISUAL INSPECTION RESULTS MAXIMUM DIMENSION RECORDED	
			VERTICAL ALIGNMENT	HORIZONTAL ALIGNMENT
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

REWELDS

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WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DE LEUW, CATHER & COMPANY
SECTION DESIGNER

PRODUCTION WELDING RECORD
EXHIBIT 05091-D

SCALE: NONE

DATE: JANUARY 2001

05091-11

DATE _____	OPERATORS _____	OPERATORS Straight-time	Over-time
MACHINE _____	_____	_____	_____
SHIFT _____	_____	_____	_____

WELD NO.	TIME	REMARKS	WELD NO.	TIME	REMARKS

HO - Horizontal Offset VO - Vertical Offset EB - Electrode Burn MI - Mag. Ind.
MB800 & MB1200 Circuit Breaker RL - Read Light - Explain. Other remarks on reverse side.

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY	
DE LEUW, CATHER & COMPANY SECTION DESIGNER	WELDER'S TIME SHEET EXHIBIT 05091-E
SCALE: NONE	DATE: JANUARY 2001
05091-12	

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies structural steel work.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Finish painting for structural steel: Section 09920.

1.03 QUALITY ASSURANCE:

- A. Options:
 - 1. Substitution of rolled shapes for welded sections and vice versa is permitted, provided that shapes and sections to be substituted are approved and comply with the following:
 - a. Keep depth, width, average or mean thickness, web shear area, moments of inertia, torsional constant and warping constant to be at least equal to those for shape or section shown. Maintain clearances and other dimensions shown as critical.
 - b. Have steel shapes, plates and bars conform to same ASTM designation as material for which substitution is made.
- B. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AWS: D1.1.
 - 3. AASHTO: Interim 1981 Fracture Control Plan; Standard Specifications for Highway Bridges, including supplements. Where conflict occurs between AWS and AASHTO, AASHTO governs.
 - 4. AISC:
 - a. Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design.
 - b. Manual of Steel Construction-Allowable Stress Design.
 - c. Code of Standard Practice for Steel Buildings and Bridges.
 - d. Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts.
 - e. Specifications for Architecturally Exposed Structural Steel.
 - 5. ASNT: Recommended Practice SNT-TC-1A.
 - 6. SSPC: SP-6, SP-10.
 - 7. ANSI: B27.2.
 - 8. MS: MIL-P-21035.
 - 9. FS: TT-P-645
 - 10. ASTM: A6, A27, A36, A108, A109, A123, A148, A153, A242, A307, A325, A370, A449, A490, A500, A501, A514, A517, A572/572M, A588, A668, A673, A709, A780, B663, B766.
- C. Source Quality Control:
 - 1. Testing and inspection:

- a. Nondestructive-test requirements for welded members, perform the following:
 - 1) Tension butt welds in fracture-critical nonredundant members and member components of structures subject to repetitive dynamic loading: 100 percent of welds inspected by radiographic and ultrasonic examination.
 - 2) Butt welds of flange material for compression and tension splices: 100 percent of welds inspected by ultrasonic examination.
 - 3) Butt welds for web splices beginning at point of maximum stress: 40 percent of welds inspected by ultrasonic examination.
 - 4) Fillet welds connecting web plates to flange plates: 25 percent of welds inspected by magnetic particle inspection.
 - 5) For all other fillet-weld connections: 10 percent of welds inspected by magnetic particle inspection.
 - 6) The Engineer may designate additional items to be inspected by radiography.
 - b. Mill testing:
 - 1) For identified stock materials provide three specimens from each heat number, one for tension test, one for bend test and one for Charpy V-notch impact test.
 - 2) Cut, machine and test specimens in accordance with ASTM A370.
 - 3) Perform Charpy V-notch impact test for tension flanges and other tension components of aerial structures in accordance with Table 05120-1.
 - c. Bolts:
 - 1) The Engineer will randomly select at least five bolts for test purposes from each bin of bolts furnished.
- D. Qualification of Welding Personnel and Procedures:
- 1. Prior to qualifying welding personnel and welding procedures, confirm an agreement with the Engineer as to procedural details, sequence of welding, handling of materials to be inspected, and approval of electrodes, wire, flux and other welding materials and equipment.
 - 2. Employ welding personnel whose qualification is certified in accordance with AWS D1.1. Such certification is to remain in force for the duration of the welding operations under this Contract.
 - 3. Do not start fabrication until qualification has been successfully completed.
- E. Qualification of Nondestructive-Testing Personnel:
- 1. Nondestructive testing of fracture-critical members to be conducted by personnel qualified as NDT Level II or Level III in accordance with ASNT SNT-TC-1A.
 - 2. Level-II technicians to be supervised by Level III-personnel.
- F. Stock Material:
- 1. For qualification of welding personnel and procedures and for quality-assurance testing, use only stock materials which can be identified as having been rolled from a given heat and for which certified mill tests can be produced.
 - 2. When stock material is proposed, inform the Engineer of such intention at least 10 days in advance of commencing fabrication to permit sampling and testing. Select identified material from as few heats as possible.
- G. Welder's Identification Mark (for Fabrication Shops):

1. Assign each welder and welding operator an identification mark to stamp on pieces he has welded.
2. Have welder or welding operator place his identification mark by metal-die stamp in letters 3/8-inch high in position that identification of welder or operator will appear adjacent to each of his welds in finally assembled members for ready reference to radiographic films and for identification by the Engineer.

H. Elevator Hoistways:

1. Fabricate framing not to exceed 1/8-inch deviation from dimensions shown throughout. Perform straightening where necessary.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Shop Drawings:

1. Structural details: Include the following:
 - a. Bills of materials giving complete information for fabrication and erection of component parts of structures including material and finish information.
 - b. Details of location, type, sizes of bolts and welds and for welded structures details of welding as specified.
 - c. Structural computations for Contractor-designed work certified by a professional engineer registered in the jurisdiction where the work is to be performed.
2. Match marks:
 - a. Provide diagram showing match marks for connecting structural parts assembled in shop for purpose of drilling or reaming holes in field connections.
3. Welding:
 - a. Complete shop details of qualification test specimens.
 - b. Include information on specimen identification, number of pieces and welding procedure specification, type of material, sizes of pieces and welds and other variables affecting detail or tests.
4. Erection Plan:
 - a. Details of methods of erection proposed to be used, including calculated stresses for proposed erection certified by a professional engineer registered in the jurisdiction where the work will be performed. Do not proceed until approval has been received.
5. Manufacturer's test procedures for bolts.

B. Certification:

1. Certified mill test reports of structural steel at least 10 days prior to start of fabrication.
2. Certified quality-assurance testing and inspection reports.
3. Certification verifying that welding personnel have been qualified in accordance with AWS D1.1 and as specified above under Qualifications of Welding Personnel and Procedures.
4. Manufacturer's certification that bolts meet approved testing.
5. Certification of nondestructive-testing personnel.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. General:
 - 1. Load, transport, unload and store structural materials so as to keep them clean and free from damage.
 - 2. Store material on platforms, skids or other supports above the ground and ensure proper drainage and protection from corrosion.

- B. Steelwork:
 - 1. When handling and shipping steelwork, prevent bending, scraping or over stressing members.
 - 2. Block projecting parts likely to be bent or damaged during handling with wood or other approved material
 - 3. Replace pieces bent or damaged unless repair is approved.
 - 4. Indicate weight on members weighing more than three tons by means of paint contrasting with shop coat.

- C. Bolts and Nuts:
 - 1. Ship small parts such as bolts, nuts, washers, pins, fillers and small connecting plates or angles in boxes, crates or barrels.
 - 2. Pack separately bolts of each length and diameter and loose nuts or washers of each size.

- D. Paint:
 - 1. Have paint materials delivered in manufacturer's original sealed containers, bearing manufacturer's label and name, specification identification number where applicable as well as month and year of manufacture.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. Welding:
 - a. When welding during cold weather, avoid chilling weld metal within zone of welding influence and avoid restraining manual functions of welder or welding operator.
 - b. When temperature where steel is stored is more than 20F below that of welding shop, move steel to be welded into shop sufficiently in advance of welding to allow it to attain shop temperature prior to welding.
 - c. Steel to be free of moisture. Dry as necessary by application of heat not exceeding 100F.
 - d. Do not weld when shop temperature is below 40F.
 - 2. Painting:
 - a. Apply paint when temperature of steel and paint is above 40F and temperature is forecast to remain above 40F until paint has dried.
 - b. Painting steel at a temperature which can cause blistering, porosity or conditions otherwise detrimental to life of paint is prohibited. When paint is applied in hot weather or thinned in cold weather, ensure that specified thickness of paint coating is obtained.
 - c. Application of paint in rain, wind, snow, fog or mist or when steel surface temperature is below dew point is prohibited, unless otherwise approved. If painting in damp or cold weather is unavoidable, provide protective covering and heat steel and surrounding air to 40F minimum. Maintain this temperature until weather conditions permit discontinuance.

PART 2- PRODUCTS

2.01 MATERIALS:

- A. General Requirements for Rolled-Steel Plates, Shapes and Bars: ASTM A6.
- B. Carbon-Steel Plates, Shapes and Bars: ASTM A36, ASTM A709, Grade 36.
- C. High-Strength, Low-Alloy, Structural-Steel Plates, Shapes and Bars: ASTM A242.
- D. High-Strength, Low-Alloy, Structural, Columbium-Vanadium Structural Steel: ASTM A572/A572M.
- E. Corrosion-Resistant Structural Steel: ASTM A242., A588
- F. High-Strength, Low-Alloy, Corrosion-Resistant Structural-Steel Shapes, Plates, and Bars: ASTM A588.
- G. Low-Carbon Steel Bolts and Nuts: ASTM A307, Grade A or B.
- H. High-Strength Carbon-Steel Bolts, Nuts and Washers for Structural Joints: ASTM A325; for bolts over one-inch diameter, ASTM A449.
- I. High-Strength Alloy-Steel Bolts, Nuts and Washers for Structural Joints: ASTM A490.
- J. Round Washers Other Than Those In Contact With High-Strength Bolt Heads And Nuts: ANSI B27.2, Type B.
- K. Beveled Washers:
 - 1. Square, smooth and sloped to make contact surfaces of bolt head and nut parallel.
 - 2. Diameter of hole in square beveled washers as follows:
 - a. For bolts less than one-inch diameter: 1/16-inch larger than bolt size.
 - b. For bolts larger than one-inch diameter: 1/8-inch larger than bolt size.
- L. Carbon-Steel Forgings: ASTM A668, Class C.
- M. Alloy-Steel Forgings: ASTM A668, Class G.
- N. Structural-Steel Tubing:
 - 1. Structural framing for elevator hoistways: ASTM A500, Grade B.
 - 2. Other structural tubing: ASTM A501.
- O. High-Strength Steel Casting: ASTM A148, metal type as shown.
- P. Mild-To-Medium-Strength Carbon-Steel Castings: ASTM A27, grade as shown.
- Q. Shear Connectors:
 - 1. Cold-rolled carbon-steel strip.
 - 2. Stud-welding fasteners with upset head developing tensile strength of 65,000 psi-minimum and yield strength of 52,000-psi minimum.
 - 3. Complying otherwise to the following:

- a. Cold-finished bars, Grade 1015, Grade 1018 or Grade 1020, semi-killed or fully killed: ASTM A108.
 - b. Low-carbon steel suitable for welding: ASTM A109.
 - 4. Stud welding conforming to AWS D1.1.
 - 5. Sizes and shapes: As shown.
 - 6. Lengths to be after-weld lengths.
 - 7. Studs arc-welded to parent metal as shown.
 - 8. Before welding, parent-metal surface to be free from rust, oil, paint, plating and other foreign matter.
 - 9. Heat treat parent metal where needed to develop full weld strength.
- R. Galvanizing:
- 1. Steel products specified as galvanized to be hot-dip galvanized after fabrication in accordance with the following:
 - a. Zinc coatings on products fabricated from rolled, dressed and forged steel shapes, plates and strips: ASTM A123.
 - b. Zinc coating on iron and steel hardware: ASTM A153.
 - c. Zinc coating on assembled steel products: ASTM A123.
 - d. Zinc-coating weight: Two ounces per square foot minimum.
 - e. Zinc-dust zinc-oxide primer conforming to MS MIL-P-21035 applied in accordance with ASTM A780 in two coats for repairs to damaged surfaces after removal of loose or cracked zinc coating.
- S. Electroplated Zinc Coating: ASTM B663 for type specified.
- T. Cadmium Plating: ASTM B766 for type specified.
- U. Paint for Shop Prime Coating: FS TT-P-645.
- V. Cleaning Solution: Muriatic acid solution, specific gravity 1.18, prepared in a solution of one-part muriatic acid and five parts water.

PART 3 - EXECUTION

3.01 FABRICATION:

- A. Workmanship and finish to best commercial practice accomplished in structural or bridge shops.
- B. Straightening Material:
 - 1. Use rolled material that, before being laid off or worked, is straight within tolerances specified in ASTM A6.
 - 2. Perform straightening where necessary by approved methods which will not overstress material.
 - 3. Do not heat-shrink low-alloy structural steel.
 - 4. Achieve fabrication tolerances which will result in full bearing.
 - 5. Perform straightening, planing and connecting of portions of members in bearing assemblies and in direct bearing after fabrication as necessary to provide full bearing assemblies and bearing areas.
- C. Cutting:

1. Flame-cut edges of members subject to dynamic loading by mechanically guided torch or by hand. Remove nicks by grinding to depth not exceeding 1/4 inch.
2. Shape re-entrant corners notch-free to radius of 1/2-inch minimum.
3. Perform flame cutting so that metal does not carry stress during cutting operation.
4. Direct flame so that remaining material is not damaged.

D. Planing and Facing:

1. Plane to depth of 1/4 inch sheared edges of plates more than 5/8-inch thick which will carry calculated stress.
2. Face and bring abutting joints to even bearing where shown.
3. Fabricate floor beams, stringers and girders having end connection angles to exact length back-to-back of connection angles.
4. For compression joints depending on contact, prepare bearing surfaces to a common plane by milling, sawing or other approved means.
5. Where end connections are faced, ensure that finished thickness of angle is not less than that shown.

E. Bolt Holes:

1. Punch or drill holes for bolts.
2. Subpunch or subdrill and ream assemblies using steel template for alignment of connections as necessary. Flame cutting is prohibited.
3. Subdrill or subpunch holes 3/16-inch less than nominal diameter of bolt; drill or ream holes 1/16-inch greater than nominal diameter of bolt.

F. Connections:

1. Except where welded or ASTM A307 bolted connections are shown, use ASTM A325 or ASTM A490 bolts for shop connections.
2. Unless otherwise shown, bolt field connections using ASTM A325 or ASTM A490 bolts in accordance with AISC Specifications for Structural Joints.
3. Use of ASTM A490 bolts for dynamic or fluctuating loadings is prohibited.

G. Plates:

1. Bent plates: For load carrying cold-bent plates, use identified stock and arrange direction of bending at right angles to direction of rolling. Ensure radius of bend, measured on concave face of metal, is not less and preferably more than the following:

Angle of Plate Bend in Degrees	Minimum Radius
61 - 90	1.0T*
91 - 120	1.5T*
121 - 150	2.0T*

*T = Plate thickness.

2. Sheared plates: For gusset plates or connection plates, use sheared plates designed to resist applied loads in more than one direction in plane of plate.

3.02 WELDING:

- A. Perform welding in accordance with AWS D1.1.

- B. Perform procedure and sequence of welding so as to avoid needless distortion and to minimize stresses. Straighten transverse warpage of flanges, if necessary, by controlled heating along outside face.
- C. Make allowance in shop for expected weld shrinkage in laying out and assembling members. Trim members to size when most or all of welding has been completed.
- D. Complete butt welds in flange joints before flanges are assembled on web. Use extension blocks on such joints when making ends of butt welds, removing extension blocks only upon completion and cooling of weld. Ensure ends of welds are finished smooth and flush with edges of abutting parts. Use double-V-flange butt welds, unless otherwise shown. Back puddle all end craters.
- E. Make welds in web plates where shown.
- F. Prior to ultrasonic or radiographic testing of butt welds of flanges and webs, grind or machine weld reinforcement of joint to remove irregularities of weld surface so that it merges smoothly with base surface; one side for ultrasonic testing and both sides for radiographic testing.
- G. Ensure that welded joints which are to be radiographed are free of paint, scale and grease. Grind off welded ripples and surface irregularities on both sides of joint. Grind perpendicular to length of weld and to such a degree that resulting radiographic contrast due to remaining irregularities cannot mask or be confused with that of objectionable defect and so that weld surface will merge smoothly into adjoining surface.
- H. Repair defective welds by chipping or melting out such defects from one or both sides of joint removing no more weld metal than necessary to correct defect. Reweld and have weld retested radiographically.
- I. Welded Structures Subjected to Dynamic Loads:
 1. Do not use backup bars for fracture-critical nonredundant members or member components, as defined by AASHTO on Interim 1981 Fracture Control Plan.
 2. Avoid use of backup bars elsewhere, unless explicitly permitted by original design.
 3. When use of backup bars is unavoidable because of practicality but not explicitly permitted by original design, remove backup bar after welding is completed and affected surfaces of weld metal and base metal is ground flush. Roughness of ground surfaces to be similar to that of surrounding unaffected plate surface.

3.03 BOLTING:

- A. Connections using high-strength steel bolts in accordance with AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 bolts.
- B. Assemble high-strength bolted parts so that they fit solidly together when assembled. Do not use gaskets or other compressible materials.
- C. Remove scale, dirt, burrs and other defects likely to prevent proper seating when assembling joint surfaces, including those adjacent to washers.
- D. Remove oil, paint, lacquer and galvanizing from contact surfaces of friction joints.

- E. Use two nuts on unfinished bolts and turned bolts in tension.
- F. Tightening Bolts:
 - 1. Tighten ASTM A325 or A490 bolts to bolt tension not less than proof load given in AISC Specifications for Bolts.
 - 2. If approved, tighten by means of properly calibrated wrenches or turn-of-nut method.
 - 3. When tightening, place hardened washer under nut or bolt head, depending on which element is turned in tightening operation.
 - 4. Calibrate torque wrenches daily by tightening bolt assembly in device capable of indicating actual bolt tension.
 - 5. Install three bolts minimum from each lot.
 - 6. Nuts or bolts to be in tightening motion when torque is measured.
 - 7. Adjust power wrenches to cut-out or stall at required tension.
- G. Arrange bolts so that heads show in areas exposed to public view.

3.04 SHOP ASSEMBLY:

- A. Undertake complete or progressive shop assembly of continuous plate and box girders, rigid frames, bents and towers when shown. Obtain approval of progressive shop-assembly procedure.
- B. Clean surfaces of metals in contact with each other with high speed wire brushes before assembling.
- C. Assemble parts to line and fit; drill or ream bolt holes while assembled. Hand reaming is prohibited unless approved.

3.05 SHOP PRIME PAINTING:

- A. Clean steel surfaces in accordance with SSPC SP-6 or SP-10.
- B. Shop Painting:
 - 1. Shop paint structural-steel work which will be left bare in finished structures.
 - 2. Do not shop paint the following:
 - a. Surfaces within three inches of joints to be field welded.
 - b. Galvanized surfaces and surfaces to be galvanized.
 - c. Contact surfaces: Apply rust-inhibitive treatment to such surfaces; remove by means of appropriate solvent prior to assembly.
 - d. Surfaces to be encased in concrete or in fire-protection material.
 - e. Weathering steel.
 - 3. Use paint-spraying equipment, if approved, with type of spray gun recommended by paint manufacturer for paint being applied.
 - 4. Use brushes of good quality bristle. Nylon brushes and roller coaters are prohibited.
 - 5. Neutralize areas of welding which are to be painted by applying specified cleaning solution. Wash neutralized area thoroughly with clean water and allow to dry before painting.
 - 6. Apply shop prime coat at minimum wet-film thickness of three mils. Give surfaces which will be inaccessible after assembly or erection three coats of paint before assembly.

7. Caulk small cracks, cavities and open seams around stiffeners and connections with pasty mixture of red lead and linseed oil or approved caulking putty and allow to dry before applying full shop coat.
8. Apply stripe coat of paint to edges, corners, bolts, welds and other sharp edges before giving steel full shop coat of paint. Apply stripe coat at least one-inch beyond area to be striped and allow to dry before applying full shop coat.
9. Paint erection marks and weight on each member after shop coat has dried.
10. Complete shop painting and ensure paint has completely dried prior to shipment of steel.

3.06 ERECTION:

- A. Install anchor bolts accurately in positions shown.
- B. If anchor bolts are cast in substructure masonry during its construction, ensure that each bolt is firmly held in its correct position and elevation by suitable templates.
- C. If approval is given for installing anchor bolts in preformed holes or in drilled holes in concrete or masonry, use approved nonshrink, nonstaining grout to secure them in place.
- D. Set bearing assemblies to lines and grades shown and adjust to horizontal position shown.
- E. Erect steel structures true and plumb following match marks.
- F. Use temporary bracing to support loads to which structures may be subjected including erection equipment and their operations. Leave bracing in place as long as safety requires.
- G. Report immediately to the Engineer errors in shop fabrication or deformation resulting from handling or transportation which prevent proper erection and fitting of parts.
- H. As erection progresses perform sufficient bolting of work to support dead load, wind load and erection load. Perform permanent bolting when enough alignment has been accomplished to ensure that as much of structure as possible will be supported by such fastening work.
- I. Ensure that holes are not enlarged and that metal in vicinity of holes is not disturbed by drifting during assembly.
- J. Enlargement of holes to accept bolts for connections is prohibited unless approved. Make enlargement by reaming not by burning. Avoid hand reaming.
- K. Do not field weld main stress members.
- L. Bond premolded elastic filler with adhesive to structural framing at elevator hoistways.

3.07 NONDESTRUCTIVE TESTING OF FIELD WELDS:

- A. Perform pertinent testing specified for source quality control.

3.08 FIELD TOUCH-UP PAINTING:

- A. Retouch surfaces where shop coat has been damaged using paint and paint-film thickness identical to original shop coat.

- B. After erection, clean field bolts, nuts and adjacent areas and apply coat of paint identical to original shop coat.
- C. Finish painting for structural steel in accordance with Section 09920.

TABLE 05120-1

BASE METAL CHARPY V-NOTCH REQUIREMENTS ^a FOR FRACTURE-CRITICAL MEMBERS				
ASTM	Thickness, Inches (mm)	Zone 1 ^b	Zone 2 ^c	Zone 3 ^d
A36	Up to 4 inches (101.6)	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
A572 ^e	Up to 4 inches (101.6) mechanically fastened	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
	Up to 2 inches (50.8) welded	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
A588 ^e	Up to 4 inches (101.6) mechanically fastened	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
	Up to 2 inches (50.8) welded	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
	Over 2 inches to 4 inches (50.8 to 101.6) welded	30 at 70F (40.7 Nm at 21.1C)	30 at 40F (40.7 Nm at 4.4C)	30 at 10F (40.7 Nm at minus 12.2C)
A514 ^f	Up to 4 inches (101.6) mechanically fastened	35 at zero degree F (47.5 Nm at minus 17.8C)	35 at zero degree F (47.5 Nm at minus 17.8C)	35 at minus 30F (47.5 Nm at minus 34.4C)
	Up to 2-1/2 inches (63.5) welded	35 at zero degree F (47.5 Nm at minus 17.8C)	35 at zero degree F (47.5 Nm at minus 17.8C)	35 at minus 30F (47.5 Nm at minus 34.4C)
	Over 2-1/2 inches to 4 inches (63.5) welded	45 at zero degree F (61.0 Nm at minus 17.8C)	45 at zero degree F (61.0 Nm at minus 17.8C)	Not permitted

^a CVN impact testing to be P-plate frequency testing in accordance with ASTM A673. Code Charpy test pieces with respect to heat/plate number and record such code on mill-test report of steel supplier with test result. If directed, package broken pieces from each test (three specimens, six halves) and forward to the quality-assurance organization of the jurisdictional authority. Use average of three tests. If energy value for more than one of three specimens is below minimum average requirements or if energy value for one of three specimens is less than 2/3 of specified minimum requirements, retest and obtain energy value from each of three retest specimens equal to or exceeding specified minimum average requirement.

- *b Zone 1: Minimum service temperature zero degree F (minus 17.8C) and above.
- *c Zone 2: Minimum service temperature from minus 1F to minus 30F (minus 28.3C to minus 34.4C).
- *d Zone 3: Minimum service temperature from minus 31F to minus 60F (minus 35C to minus 51.1C).
- *e If the yield strength of the material exceeds 65 ksi (448.159MPa), reduce temperature for CVN value for acceptability by 15F (8.3C) for each increment of 10 ksi (68.947MPa) above 65 ksi (448.159MPa). Yield strength is value given in certified mill-test report.
- *f ASTM A517 Charpy requirements are the same as for ASTM A514.

END OF SECTION

THIS PAGE NOT USED

SECTION 05210

STEEL JOISTS

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing steel joists.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Bearing plates and miscellaneous steel framing: Section 05120.
- B. Field painting: Section 09920.

1.03 QUALITY ASSURANCE:

- A. Reference Codes and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AWS: D1.1.
 - 3. SJI (Steel Joint Institute): Standard Specifications and Load Tables for Series-K Open-Web Steel Joist, Series-LH Longspan Steel Joists and Joist Girders.
 - 4. SSPC: Steel Structures Painting Manual.
 - 5. FS: TT-P-645.
- B. Qualification of Welding Personnel:
 - 1. Employ welding personnel whose qualification is certified in accordance with AWS D1.1. Such certification is to remain in force for the duration of the welding operations under this Contract.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Detailed joist and erection drawings showing erection marks, SJI-designation numbers, locations and spacing; bearing-plate and anchor-bolt layouts; bridging details and connections; shop coating; and details necessary for installation. Drawings to be signed and sealed by a professional engineer registered in the jurisdiction where the work will be performed.
- B. Certification:
 - 1. Certificate verifying compliance with SJI specifications.
 - 2. Certification that welding personnel are currently qualified in accordance with AWS D1.1, and as specified above under Qualification of Welding Personnel.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Load, transport, unload and store steel joists by means which will prevent damage.
- B. Use waterproof coverings during transit and storage to protect shop coats and prevent corrosion.
- C. Store off the ground preferably supported by their end bearings.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Steel Joists: Designations shown, fabricated in accordance with SJI requirements. Extended ends and ceiling extensions designed to support loads shown.
- B. Shop Coating: In accordance with FS TT-P-645 and SSPC recommendations of the Steel Structures Painting Manual, except that asphalt coating is prohibited for joists specified to be field-painted.
- C. Bridging: Member sizes, end anchorages and accessories in accordance with SJI requirements.
- D. Bearing plates and miscellaneous steel framing: Section 05500.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install steel joists and bridging in accordance with SJI recommendations.
- B. Ensure that bearing plates are set in accordance with approved working drawings. Install joists of proper designations at locations shown.
- C. Perform welding in accordance with AWS D1.1. Burning of holes, undercutting or other operations which reduce strength of joists are prohibited.
- D. Permanently secure bridging and decking before applying construction or design loads to steel-joist installation.
- E. Ensure that construction loads, such as stacked materials, do not exceed designed capacity of the installation.
- F. Repair or replace damaged joists as directed.

3.02 FIELD PAINTING:

- A. Repair shop coating where damaged. Remove welding flux, rust and other foreign matter. Coat welded and damaged areas with coating to match shop-applied coating.
- B. Use joists with asphalt coating only in areas which have ceilings.
- C. Paint joists exposed to view in completed project in accordance with Section 09920.

3.03 FIELD QUALITY CONTROL:

- A. Inspect steel joists for broken welds, bent chords or web members and other damage harmful to structural integrity of joists.
- B. Verify size, spacing, top-chord alignment and level, and tightness of fasteners.
- C. Monitor field welding for compliance with AWS D1.1 requirements.

END OF SECTION

SECTION 05310

METAL DECKING

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing metal roof decking.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Touch up and field painting of metal deck: Section 09920.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AISI Specifications for the Design of Light-Gauge Cold-Formed Steel Structural Members.
 - 3. AWS: D1.1.
 - 4. SDI (Steel Deck Institute): Design Manual for Floor Decks and Roof Decks.
 - 5. ASTM: A653/A653M.
- B. Qualification of Welding Personnel:
 - 1. Employ welding personnel whose qualification is certified in accordance with AWS D1.1. Such certification is to remain in force for the duration of the welding operations under this Contract.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Include details of fabrication and erection including materials, dimensions, methods of joining, welding, accessories, fastenings and openings through decking.
- B. Samples:
 - 1. Three of each type of the following products used in the work.
 - a. Decking: Six inches by width of material.
 - b. Accessories.
 - c. Fasteners.
- C. Certification:
 - 1. Certification that welding personnel have been qualified in accordance with AWS D1.1.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products in good condition.
- B. Store products so as to preclude corrosion, deterioration and damage.

- C. Handle products so as to prevent damage.

1.06 JOB CONDITIONS:

- A. Do not apply construction loads, such as roofing materials and aggregate, in excess of the live loads for which the deck is designed.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Steel Decking:
 - 1. Galvanized: ASTM A653/A653M, Coating G60 or G90, gauge as shown.
 - 2. Where terne-coated stainless steel is to be installed over decking, fabricate decking with clear space between ribs 1/2-inch wide maximum.
- B. Accessories:
 - 1. Types shown or necessary to complete installation, such as 14-gauge recessed sump pans for roof drains, cover plates where panels abut or change direction and closure plates.
 - 2. Same gauge and finish as decking, unless otherwise shown or specified.
- C. Fasteners: As shown on approved shop drawings.

2.02 FABRICATION:

- A. Deck units countersunk at ends to form smooth, flush top surface at overlapping ends, except for 12-gauge and 14-gauge material.
- B. Deck units having interlocking side laps, in standard width and longest practicable lengths
- C. Steel Roof Deck: Gage and depth as shown.
- D. Metal Forming (corrugated):
 - 1. Maximum Flexural Working Stress: 33,000 psi.
 - 2. Maximum Roof Deflection: 1/240 of span, c/c of supports, under live load.
 - 3. Maximum Floor Deflection: 1/360 of span, c/c of supports, under live load.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Erect steel decking and accessories in accordance with approved shop drawings and manufacturer's recommendations.
- B. Place decking units on the supporting steel, align and adjust to final position before permanently fastening.
- C. If supporting beams are not in proper alignment or at correct elevation to provide bearing and alignment of deck units; do not place decking units in deficient areas until necessary corrections have been made.

- D. Continue decking over three or more spans.
- E. Perform welding in accordance with AWS D1.1.
- F. Use electric-arc welding to weld deck panels to end supports as shown on the Contract Drawings or on approved shop drawings. Where panel ends meet, provide minimum two-inch overlap and weld to fuse ends of units together.
- G. Crimp side joints of adjacent panels and weld at intervals not exceeding three feet.
- H. Remove burrs and sharp edges.
- I. Where welding occurs through deck, use welding washers and plug welds to ensure proper attachment.
- J. Cut bevels and perform other special cutting and fitting at jobsite.
- K. Provide necessary support framing and reinforcement and openings for items penetrating deck panels.
- L. Coordinate cutting of openings for work of other trades with trades involved.
- M. Do not hang mechanical equipment or other loads from steel deck.
- N. Repair areas where galvanizing has been damaged by welding or cutting operations using cold galvanizing compound acceptable to the Engineer.
- O. Clean galvanized roof sheets with zinc oxide residue or evidence of rusting with solvent and apply zinc-rich paint to restore corrosion resistance.

3.02 CLEAN-UP:

- A. Clean up rubbish and debris caused by this work and remove from site.
- B. Leave decks and areas surrounding work in broom-clean condition.

END OF SECTION

THIS PAGE NOT USED

SECTION 05500

MISCELLANEOUS METAL

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing miscellaneous metal, with the exception of ornamental (architectural) metal and metalwork provided as a part of mechanical, electrical and construction systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Concrete, concrete fill and nonshrink grout: Section 03300.
- B. Structural steel: Section 05120.
- C. Handrails and Railings: Section 05521.
- D. Gratings and Floor Plates: Section 05531.
- E. Field painting: Section 09920.
- F. Concrete formwork: Section 03100.
- G. Concrete reinforcement: Section 03200.
- H. Wire Mesh Partitions: Section 10605
- I. Grounding and Bonding: Section 16060

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
 - 2. Manufacturer's standard drawings may be submitted in lieu of Contractor-prepared shop drawings if manufacturer's standard drawings show required details.
- B. Certification:
 - 1. Certification that welding personnel are currently qualified in accordance with AWS D1.1.
 - 2. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements for corrosion resistance of Type 316 stainless steel.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AWS: D1.1.
 - 3. AISC: Specification for Structural Steel for Buildings-Allowable Stress Design and Plastic Design (Do not use plastic design).
 - 4. SSPC: SP 11, Paint 12.

5. FED STD: 595.
6. MS: MIL-P-21035.
7. FS: A-A-462, FF-B-588, FF-H-116, FF-P-395, FF-S-325, RR-T-650, TT-P-86.
8. ASTM: A36, A53, A74, A108, A123, A167, A193, A229, A242, A276, A307, A313, A325, A413, A490, A501, A536, A570, A572, A588, A666, A780, A786/A786M, B 221, B 632, B633, D412, D1187, E488, F 593, F 594, F1554.
9. AGA: The Design and Fabrication of Galvanized Products.
10. ANSI: A14.3
11. ASME: A 17.1, B18.6.3, B18.21.1, B18.22.1.

B. Qualifications of Welding Personnel:

1. Welding: Qualify procedures and personnel according to the following:
 - a. AWS D1.1, "Structural Welding Code--Steel."
 - b. AWS D1.2, "Structural Welding Code--Aluminum."
 - c. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - d. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification. Such certification is to remain in force for the duration of the welding operations under this Contract.

C. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.05 PROJECT CONDITIONS:

- A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products undamaged.
- B. Store products so as to prevent rust.
- C. Handle products so as to prevent damage.
- D. After completion of factory testing, package and ship hatches as directed.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General Requirements:
 - 1. Insofar as practicable, furnish similar products of a single manufacturer.
 - 2. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 FERROUS METALS:

- A. Structural steel: Plates, shapes, bars and angles, ASTM A36.
- B. Rolled-Steel Floor plate: ASTM A786/A786M; Fabricate raised-pattern floor plates from rolled-steel floor plate, galvanized after fabrication, of thickness and in pattern indicated below:
 - 1. Thickness: Minimum 1/4 inch, unless otherwise shown or calculated.
 - 2. Pattern: No. 2, or as selected from manufacturer's standard patterns; flat back.
- C. High-strength low-alloy structural steel:
 - 1. ASTM A242.
 - 2. Resistance to atmospheric corrosion: Four times that of carbon steel, minimum.
- D. Load-carrier beams: ASTM A588.
- E. Structural tubing: ASTM A501.
- F. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
- G. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304. Type 316L for corrosive environments.
- H. Stainless-Steel Bars and Shapes: ASTM A276, Type 304. Type 316L for corrosive environments.
- I. Hot-rolled carbon steel sheets and strips: ASTM A570.
- J. Pipe, Pipe Sleeves and Pipe Fittings:
 - 1. Cast iron: ASTM A74, service weight.
 - 2. Steel: ASTM A53, galvanized unless otherwise shown or specified.
- K. Guard Chain: ASTM A413, Class Grade 28, galvanized steel, 9/32-inch thick, complete with stainless-steel eyes, spring-loaded catches and mounting components.

2.03 ALUMINUM:

- A. Aluminum Extrusions: ASTM B221, Alloy 6063
- B. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B 632M, Alloy 6061.

- C. Cast Aluminum.

2.04 COATINGS:

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Zinc-rich paint: MS MIL-P-21035.
- C. Electrodeposited zinc coating: ASTM B63
- D. Galvanizing repair compound: Stick form, melting point 600F to 650F, GALVABAR or equal.
- E. Bituminous coating: Cold-applied asphalt mastic complying with SSPC Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187.

2.05 FASTENERS:

- A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Screws: Material, type and size to suit the purpose; steel, except stainless, cadmium-plated.
 - 1. Stainless steel, ASTM A193, Alloy S30400.
- C. Machine bolts: Material, type and size best suited to the purpose. Minimum tensile strength 60,000 psi.
 - 1. Carbon steel: ASTM A307, Grade B, galvanized.
 - 2. Stainless steel: ASTM A193, Class 1A.
- D. Toggle bolt: FS FF-B-588.
- E. Drive stud: FS FF-S-325, Group 6.
- F. Expansion shield: FS FF-S-325 Group I, Type 2, Class 2, Style 1; Group II, Type 3, Class 1; Group IV, Type 1; best suited to the purpose.
- G. Screw anchors: Lead or plastic for wood or metal screws.
- H. Anchor-bolt sleeve: Corrugated high-density polyethylene plastic.
- I. Powder actuated: FS FF-P-395.
- J. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

K. Internally Threaded Steel Anchor: ASTM A108.

2.06 CONCRETE AND GROUT:

A. Nonshrink Grout: Section 03300.

B. Concrete Fill: Normal weight, minimum 3,000 psi structural concrete as required in Section 03300, except limit the max. coarse aggregate size to #8.

1. Non-slip aggregate: Fused aluminum oxide grits or crushed emery, factory graded and packaged, rust-proof, non glazing and unaffected by moisture and cleaning materials.
2. Surface hardener: Water-soluble, inorganic fluosilicate compound for curing, hardening and dustproofing fresh concrete.

2.07 FABRICATION, GENERAL:

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

H. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

- I. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges
- J. Remove sharp or rough areas on exposed traffic surfaces.
- K. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.08 LADDERS:

- A. General: Fabricate ladders for locations shown, with dimensions, spacings, details, and anchorages as indicated.
 - 1. Comply with ANSI A14.3, unless otherwise indicated.
 - 2. For elevator pit ladders, comply with ASME A17.1.
- B. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
- C. Bar Rungs: 3/4-inch diameter steel bars, spaced 12 inches o.c., unless shown otherwise.
- D. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.
- E. Support each ladder at top and bottom and not more than 48 inches o.c. with welded or bolted steel brackets. Size brackets to support design loads specified in ANSI A14.3.
- F. Provide nonslip surfaces on top of each rung by coating with abrasive material metallurgically bonded to rung by a proprietary process.
- G. Galvanize ladders, including brackets and fasteners, in exterior locations and in areas with corrosive environments:

2.09 LADDER SAFETY CAGES:

- A. General: Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or riveting.
- B. Primary Hoops: 5/16-by-4-inch steel flat bar hoops. Provide at tops and bottoms of cages and spaced not more than 20 feet o.c.
- C. Secondary Intermediate Hoops: 5/16-by-2-inch steel flat bar hoops, spaced not more than 48 inches o.c. between primary hoops.
- D. Vertical Bars: 5/16-by-2-inch steel flat bars secured to each hoop, spaced approximately 9 inches o.c.
- E. Fasten assembled safety cage to ladder rails and adjacent construction by welding or riveting, unless otherwise indicated.
- F. Galvanize ladder safety cages, including fasteners, in exterior locations and in areas with corrosive environments.

2.10 SHIP'S LADDERS:

- A. General: Design in accordance with AISC Specification for Structural Steel for Buildings-Allowable Stress Design, NAAMM Metal Stairs Manual and applicable OSHA requirements.
 - 1. Minimum live load for stairs: 100 psf.
 - 2. Stringers: At platforms and landings, extend stringers around perimeters. Close ends with continuously welded closure plates, ground smooth and flush.
- B. Provide ship's ladders where shown or indicated. Fabricate of open-type construction with structural-steel channel or steel plate stringers, steel pipe handrails, and steel bar grating treads, unless otherwise indicated. Provide brackets and fittings for installation.
- C. Treads, platforms and landings fabricated of steel plate with nonslip surface or steel grating, as shown.
- D. As far as practicable, holes for rivets, bolts and screws located in concealed positions.
- E. Galvanize ship's ladder, including fasteners, in exterior locations and in areas with corrosive environments.
- F. Comply with applicable requirements in Section 05520 for steel pipe railings.

2.11 SAFETY TREAD:

- A. FS RR-T-650, Type C, metallic, nonskid, class and style as shown.
- B. Drilled and countersunk to receive flathead screws.

2.12 STEEL LINTELS:

- A. Fabricated of structural steel.
- B. Multiple members riveted or welded back-to-back or separated by spacers.
- C. Shop-painted, except hot-dip galvanized after fabrication where used in exterior walls.

2.12 SHELF ANGLES:

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete. Align expansion joints in angles with indicated control and expansion joints in cavity-wall exterior wythe.
- C. Galvanize shelf angles to be installed in exterior walls.
- D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.13 CORNER GUARD, CURB ANGLE AND BUMPER:

- A. Fabricated of structural steel.

- B. Shop-painted.

2.14 CAST NOSING:

- A. Cast aluminum: Cross-hatched units, 4 inches wide with 1-inch lip, for casting into concrete steps
- B. Apply bituminous paint to concealed bottoms, sides, and edges of units set into concrete.

2.15 BOLLARDS:

- A. Pipe: Black Steel, ASTM A53, Type E, Grade A, Schedule 80, sized as shown, with 1/4-inch steel-plate cap welded all around and weld ground smooth
- B. Eyebolt: 1/4-inch diameter steel rod with 1/2-inch diameter eye.
- C. Concrete fill: Section 03300, Class 3000.
- D. Coating:
 - 1. Shop paint.
 - 2. Finish paint: Aliphatic system as specified in Section 09920.
 - 3. Hot-dip galvanize exterior bollards in accordance with ASTM A123 before bonderizing and shop priming.
- E. Chain: Guard chain, galvanized and painted to match bollard.

2.16 MISCELLANEOUS ITEMS:

- A. Fabricate metal items indicated on the drawings from materials shown or, if not otherwise described, from steel or from galvanized steel wherever exposed to the weather or in contact with concrete or masonry.
- B. Make miscellaneous items to the size and configuration indicated, welded or bolted at joints to develop full strength equal to a continuous member, and in every way complete for the intended purpose and finished in appearance.
- C. Pylon-Base Ring: Structural steel, galvanized after fabrication.
- D. Eye: ASTM A572, Grade 50, one-inch diameter steel rod, welded, galvanized after fabrication.

2.17 FINISHES:

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Finish metal fabrications after assembly.
- B. Galvanizing:
 - 1. Clean ferrous metal thoroughly before applying zinc coating.
 - 2. Apply zinc coating to products after fabrication, by hot-dip method, using coating weighing not less than 2.0 ounces per square foot.
- C. Shop Paint:

1. Ferrous metal thoroughly cleaned as recommended by primer manufacturer and in accordance with SSPC SP11 and, except for items to be encased in concrete, given prime coat of paint.
 2. Zinc yellow iron-oxide primer or red-lead base primer applied so as to thoroughly cover surfaces without leaving runs or sags.
- D. Stainless Steel: Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- E. Aluminum: AA-M10 (Mechanical Finish: as fabricated, unspecified).
- F. Non-Slip Abrasive Surfaces: SLIP-NOT as manufactured by the W. S. Molnar Company or approved equal. Fabricate from steel plate or bar with abrasive material metallurgically bonded to steel by a proprietary process. Provide material with coefficient of friction of 0.6 or higher when tested according to ASTM C1028.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Remove foreign substances from surfaces to receive metal items.
- B. Protect surrounding surfaces from damage while performing the work of this section.

3.02 INSTALLATION, GENERAL:

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.03 INSTALLING NOSINGS:

- A. Center nosings on tread widths.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

3.04 INSTALLING BOLLARDS:

- A. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. After bollards have been inserted into sleeves, fill annular space between bollard and sleeve solidly with nonshrink, nonmetallic grout, mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/4 inch toward bollard.

3.05 PAINTING AND REPAIRING COATED SURFACES:

- A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finished work, except items encased in concrete.
- B. Where shop coat is abraded or burned by welding, clean and touch-up.
- C. Touch-up primed surfaces with same material as coating.
- D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.
- E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
 1. Wire-brush areas to be coated to bright metal.
 2. Apply galvanizing repair compound at rate of two ounces per square foot.

END OF SECTION

SECTION 05511

METAL STAIRS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing Adjust list below to suit Project. steel stairs with concrete-filled treads, industrial stairs with steel floor plate treads, industrial stairs with steel grating treads.
- B. Related Work Specified Elsewhere:
 - 1. Cast-In-Place Structural Concrete: Section 03300.
 - 2. Handrails and Railings: Section 05521.
 - 3. Miscellaneous Metal: Section 05500.
 - 4. Field Painting: Section 09920.

1.02 PERFORMANCE REQUIREMENTS:

- A. Structural Performance: Provide metal stairs capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each component of metal stairs.
 - 1. Treads and Platforms of Metal Stairs: Capable of withstanding a uniform load of 100 lbf/sq. ft. or a concentrated load of 300 lbf on an area of 4 sq. in., whichever produces the greater stress; or higher load if required by the jurisdictional authority where the stair is installed.
 - 2. Stair Framing: Capable of withstanding stresses resulting from loads specified above in addition to stresses resulting from railing system loads.
 - 3. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less or as required by the jurisdictional authority where the stair is installed.
- B. Metal stairs shall be designed in accordance with AISC's "Specification for Structural Steel for Buildings-Allowable Stress Design," NAAMM's "Metal Stairs Manual" and applicable OSHA requirements.

1.02 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each.
 - 1. Product Data: For metal stairs and the following:
 - a. Prefilled metal-pan stair treads.

- b. Precast concrete treads.
 - c. Nonslip aggregates and nonslip-aggregate finishes.
 - d. Steel floor plate.
 - e. Grout.
2. Shop Drawings: Show fabrication and installation details for metal stairs. Include plans, elevations, sections, and details of metal stairs and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
 3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 4. Samples for Initial Selection: Manufacturer's color charts or sections of units showing the full range of colors and patterns for the following products
 5. Samples for Verification: For the following products. Prepare Samples from the same material to be used for the Work.
 - a. Stair treads with nonslip-aggregate surface finish.
 - b. Floor plate treads.
 - c. Grating treads.
 6. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 1. Comply with codes and regulations of the jurisdictional authorities.
 2. ADA: Americans with Disabilities Act.
 3. AGA: The Design and Fabrication of Galvanized Products.
 4. AISC: Specification for Structural Steel for Buildings-Allowable Stress Design
 5. ASME: B18.2.1, B18.6.3, B18.21.1, B18.22.1.
 6. ASTM: A36, A82, A90, A123, A143, A153, A185, A283, A307, A366, A384, A500, A510, A563, A611, B633, C1028, C1107, D1187, E488, F593, F594.
 7. AWS: D1.1, D1.3.

8. FS: TT-P-664
 9. MS: MIL-P-21305.
 10. NAAMM: Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads, Metal Finishes Manual for Architectural and Metal Products, Metal Stairs Manual.
 11. SSPC: Paint 12, PA-1, SP 3, SP 6/NACE No. 3.
- B. Installer Qualifications: Arrange for metal stairs specified in this Section to be fabricated and installed by the same firm.
- C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal stairs (including handrails and railing systems) that are similar to those indicated for this Project in material, design, and extent.
- D. Fabricator Qualifications: A firm experienced in producing metal stairs similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- E. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

1.05 COORDINATION:

- A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 -PRODUCTS

2.01 FERROUS METALS:

- A. Metal Surfaces, General: Provide metal free from pitting, seam marks, roller marks, and other imperfections where exposed to view on finished units. Do not use steel sheet with variations in flatness exceeding those permitted by referenced standards for stretcher-leveled sheet.
- B. Steel Plates, Shapes, and Bars: ASTM A36.
- C. Steel Tubing: Cold-formed steel tubing complying with ASTM A500.
- D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- E. Steel Bars for Gratings: ASTM A36.
- F. Wire Rod for Grating Crossbars: ASTM A510.

- G. Uncoated, Cold-Rolled Steel Sheet: Commercial quality, complying with ASTM A366/A366M; or structural quality, complying with ASTM A611, Grade A, unless another grade is required by design loads.
- H. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.02 FASTENERS:

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. Machine Screws: ASME B18.6.3.
- D. Lag Bolts: ASME B18.2.1.
- E. Plain Washers: Round, carbon steel, ASME B18.22.1.
- F. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

2.03 COATINGS:

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for
- B. Galvanizing (zinc-coating by hot-dipped process): ASTM A90, ASTM A123, or ASTM A143, ASTM A153 or ASTM A384, as applicable.
- C. Zinc-rich paint: MS MIL-P-21305.
- D. Galvanizing Repair Compound: Stick form, melting point 600-degree F to 650-degree F, GALVABAR or equal.

2.04 CAST ABRASIVE NOSINGS:

- A. Fabricate units from cast iron in sizes and configurations indicated and in lengths

necessary to accurately fit openings or conditions. Provide units with an integral corundum or silicon carbide abrasive finish. See Section 05500, "Miscellaneous Metals."

- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Apply bituminous paint to concealed bottoms, sides, and edges of units set into concrete.
- D. Provide a cross-hatched surface texture, unless other surfaces are indicated.

2.05 GROUT:

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.06 CONCRETE FILL AND REINFORCING MATERIALS:

- A. Concrete Materials and Properties: Comply with requirements in Section 03300, "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 3000 psi, limit the max. coarse aggregate size to #8, unless higher strengths are indicated.
- B. Nonslip-Aggregate Finish: Factory-packaged and graded abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.
- C. Welded Wire Fabric: ASTM A185, 6 by 6 inches--W1.4 by W1.4, unless otherwise indicated.
- D. Surface Hardener: Water-soluble, inorganic fluosilicate compound for curing, hardening and dustproofing fresh concrete.

2.07 PRECAST CONCRETE TREADS:

- A. Concrete Materials and Properties: Comply with requirements in Section 03300, "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 5000 psi and a total air content of not less than 4 percent or more than 6 percent.
- B. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch-diameter wire; comply with ASTM A185 and ASTM A82, except for minimum wire size.

2.08 FABRICATION, GENERAL:

- A. Fabricate and prepare products required to be galvanized in accordance with recommendations of AGA.
- B. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure. Delete subparagraphs below if not

required.

1. Join components by welding, unless otherwise indicated.
 2. Use connections that maintain structural value of joined pieces.
 3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.
- C. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
1. Architectural class, where indicated.
 2. Commercial class, unless otherwise indicated.
 3. Service class, unless otherwise indicated.
 4. Industrial class, where indicated.
- D. Shop Assembly: Preassemble stairs in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation
- E. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Shear and punch metals cleanly and accurately. Remove sharp or rough areas on exposed surfaces.
- F. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- G. Weld connections to comply with AWS and the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Weld exposed corners and seams continuously, unless otherwise indicated.
 5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

- I. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.09 STEEL-FRAMED STAIRS:

- A. Stair Framing: Fabricate stringers of structural-steel channels, plates, or a combination of both, as indicated. Provide closures for exposed ends of stringers. At platforms and landings, extend stringers around perimeters. Close ends with continuously welded closure plates, ground smooth and flush. Construct platforms of structural-steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to stringers; bolt or weld framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
 1. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- B. Metal Risers, Subtread Pans, and Subplatforms: Form to configurations shown from steel sheet of thickness necessary to support indicated loads, but not less than 0.0677 inch.
 1. Steel Sheet: Uncoated cold-rolled steel sheet, unless otherwise indicated.
 2. Directly weld metal pans to stringers; locate welds on side of subtreads to be concealed by concrete fill. Do not weld risers to stringers.
 3. Attach cast abrasive nosings to risers. Make nosings full width of tread, with noses flush with riser faces and level with tread surfaces.
- C. Steel Floor Plate Treads, Risers, and Platforms: Form to configurations shown from abrasive-surface floor plate of thickness necessary to support indicated loads, but not less than 1/4 inch.
 1. Abrasive-Surface Floor Plate: Fabricate from steel plate, with abrasive material metallurgically bonded to steel by a proprietary process. Provide material with coefficient of friction of 0.6 or higher when tested according to ASTM C1028.
 - a. Products: Subject to compliance with requirements, provide one of the following: 1) Mebac; IKG Borden. 2) SLIP-NOT; W. S. Molnar Company. 3) Or equal.
 2. Form treads with integral nosing and back edge stiffener. Weld steel supporting brackets to stringers and weld treads to brackets.
 3. Fabricate platforms with integral nosings matching treads and weld to platform framing.
- D. Floor Grating Treads and Platforms: Form to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel Stainless Steel, and Aluminum Gratings and Stair Treads."
 1. Fabricate treads and platforms from welded steel grating or pressure-locked steel

grating with bearing bars and crossbars of sizes to meet the required loads.

2. Surface: Serrated.
3. Finish: Galvanized.
4. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.10 STAIR HANDRAILS AND RAILINGS:

- A. General: Comply with applicable requirements in Section 05521.
 1. Railings may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
 2. Connect railing posts to stair framing by direct welding, unless otherwise indicated.

2.11 FINISHES:

- A. General:
 1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 2. Finish metal stairs after assembly.
- B. Galvanizing:
 1. Clean ferrous metal thoroughly before applying zinc coating.
 2. Apply zinc coating to products after fabrication, by the hot-dip method, using coating weighing not less than two ounces per-square-foot.
- C. Preparation for Shop Priming: Prepare uncoated or non-alvanized ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed items:
 1. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- D. Apply shop primer to non-galvanized surfaces of gratings, frames, and supports, except those with galvanized finishes and those to be embedded in concrete or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
 1. Do not apply primer to galvanized surfaces.
 2. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 3. For items shown or indicated to receive paint: Section 09920.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- G. Install precast treads with adhesive supplied by manufacturer.

3.02 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES:

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.
- B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonmetallic, nonshrink grout, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 INSTALLING STEEL RAILINGS AND HANDRAILS:

- A. Adjust handrails and railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:
 - 1. Anchor posts to steel by welding directly to steel supporting members.
 - 2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.
- B. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - a. For hollow masonry anchorage, use toggle bolts.

3.04 PAINTING AND REPAIRING COATED SURFACES:

- A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finish work, except items encased in concrete.
- B. Where shop coat is abraded or burned by welding, clean and touch-up.
- C. Touch-up primed surfaces with same material as coating.
- D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.
- E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
 - 1. Wire brush areas to be coated to bright metal.
 - 2. Apply galvanizing repair compound at rate of two ounces per-square-foot.

END OF SECTION

**SECTION 05521
HANDRAILS AND RAILINGS**

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing pipe and tube handrails and railings.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Miscellaneous Metal: Section 05500.
- B. Metal Stairs: Section 05511.
- C. Ornamental Metal: Section 05700.
- D. Field Painting: Section 09920
- E. Wire Mesh Partitions: Section 10605
- F. Grounding and Bonding: Section 16060

1.03 PERFORMANCE REQUIREMENTS:

- A. General: In engineering handrails and railings to withstand structural loads indicated, determine allowable design working stresses of handrail and railing materials based on the following: Retain only those requirements below that apply to materials specified in Part 2.
 - 1. Structural Steel: AISC S335, "Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design with Commentary."
 - 2. Cold-Formed Structural Steel: AISI SG-673, Part I, "Specification for the Design of Cold-Formed Steel Structural Members."
- B. Structural Performance of Handrails and Railings: Provide handrails and railings capable of withstanding the following structural loads without exceeding allowable design working stresses of materials for handrails, railings, anchors, and connections:
 - 1. Top Rail of Guards: Capable of withstanding the following loads applied as indicated or higher if required by the jurisdictional authority where installed
 - a. Concentrated load of 200 lbf applied at any point and in any direction.
 - b. Uniform load of 50 lbf/ft. applied horizontally and concurrently with uniform load of 100 lbf/ft. applied vertically downward.
 - c. Concentrated and uniform loads above need not be assumed to act concurrently.
 - 2. Handrails Not Serving As Top Rails: Capable of withstanding the following loads applied as indicated or higher if required by the jurisdictional authority where installed:
 - a. Concentrated load of 200 lbf applied at any point and in any direction.
 - b. Uniform load of 50 lbf/ft. applied in any direction.
 - c. Concentrated and uniform loads above need not be assumed to act concurrently.
 - 3. Infill Area of Guards: Capable of withstanding a horizontal concentrated load of 200 lbf applied to 1 sq. ft. at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area or higher if required by the jurisdictional authority where installed.
 - a. Load above need not be assumed to act concurrently with loads on top rails in determining stress on guard.

- C. Thermal Movements: Provide handrails and railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints; overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of handrails and railings.
 - 2. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Show fabrication and installation of handrails and railings. Include plans, elevations, sections, component details, and attachments to other Work.
 - 1. For installed handrails and railings indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for products with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, prepared on components indicated below and of same thickness and material indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
 - 1. 6-inch-long sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Assembled sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Sample need not be full height.
- E. Product Test Reports: From a qualified testing agency indicating products comply with requirements, based on comprehensive testing of current products.
- F. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.05 ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ADA: Americans with Disabilities Act.
 - 3. AGA: The Design and Fabrication of Galvanized Products.
 - 4. AISC: S335.
 - 5. AISI: SG-673, Part I.
 - 6. ASTM: A36, A53, A90, A123, A143, A153, A384, A500, A780, B633, C1107, D256, D635, D638, D695, D790, E488, E548.

7. AWS: D1.1, D1.3.
 8. FED STD: 595.
 9. FS: A-A-462, FF-B-588, FF-H-116, FF-P-395, FF-S-325, TT-P-644.
 10. NAAMM: Metal Finishes Manual for Architectural and Metal Products, Pipe Railing Manual.
 11. SSPC: PA 1, Paint 5, SP 6, SP 7.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of handrails and railings that are similar to those indicated for this Project in material, design, and extent.
- C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E548.
- D. Welding: Qualify procedures and personnel according to AWS D1.1 "Structural Welding Code-Steel, and AWS D1.3," Structural Welding Code-Sheet Steel".
- E. Source Limitations: Obtain each type of handrail and railing through one source from a single manufacturer.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products undamaged.
- B. Store handrails and railings in a dry, well-ventilated, weathertight place.
- C. Handle products so as to prevent damage.

1.07 PROJECT CONDITIONS:

- A. Field Measurements: Verify handrail and railing dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating handrails and railings without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.08 COORDINATION:

- A. Coordinate installation of anchorages for handrails and railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.09 SCHEDULING:

- A. Schedule installation so handrails and railings are mounted only on completed walls. Do not support temporarily by any means that does not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.01 FERROUS METALS:

- A. Metal Surfaces, General: Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.
- B. Steel and Iron: Provide steel and iron in the form indicated, complying with the following requirements:
 - 1. Steel Pipe: ASTM A53; finish, type, and weight class as follows
 - a. Black finish, unless otherwise indicated.
 - b. Galvanized finish for exterior installations and where indicated. Type E, Grade A, standard weight (Schedule 40) for rails and extra heavy weight (Schedule 80) for posts, unless another grade and weight are required by structural loads.
 - 2. Steel Tubing: Cold-formed steel tubing, ASTM A500, Grade A, unless another grade is required by structural loads.
 - 3. Steel Plates, Shapes, and Bars: ASTM A36.
- C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.02 FIBERGLASS REINFORCED PLASTIC (FRP) NON-CONDUCTIVE RAILINGS:

- D. Fabricated from isophthalic-polyester or vinyl ester resin poltruded fiberglass components with polyurethane UV coating, flame retardant per ASTM E4 Class I, meeting the structural performance requirements and with the following minimum properties:
 - 1. Compressive Stress, ASTM D695: 30,000 psi.
 - 2. Tensile Stress, ASTM D638: 30,000 psi.
 - 3. Flexural Stress, ASTM D790: 30,000 psi.
 - 4. Flexural Modulus, ASTM D790: 1.6 x 10⁶ psi.
 - 5. Flamability: Self-extinguishing.
 - 6. Color: Manufacturer's standard unless otherwise indicated.

2.03 WELDING MATERIALS, FASTENERS, AND ANCHORS:

- A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Fasteners for Anchoring Handrails and Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated and capable of withstanding design loads.
 - 1. For steel handrails, railings, and fittings, use plated fasteners complying with ASTM B633, Class Fe/Zn 25 for electro-deposited zinc coating.
- C. Fasteners for Interconnecting Handrail and Railing Components: Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
 - 1. Provide concealed fasteners for interconnecting handrail and railing components and for attaching them to other work, unless otherwise indicated.
 - 2. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

- D. Cast-in-Place and Post-installed Anchors: Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E488 conducted by a qualified independent testing agency.
 - 1. Cast-in-place anchors.
 - 2. Expansion anchors.

- E. Anchoring Devices:
 - 1. Toggle bolt: FS FF-B-588.
 - 2. Drive Stud: FS FF-S-325, Group 6.
 - 3. Expansion Shield: FS FF-S-325, Group I, Class 2, Style 1; Group II, Type 3, Class 1, Group IV, Type 1; best suited to the purpose.
 - 4. Screw Anchors: Lead or plastic for wood or metal screws.
 - 5. Anchor-bolt sleeve: Corrugated high-density polyethylene plastic.
 - 6. Powder actuated: FS FF-P-395.

2.04 COATINGS:

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

- B. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated, and complying with SSPC-Paint 5.

- C. Galvanizing (zinc-coating by hot-dipped process): ASTM A90, ASTM A123, or ASTM A143, ASTM A153 or ASTM A384, as applicable.

- D. Galvanizing Repair Compound: Stick form, melting point 600-degree F to 650-degree F, GALVABAR or equal.

- E. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

2.05 GROUT AND ANCHORING CEMENT:

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

- B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.06 FABRICATION, GENERAL:

- A. Fabricate and prepare products required to be galvanized in accordance with recommendations of AGA.

- B. Fabricate handrails and railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- C. Assemble handrails and railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- D. Form changes in direction of railing members as follows:
 - 1. By bending.
 - 2. By radius bends of radius indicated on approved shop drawings.
- E. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- F. Welded Connections: Fabricate metal handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.
- H. Provide inserts and other anchorage devices for connecting handrails and railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.
- I. For railing posts set in concrete, provide preset sleeves of steel not less than 6 inches long with inside dimensions not less than $\hat{A}1/2$ inch greater than outside dimensions of post, and steel plate forming bottom closure, unless indicated otherwise on approved shop drawings.
- J. For removable railing posts, fabricate slip-fit sockets from steel tube whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
 - 1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- K. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.
- L. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

- M. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.
- N. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members that are exposed to exterior or to moisture from condensation or other sources.
- O. Fabricate joints that will be exposed to weather in a watertight manner.
- P. Close exposed ends of handrail and railing members with prefabricated end fittings.
- Q. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of railing and wall is 1/4 inch or less.
- R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated on approved shop drawings.

2.07 FABRICATION, PIPE RAILINGS AND RAILING GATES:

- A. Pipe: Black steel, ASTM A53, Type E, Grade A, standard weight (Schedule 40) for rails and extra heavy weight (Schedule 80) for posts, unless another grade and weight are required by structural loads, 1 inch nominal ID unless otherwise shown on approved shop drawings. Fabricated in accordance with NAAMM," Pipe Railing Manual" and as shown on approved shop drawings.
- B. Plates, shapes and bars: Structural Steel.
- C. Intersections neatly coped, fully welded and ground smooth.
- D. Heated and bent smoothly, without distortion.
- E. Galvanized after fabrication.
- F. Hardware:
 - 1. Hinges: FS FF-H-116, Type 2127H, US2H finish.
 - 2. Cane bolt: FS A-A-462.
 - 3. Double-acting latch:
 - a. Shop fabricated.
 - b. Housing and strike: Steel, ASTM A36.
 - c. Turn piece and bolt: Bronze, US10B
 - d. Spring: Phosphor bronze.

2.08 FABRICATION, HANDRAILS:

- A. Pipe: Black steel, ASTM A53, Type E, Grade A, standard weight (Schedule 40), 1 inch nominal ID, unless otherwise indicated on approved shop drawings.
- B. Returned to walls at ends with quarter-round bends, with wall flanges welded to bends.
- C. Wall brackets included.
- D. Galvanized after fabrication.

- E. Bonderized and shop primed.

2.09 FINISHES, GENERAL:

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.10 STEEL FINISHES:

- A. Galvanized Handrails and Railings: Hot-dip galvanize exterior steel and iron handrails and railings to comply with ASTM A123. Hot-dip galvanize hardware for exterior steel and iron handrails and railings to comply with ASTM A153/A153M.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A123, for galvanizing steel and iron products.
 - 2. ASTM A153/A153M, for galvanizing steel and iron hardware.
- C. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- D. For galvanized handrails and railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- E. Preparation for Shop Priming: After galvanizing, thoroughly clean handrails and railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.
- F. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed handrails and railings:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 7, "Brush-off Blast Cleaning." Apply shop primer to prepared surfaces of handrail and railing components, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 - 3. Do not apply primer to galvanized surfaces.
 - 4. Stripe paint edges, corners, crevices, bolts, and welds.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

- A. Fit exposed connections together to form tight, hairline joints.

- B. Perform cutting, drilling, and fitting required to install handrails and railings. Set handrails and railings accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.
 - 1. Do not weld, cut, or abrade surfaces of handrail and railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Adjust handrails and railings before anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.
- D. Where pipe railing is mounted on concrete, attach by means of bolts and expansion shields. If concrete surface upon which posts are to be set is low, use full-size steel shims to bring railing to correct elevation.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.

3.02 RAILING CONNECTIONS:

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.03 ANCHORING POSTS:

- A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's written instructions:
- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's written instructions:
 - 1. Nonshrink, nonmetallic grout.
- C. Cover anchorage joint with flange of same metal as post, attached to post as follows:
 - 1. Welded to post after placing anchoring material.
- D. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8-inch build-up, sloped away from post.
- E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
 - 2. Install removable railing sections, where indicated, in slip-fit metal sockets cast in

concrete.

3.04 ANCHORING RAILING ENDS:

- A. Anchor railing ends into concrete and masonry with round flanges connected to railing ends and anchored into wall construction with postinstalled anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces.
 - 1. Weld flanges to railing ends.

3.05 ATTACHING HANDRAILS TO WALLS:

- A. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface.
- B. Locate brackets not more than four feet on centers, or less if required to support structural loads.
- C. Secure wall brackets to building construction with 3/8-inch bolts and expansion shields, powder actuated fasteners or toggle bolts, as applicable.

3.06 PAINTING AND REPAIRING COATED SURFACES:

- A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finish work, except items encased in concrete.
- B. Where shop coat is abraded or burned by welding, clean and touch-up.
- C. Touch-up primed surfaces with same material as coating.
- D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.
- E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
 - 1. Wire brush areas to be coated to bright metal.
 - 2. Apply galvanizing repair compound at rate of two ounces per-square-foot.

3.07 PROTECTION:

- A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 05531

GRATINGS AND FLOOR PLATES

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section includes providing steel gratings, corrosion-resistant gratings, and underground safety walk gratings and floor plates.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Structural Steel: Section 05120.
- B. Miscellaneous Metal: Section 05500.
- C. Metal Stairs: Section 05511.
- D. Handrails and Railings: Section 05521.

1.03 PERFORMANCE REQUIREMENTS:

- A. Structural Performance: Provide gratings capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections:
 - 1. Steel gratings: For walkways, ventilation shafts, light wells and other locations subject to possible vehicular traffic: Capable of withstanding AASHTO HS-20-44 load or higher load if required by the jurisdictional authority where the grating is installed.
 - 2. Steel gratings: For track drainage pumping stations and other locations subject to foot traffic only: Capable of withstanding a uniform load of 250 lbf/sq. Ft. Limit deflection to 1/200 of span.
 - 3. Corrosion-resistant gratings: Capable of withstanding a uniform live load as shown or specified.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For the following:
 - 1. Gratings.
 - 2. Clips and anchorage devices for gratings.
 - 3. Paint products (if applicable).
- B. Shop Drawings: Show fabrication and installation details for gratings. Include plans, elevations, sections, and details of connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
- D. Welding Certificates: Copies of certificates for welding procedures and personnel.

- E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.05 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ADA: Americans with Disabilities Act.
 - 3. ASME: B18.21.1, B18.22.1.
 - 4. ASTM: A36, A90, A123, A143, A153, A242, A307, A384, A510, A570, A536, A563, C633, A653, A780, B633, C1028, D1187, E140, E384, F594.
 - 5. AASHTO HS-20-44.
 - 6. AWS: D1.1, D1.3.
 - 7. FS: RR-G-661.
 - 8. MS: MIL-P-21305.
 - 9. NAAMM: MBG 531, MBG 532.
 - 10. SSPC: PA 1, SP 3, SP 6/NACE No. 3, Paint 12
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of gratings that are similar to those indicated for this Project in material, design, and extent.
- C. Fabricator Qualifications: A firm experienced in producing gratings similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Metal Bar Grating Standards: Comply with applicable requirements of the following:
 - 1. Non-Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads."
 - 2. Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."
- E. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.06 PROJECT CONDITIONS:

- A. Field Measurements: Where gratings are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating gratings without

field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products undamaged.
- B. Store products so as to prevent rust.
- C. Handle products so as to prevent damage.

1.08 COORDINATION:

- A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General Requirements:
 - 1. Insofar as practicable, furnish similar products of a single manufacturer.
 - 2. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 FERROUS METALS:

- A. Steel Plates, Shapes, and Bars: ASTM A36.
- B. High-Strength Low Alloy Structural Steel:
 - 1. ASTM A242.
 - 2. Resistance to atmospheric corrosion: Four times that of carbon steel, minimum.
- C. Wire Rod for Grating Crossbars: ASTM A510.
- D. Uncoated Steel Sheet: ASTM A570, Grade 33.
- E. Galvanized Steel Sheet: ASTM A653, structural quality, Grade 33, with G90 coating.
- F. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy to be welded.
- G. Ductile Iron: ASTM A536.
- H. Grating: Steel, bar and crossbar type as shown, hot-dipped galvanized after fabrication and sizing, FS RR-G-661, Type , Class 1 or 2.

2.03 COATINGS:

- A. Shop Primer for Ferrous Metals: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Zinc-rich paint: MS MIL-P-21305.
- C. Galvanizing (zinc-coating by hot-dipped process): ASTM A90, ASTM A123, or ASTM A143, ASTM A153 or ASTM A384, as applicable.
- D. Galvanizing Repair Compound: Stick form, melting point 600-degree F to 650-degree F, GALVABAR or equal.
- E. Bituminous Coating: Cold-applied asphalt mastic complying with SSPC Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187.

2.04 FASTENERS:

- A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. Plain Washers: Round, carbon steel, ASME B18.22.1.
- D. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.
- E. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

2.05 FABRICATION:

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- C. Shear and punch metals cleanly and accurately. Remove burrs.

- D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated.
- E. Fit exposed connections accurately together to form hairline joints.
- F. Welding: Comply with AWS recommendations and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
 - 4. Fabricate toeplates at height indicated to fit grating units and weld to units in shop, unless otherwise indicated.

2.06 STEEL GRATINGS:

- A. Angles or other structural shapes as supports for grating: Structural steel.
- B. Grating manufactured by electro-pressure welding or pressure-locking process, forming sound welded or pressure-locked joints at intersection of bars and having bars in the same plane.
- C. For walkways, ventilation shafts, light wells and other locations subject to possible vehicular traffic:
 - 1. Traffic Surface: Plain.
 - 2. Gratings: Rectangular type subject to loadings identified under "Performance Requirements.
- D. For track bed drainage pumping stations and other locations subject to foot traffic only:
 - 1. Traffic Surface: Serrated.
 - 2. Gratings: Rectangular type, unless otherwise shown, subject to loadings identified under "Performance Requirements." Fabricated of 1-1/4-inch by 1/8-inch bearing bars at 1-3/16-inch o.c. and crossbars at 4 inches o.c.
- E. Steel Finish: As follows:
 - 1. Shop primer applied according to manufacturer's standard practice.
 - 2. Hot-dip galvanized with a coating weight of not less than two ounces per-square foot of coated surface.
- F. Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
 - 1. Provide not less than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
 - 2. Provide not less than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch or less in thickness and spaced 15/16 inch or more o.c., with each clip designed and fabricated to fit over two bearing bars.
 - 3. Furnish removable steel gratings equipped with locking lugs and provision for bolting to supporting members with stainless steel bolts.
- G. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge-band openings in grating that interrupt four or more bearing bars with bars of the same size and material as bearing bars.
- H. Do not notch bearing bars at supports to maintain elevation.

2.07 CORROSION-RESISTANT GRATINGS:

- A. Fabricate from high-strength low alloy structural steel.
- B. Grating manufactured by electro-pressure welding or pressure-locking process, forming sound welded or pressure-locked joints at intersection of bars and having bars in the same plane.
- C. Grating system shall be fabricated to mechanically secure units in place and of such size to permit one-man operation.
- D. Traffic Surface: As shown.
- E. Gratings: Rectangular type, unless otherwise shown, subject to loadings identified under "Performance Requirements." Fabricated of 2-inch by 3/16-inch bearing bars at 5-inch o.c. and with crossbars at end of six-foot long units.
- F. Subject to compliance with requirements, products are manufactured by Blaw-Knox Company, Irving Grating Company, Reliance Steel Products Company or equal.

2.08 FLOOR PLATES:

- A. Steel Floor Plates: Form to configurations shown from abrasive-surface floor plate of thickness necessary to support indicated loads, but not less than 1/4 inch.
1. Abrasive-Surface Floor Plate: SLIP-NOT as manufactured by the W. S. Molnar Company or approved equal:
 - a. Surface Texture: Grade 1, fine.
 - b. Surface: All metal plasma stream deposition process bonds surface to substrate. Anti-slip primarily martensitic steel surface consisting of a random hatch matrix.
 - c. Surface Hardness, Rockwell C Scale, ASTM E 140 and E 384: Minimum of 55.
 - d. Bond Strength, Surface to Substrate, ASTM C 633: Minimum of 4,000 psi.
 - e. Coefficient of Friction, Anti-Slip Surface: Minimum of 0.6.
 - f. UL Listed: Slip-resistant.

2.09 GRATING FRAMES AND SUPPORTS:

- A. Steel Frames and Supports: Fabricate from structural-steel shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
- B. Equip units with integrally welded anchors for casting into concrete or building into masonry.
1. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.
 2. Galvanize frames and supports unless otherwise indicated.

2.10 FINISHES:

- A. General:
 - 1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 2. Finish gratings, frames, and supports after assembly.
- B. Galvanizing:
 - 1. Clean ferrous metal thoroughly before applying zinc coating.
 - 2. Apply zinc coating to products after fabrication, by the hot-dip method, using coating weighing not less than two ounces per-square-foot.
- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed items:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning".
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- D. Apply shop primer to uncoated surfaces of gratings, frames, and supports, except those with galvanized finishes and those to be embedded in concrete or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.02 INSTALLING GRATINGS:

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
- C. Use bolts, screws or locking lugs to secure safety walk gratings; do not weld.
- D. Consecutively number walkway plate covers with steel stamp after screwed to support channels.

3.03 PAINTING AND REPAIRING COATED SURFACES:

- A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finish work, except items encased in concrete.
- B. Where shop coat is abraded or burned by welding, clean and touch-up.
- C. Touch-up primed surfaces with same material as coating.
- D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.
- E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
 - 1. Wire brush areas to be coated to bright metal.
 - 2. Apply galvanizing repair compound at rate of two ounces per-square-foot.

END OF SECTION

SECTION 05651

GENERAL TRACK CONSTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This section specifies general track construction procedures and requirements including laying continuous welded rail, joining CWR strings, final alignment and inspection. The Design-Builder shall comply with all safety and health regulations. Associated train control and traction power Sections are located elsewhere in this Specification.
- B. Track construction shall include yard and storage tracks as indicated on the Drawings, and specified herein.

1.02 RELATED SECTIONS

- Section 02727 - Ballast
- Section 05091 - Rail Welding
- Section 05652 - Ballasted Track Construction
- Section 05654 - Special Trackwork Construction - Ballasted
- Section 05656 - Rail
- Section 05658 - Track Appurtenances and Other Track Material
- Section 05659 - Special Trackwork
- Section 05660 - Restraining Rail and Lubricators
- Section 06130 - Timber Ties
- Section 06132 - Timber Grade Crossings

1.03 REFERENCES

Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

- 1. American Railway Engineering and Maintenance-of-Way Association, Manual for Railway Engineering, herein referred to as the AREMA Manual.
- 2. American Railway Engineering and Maintenance-of-Way Association, Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio
- 3. American Society of Testing and Materials (ASTM)

1.04 SUBMITTALS

- A. Submittals shall be in accordance with Section 01330, Submittals of these Specifications.
- B. Submittals shall include certificates of compliance, codes and regulations of the jurisdictional authorities as well as other submittals stipulated in these Specifications.
- C. Provide five each AREMA approved rail thermometers. Two of the five shall be a quick reading digital type. The thermometers shall become WMATA property.
- D. Provide four Geismar RCAT-A1 two-piece combination track levels and gauges, or approved equal, with current calibration. They shall become WMATA property.
- E. Provide three Aldon AL-102 combination rolling track gauge readers and digital track levels, equipped with distance counters and carrying cases, or approved equal, with current calibration. They shall become WMATA property.

- F. Submit method and equipment for transport of rail.
- G. Submit rail end-hardening procedure and the personnel who will perform the end-hardening of the rails in the field.
- H. Submit test reports on two samples of field end-hardened rail which shall be tested by an approved independent laboratory.
- I. Submit for approval detailed procedures of the following items required in connection with laying and joining CWR strings:
 - 1. String schedule showing length and location of strings.
 - 2. Equipment to be used.
 - 3. Procedure for positioning CWR strings in track, setting gaps between strings and initial fastening.
 - 4. Procedure for lining, gauging and profiling of rails, and tightening of anchor bolts.
 - 5. Procedure for joining CWR strings, including method of obtaining correct gap if joined at a different temperature than at which it was laid.
 - 6. Procedure for zero thermal rail stress adjustment and for anchoring CWR strings to zero thermal stress temperature, including control of rail movement and installing rail clips for fastening of rail to plates or D.F. fasteners.
 - 7. Special procedure for closing last string with previously anchored rail or special trackwork.

1.05 QUALITY ASSURANCE

Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan. Perform all measures necessary to assure quality of the Work. This shall include source quality control and field quality control requirements specified in these Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

General: All trackwork materials required by the specifications for the track construction, except those furnished by the Authority, shall be furnished by the Design-Builder in accordance with the related section and references.

PART 3 - EXECUTION

3.01 CONSTRUCTION EQUIPMENT

- A. Track gauge, guardrail, restraining rail, flangeway width, curve radii, rail sections and special trackwork components are designed for WMATA Metro Rail Vehicle and Crane Car operation. Modify on-track equipment, as required, to operate over this track without causing damage to the track structure. Damages to the track structure shall be repaired by Design-Builder at the Design-Builder's own expense.
- B. Clearance for the on-track equipment shall conform to the requirements for vehicle clearances.
- C. Design-Builder's equipment shall not exceed the design loads. Further information concerning vehicle characteristics will be provided by the Authority upon request by Design-Builder. Verify that proposed equipment meets these requirements.

3.02 MONUMENTATION

- A. Monuments will be furnished and installed by other trades to establish the centerline of track.
- B. Monuments will be set at all points of change in horizontal alignment including PC and PT, and on tangents and within curves as needed to provide monuments not more than 1,000 feet apart throughout the work. All adjacent monuments will be intervisible. The location of the monuments will be offset outside the track invert section.
- C. The Authority Representative will provide the Design-Builder with identifications and elevations to one thousandth of a foot for all monuments.
- D. The use of controls for survey other than the monumentation described above shall be at the Design-Builder's risk.

3.03 ALIGNMENT AND PROFILE DATA

- A. Track shall be constructed conforming to the alignment and profile data shown on the drawings as modified by the requirements in these specifications.
- B. Alignment information shown on the drawings refers to geometric control points for the track. Alignment is based on the centerline of track, equidistant between gauge sides of the running rails. Profile refers to top of the lower rail in final position.
- C. Construction of embedded shop tracks and direct fixation track shall not begin until final alignment data is available.

3.04 ENGINEERING STATIONING

- A. Engineering stationing is not continuous and is subject to equations.
- B. Engineering stationing is used to reference all geometric control points.
- C. Mathematized alignment data for each track is included in drawings.

3.05 RAIL CANT

- A. Construct track with rails canted at 40 to 1 inclination toward the centerline of track
- B. Construct rail in special trackwork with no cant.
 - 1. Construct the outside rail in track with restraining rail with 40 to 1 cant inclined toward the centerline of track. Construct the inside rail and restraining rail with no cant.

3.06 TRACK GAUGE

- C. Track gauge will be measured between points 5/8 inch below top of rail on the inside faces of the running rails.
- D. Track gauge shall be as follows:
 - 1. Tangent and curves with radius greater than or equal to 350 feet: 4 feet, 8-1/2 inches. The gauge lines shall be equidistant between the centerline of track.
 - 2. Curve of radius less than 350 feet: 4 feet, 9-1/4 inches. The gauge line for the outside rail shall be 2 feet, 4-1/4 inches from the centerline of track.
 - 3. No. 6 Guarded and No. 8 Turnouts: 4 feet, 8-1/2 inches for both tracks.

3.07 TRACK GAUGE TRANSITIONS

- A. Gauge widening at curves shall be done on the tangents and shall be completed at the junction of the tangent and the circular curve. Minimum transition length shall be 15 feet.

3.08 TRACK TOLERANCES

- A. The final gauge, cross level, horizontal and vertical alignment of all tracks shall be as specified within the tolerances as shown in **Exhibit 05651-A** for each specific type and class of track.
- B. Variations of gauge and cross level with respect to tolerances shall be at a rate of change not exceeding 1/8 inch per 31 feet of track.
- C. All rail between the limits shown on the drawings for high strength rail shall be high strength rail. High strength rail may extend beyond the limits shown.
- D. Prior to start of rail installation the Design-Builder shall furnish to the Authority Representative three Aldon AL - 102 Combination Rolling Track Level and Gauge Readers equipped with optional distance counters and carrying cases, or approved equal. Also furnish to the Authority Representative four Geismar RCAT-A1 two-piece combination track levels and gauges.

3.09 CLEARANCE ENVELOPE

- A. The transit car outline in the design of the Metro system is shown in **Exhibit 05651-B** for information.
- B. Equipment proposed for use by the Design-Builder for performance of work under this Contract shall be submitted for approval. The submittal shall include a drawing showing the outline of the proposed equipment superimposed on the transit car outline.

3.10 TYPES OF RAIL

- A. 115 RE rail shall be in accordance with Section 05656, Rail, and shall be used in the following locations.
 - 1. As running rail in yard and storage tracks.
 - 2. As stock rails, switch rails, closure rails, and other rails in special trackwork but not as frog, front and turnout guard rails and not as restraining rail.
- B. 132 RE rail shall be in accordance with Section 05656, Rail, and shall be used in the following locations.
 - 1. As frog guard rails.
 - 2. As front and turnout guard rails in Guarded No. 6 Turnouts.
 - 3. As restraining rail.
- C. Running rail for use in yard and storage tracks shall be either standard carbon or high strength rail (head hardened or fully heat treated) in accordance with Section 05656, Rail, and shall be used where indicated on the Design Drawings. Where the design drawings show high strength rail is to be used in a track, both running rails in the track shall be high strength rail. High strength rail may be used in lieu of standard rail.
- D. Special trackwork rails (stock rails, switch rails, closure rails, frog guard rails, front guard rail, turnout guard rail, etc.) and restraining rail shall be high strength rail (head hardened or fully heat treated) in accordance with Section 05656, Rail.

3.11 RUNNING RAIL REQUIREMENTS

- A. Running rail procurement is covered under Section 05656, Running Rail.
- B. Running rail for use in continuous welded rail (CWR) track shall be welded in accordance to Section 05091, Rail Welding.
- C. Transport and distribute rail:
 - 1. Rail shall be transported and distributed in such a manner and by use of such equipment that bumping or striking of the rail will be avoided. The method and equipment used by the Design-Builder shall be subject to approval by the Authority Representative. Continuous welded rail (CWR) shall be transported and laid in place in an efficient, expeditious manner that will prevent damage to fasteners, rail and structures.
 - 2. Rail should not be dropped or dragged on the track bed. The use of rollers is required to facilitate transporting and reduce the risk of damage to rail, track fasteners, track appurtenances and facilities.
- D. Procedure of laying and joining CWR strings: Submit for Authority Representative's approval the detailed procedure of the following items of work required in connection with laying and joining CWR strings.
 - 1. String schedule showing length and location of strings. Refer to string schedule requirements in Section 05091, Rail Welding.
 - 2. Equipment to be used.
 - 3. Procedure for positioning CWR strings in track, setting of gaps between strings and initial fastening.
 - 4. Procedure for lining and gauging the rails and surfacing the track.
 - 5. Procedure for joining CWR strings including method of obtaining correct gap.
 - 6. Procedure for zero thermal stress adjustment and for anchoring strings to zero thermal-stress temperature, including control of rail movement and installing rail clips for fastening of rail to the standard Pandrol tie plate.
 - 7. Procedure for closing string with previously anchored rail/special trackwork units.
- E. Cutting and drilling of rails:
 - 1. No holes or cuts in the CWR shall be permitted except as shown and specified. Rails shall be cut square and clean by means of rail saws or abrasive cutting disks in accordance with AREMA Manual Chapter 4, Part 2 Specifications. Cut no rail for the installation of a bonded joint within 5 feet of a weld.
 - 2. For insulated and non-insulated running, guard and restraining rail joints and for separator, filler and end blocks for guard and restraining rails, holes shall be located as shown and as directed by the Authority Representative.
 - 3. Holes shall be cylindrical and perpendicular to the rails vertical centerline.
 - 4. Diameter of holes for restraining rail shall be as shown on the drawings.
 - 5. Diameter of holes for running rail and guard rail joints and for guard rail separator and end blocks shall be of the proper diameter for the bolt required.
 - 6. Holes shall be drilled directly through the web of the rail with an approved rail drill.
 - 7. An approved template shall be used as a guide for drilling holes. In no case shall a joint bar be used for this purpose.
 - 8. All rejected rail holes must be saw-cut from the rail. Saw cut shall be made at least 3 inches from the hole.
 - 9. All holes shall be reamed smooth, edges beveled and burrs removed.
 - 10. The process for drilling and deburring holes shall not mechanically or metallurgically damage the rail.
 - 11. Cutting rail or burning holes in rail by use of a torch is prohibited.
 - 12. Accurately space holes for bolting of rail and drill with a rail drill in accordance with the current requirements of AREMA Manual for Railway Engineering, Specifications for Rail Drilling, Bar Punchings and Track Bolts.

- F. Beveling of Rail Ends:
1. Bevel rail ends at non-insulated joints in accordance with current AREMA Standard Plan No. 1005.
 2. Rail ends in insulated joints shall be beveled in accordance with the joint manufacturer's written specifications. Unless otherwise stated in a manufacturer's written specifications, rail ends shall be beveled in accordance with AREMA Standard Plan No. 1005.

G. End-Hardening

1. Rail ends in standard rail and high strength rail with Brinell hardness below 341 shall be shall be end-hardened in the field. Joints bars and their insulating material shall be removed from rail ends during the end-hardening process.

Rail ends that have been end hardened and are found to fail to meet the hardness requirements may be retreated and checked for minimum hardness.

The end-hardening procedure, and the personnel who perform the end-hardening of the rails in the field, shall be subject to approval by the Authority Representative, which will depend upon the acceptance of two samples of field end-hardening performed according to the approved procedure and by the personnel who will perform the field end-hardening. The two samples of field end-hardened rail shall be tested by an approved independent laboratory. The Design-Builder shall notify the Authority Representative 48 hours prior to the performance of field end-hardening of rails.

2. End Hardening Tests:
 - a. The two samples shall be tested for Brinell hardness in accordance with ASTM E10, in a grid pattern on the rail head surface of 1/8 inch increments for a distance of six inches from the end of the rail.
 - b. When Brinell hardness is not directly measured, the hardness results shall be converted using ASTM E140.
 - c. The hardness number and location shall be recorded.
 - d. After the hardness test is performed, one sample shall be sectioned for one foot along the centerline of rail and the other sample shall be sectioned transversely 1/2 inch from the end of rail. These cross sections shall be etched to enable the observation of the hardness pattern.
3. Acceptance Criteria:
 - a. The hardness measured at a spot on the centerline of the head 1/4 inch to 1/2 inch from the end of the rail shall show a Brinell hardness number range of 341 to 401 when decarburized surface has been removed.
 - b. The heat-affected zone defined as the region in which the hardness is above that of the parent metal shall cover the full width of the rail head and extend longitudinally a minimum of 1-1/2 inch from the end of the rail. The effective hardness zone 1/2 inch from the end of the rail shall be at least 1/4 inch deep.
 - c. A report of hardness determination shall be given to the Authority Representative.
 - d. The hardness pattern shall be uniform across the top surface of the rail head.
 - e. The etched cross sections of the rail shall exhibit a uniformly distributed hardness pattern.

3.12 LAYING CONTINUOUS WELDED RAIL

- A. Laying CWR String: The contractor shall submit to the Authority Representative for approval a CWR string laying procedure that includes the following requirements.

1. In the yard, CWR string refers to all running rail lengths per the string welding schedule and individual rail sticks including the minimum length rail stick permitted to be installed.
 2. CWR strings shall be laid on the installed tie plate in accordance with the approved string schedule submitted under Section 05091, Rail Welding.
 3. The temperature of the strings and other data shall be measured and recorded. Information to be recorded shall be as shown on **Exhibit 05651-C (Part 1 of 2) and (Part 2 of 2)**.
 4. The strings shall be laid with a gap between them. The size of the rail laying gap shall consider:
 - a. String(s) length(s),
 - b. Actual rail temperature at time of laying,
 - c. The prescribed zero thermal rail stress temperature,
 - d. The use of Dutchman or other techniques to protect rail ends from damage by on-rail equipment prior to the strings being joined,
 - e. The method of preventing damage due to thermal expansion prior to the rails being fully anchored and ballast cribs and shoulders fully developed.
 - f. Initial Fastening of Rail
 - 1) Prior to use by on-track equipment, fastening the newly laid rail at proper gauge at a number of ties on tangent and curved track.
 5. When and where strings will be anchored, unanchored and vibrated during the rail laying process.
- B. Rail Temperature and Rail Thermometer:
1. Rail temperature shall be determined by means of reliable AREMA standard rail thermometers as specified in Chapter 5 of the AREMA Manual.
 - a. Place two rail thermometers on the shaded side of the rail base next to the web and leave in place until no change in the readings are detected, but not less than ten minutes.
 - b. When determining the actual rail temperature average the temperature readings taken at a minimum of two locations along the rail string..
 2. Deliver five each AREMA approved rail thermometers to the Authority Representative within 30 days after NTP.
 3. Two of the five thermometers shall be a quick reading digital type. Thermometers shall become Authority Property.
- C. Determining Gap Between Rail Ends:
1. The gap between CWR strings, or between CWR and bolted rail shall be determined by the equation:

$$G=(t-T)(L)(K)+Q$$

Where: G=rail gap in inches;

t=zero thermal stress temperature for type of track construction (Sections 05652);

T=Average actual rail temperature at time of laying degrees F.;

L=The length of the rail being laid or the length of the rail being adjusted to the zero thermal stress temperature ;

K=Coefficient of thermal expansion for rail steel, (0.000078 inch per foot per degree F.); and

Q=Rail gap as required by manufacturers of bonded standard joints For insulated joints, Q equals the end post thickness. For AREMA standard bolted joints, as recommended by AREMA for a rail length equal to the string length or 100 feet, which ever is smaller.

3.13 LINING, GAUGING, AND PROFILING CWR

- A. Each CWR string shall be brought to within 1/2 inch or less of final horizontal and vertical alignment before joining, thermal adjustment and anchoring. The procedures specified for ballasted track construction shall be used

3.14 JOINING CWR STRINGS

- A. Yard and secondary track CWR shall be joined by bonded non-insulated joints or, where required by the signal design, bonded insulated joints. CWR joined to turnouts shall be joined by AREMA bolted standard joints or, where required by the signal design, bonded insulated joints.
- B. Joints shall not be placed in the following locations unless specifically shown or specified otherwise:
 - 1. Within 19 feet from the center of bonded or bolted joints in the same rail.
 - 2. Within eight feet of joints in the opposite rail, except when joining turnout rails.
 - 3. Within eight feet of shop welds in the same rail.
- C. Joint Requirements: Joints shall be installed in accordance with Section 05658, Track Appurtenances and Other Track Material.

3.15 ZERO THERMAL RAIL STRESS ADJUSTMENT AND ANCHORING OF CWR

- A. The contractor shall submit to the Authority Representative for approval the procedures for adjusting the rail strings to the zero thermal rail stress temperature and for anchoring the adjusted strings. The procedure shall include the following requirements.
 - 1. The installation of the Pandrol e2056 Spring Clips (or any other rail anchoring devise) shall be considered as anchoring the rail.
 - 2. Rail strings shall not be adjusted until the string is within 1/2 inch or less of the final horizontal and vertical alignment. Method of demonstrating the rail string to be adjusted is within 1/2 inch or less of final horizontal and vertical alignment.
 - 3. Immediately prior to adjusting the string(s), the actual rail string(s) temperature(s) shall be measured.
 - 4. Method of determining the length of rail to be adjusted.
 - 5. Method of calculating each rail string's end and quarter points will move when thermally adjusted.
 - 6. Method of marking the rail and reference points at the string(s) end and quarter points.
 - 7. The rail string shall be fully unanchored and vibrated to relieve thermal rail stresses before marking the rail and reference points.
 - 8. Method of calculating and marking the rail and reference points to demonstrate the amount of rail movement at the string(s) end and quarter points are within the zero thermal stress temperature range specified in Section 05652, Ballasted Track Construction.
 - 9. The method of heating or cooling and vibrating the rail so it will be adjusted uniformly along the rail string. Rail pulling shall not be used.
 - 10. The method the rail string will be fully anchored when the rail string is adjusted uniformly. If the adjustment falls out of the adjustment range while anchoring, anchoring shall cease and not begin again until uniform adjustment has been achieved again within the specified tolerance.
 - 11. When a CWR string closes on and is to join a fully anchored string or existing rail as soon as the adjustment is completed, the fully anchored string or existing rail shall have its anchors removed and vibrated for 300 feet and the 300 feet shall be adjusted and vibrated uniformly to the zero thermal-rail stress temperature at the time the strings are joined. This requirement does not apply when a string closes on a new or existing turnout.

12. If the procedure requires the adjusted rail string to be joined to another anchored string or existing rail or turnout with rail anchoring to occur at a later time, the procedure shall explain how the track and turnouts will be protected from damage resulting from subsequent thermal rail string expansion and contraction.
13. If the procedure requires the adjusted rail string to be fully anchored and the string end to be joined at a later time, the procedure shall require that when the rail end is to be joined, 300 feet of the string shall be unanchored, vibrated, uniformly adjusted and vibrated before joining.
14. The size of gap each type of joint requires after the rail strings are uniformly adjusted.
15. The method of achieving the gap a joint requires when the rail strings are uniformly adjusted to within the rail's zero thermal stress temperature range.
16. If at any time during the thermal adjustment, anchoring and joining process the string falls outside of 1/2" from the final horizontal and vertical alignment, the process shall be stopped, anchors removed, alignment adjusted, and the procedure started again from the beginning.
17. When the second rail of the track is adjusted, anchored and joined, same procedures shall apply with the additional requirement that the temperature of the second rail shall be within 5 F of the rail temperature of the first rail immediately before it was adjusted.
18. When thermally adjusted rail is cut to remove a defect, to install a rail component, etc., then 300 feet of rail in both directions from the cut(s) shall be unanchored, vibrated, thermally adjusted, vibrated, anchored and joined using the same procedures.

- B. Record of Laying, Joining, Zero Thermal Rail Stress Adjustment and Anchoring: A record of rail laying, joining, thermal adjustment and anchoring data shall be made by the Design-Builder and be witnessed and approved by the Authority Inspector, for each installed string of CWR. The record shall be made on and include the data shown on **Exhibit 05651-C (Part 1 of 2)**.

3.16 FINAL ALIGNMENT AND TRACK INSPECTION

- A. The final horizontal and vertical alignment, gauge and cross level shall be within the specified tolerances.
- B. In order to determine the acceptability of finished track, the Authority will make an inspection of the track.
- C. Track deviations, as disclosed by the inspection, which exceed specified tolerances shall be corrected by the Design-Builder at no additional cost to the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

No separate measurement of work specified in this Section shall be made.

4.02 PAYMENT:

Compensation for work specified in this Section will be included in the price of the work of which it is a part.

TRACK CONSTRUCTION TOLERANCES

TYPE AND CLASS OF TRACK	GAUGE VARIATION	GROSS LEVEL AND SUPERELEVATION VARIATION	VERTICAL TRACK ALIGNMENT		HORIZONTAL TRACK ALIGNMENT	
			TOTAL DEVIATION	MIDDLE ORDINATE IN 62' CHORD	TOTAL DEVIATION	MIDDLE ORDINATE IN 62' CHORD
DIRECT FIXATION, MAIN	± 1/8"	± 1/8"	± 1/4"	± 1/8"	± 1/4"*	± 1/8"
BALLASTED, MAIN	± 1/8"	± 1/8"	± 1/2"	± 1/8"	± 1/2"*	± 1/8"
DIRECT FIXATION, YARD & SECONDARY	± 1/8"	± 1/8"	± 1/2"	± 1/8"	± 1/4"	± 1/8"
BALLASTED, YARD & SECONDARY	+1/4" -1/8"	± 1/4"	± 1/2"	± 1/4"	± 1/2"	± 1/8"

TOTAL DEVIATION IS MEASURED BETWEEN THE THEORETICAL AND ACTUAL ALIGNMENTS AT ANY POINT IN THE TRACK.

* TOTAL DEVIATION IN STATION AREAS SHALL BE 0" TOWARD PLATFORM AND 1/4" AWAY FROM PLATFORM.

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

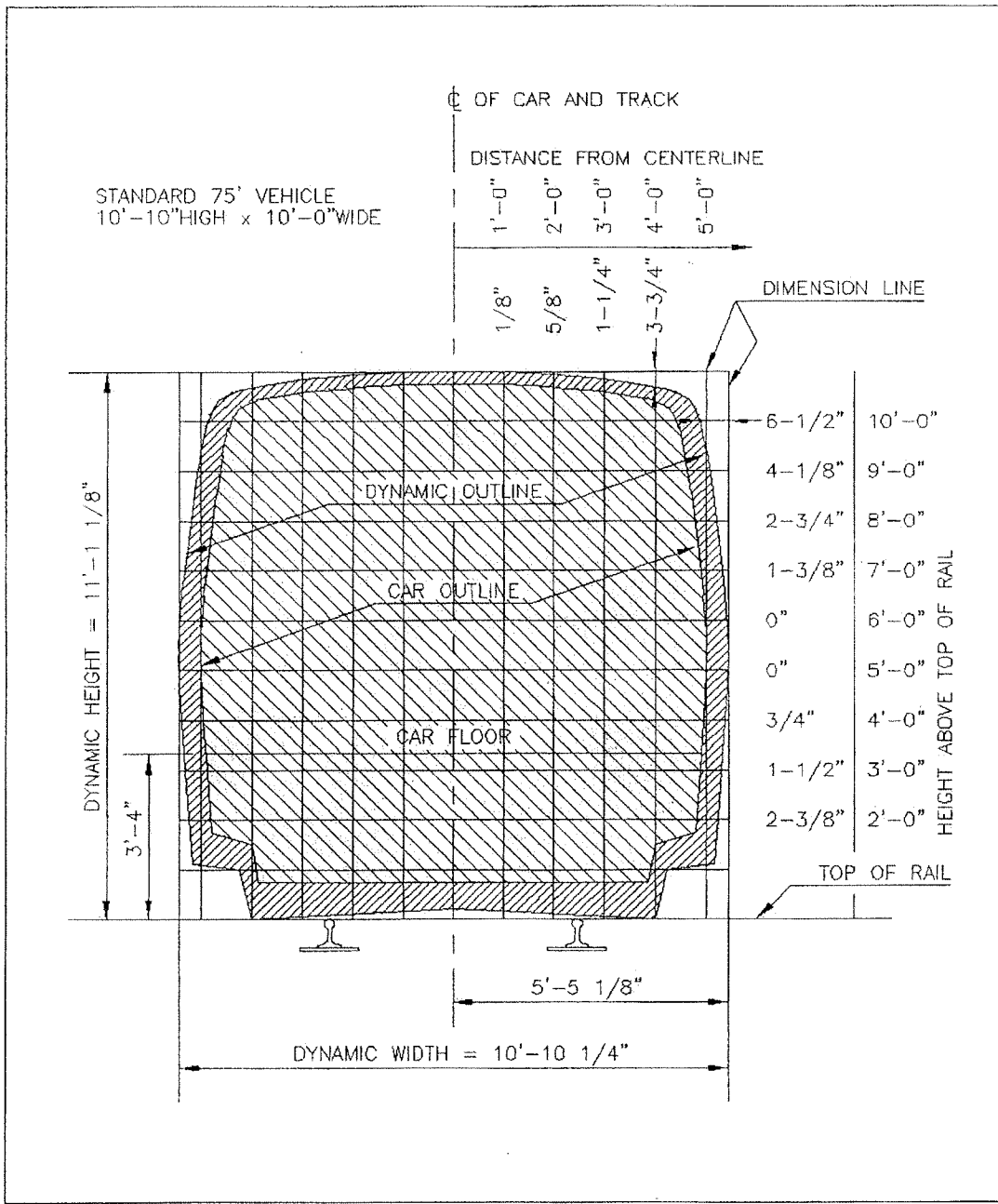
DE LEUW, CATHAR & COMPANY
SECTION DESIGNER

TRACK CONSTRUCTION TOLERANCES
EXHIBIT 05651-A

SCALE: NONE

DATE: JANUARY 2001

05651-12



WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

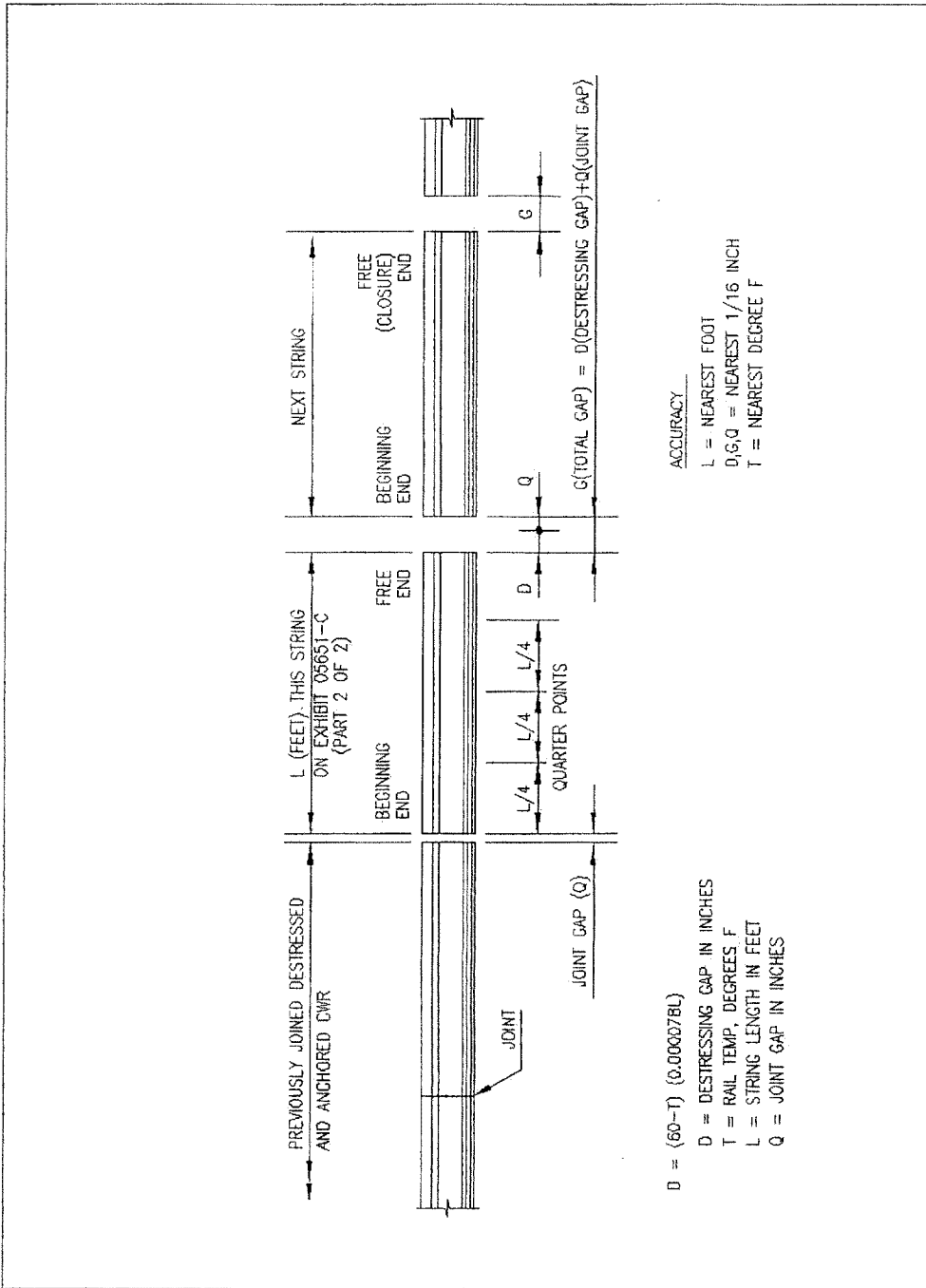
DE LEUW, CATHER & COMPANY
SECTION DESIGNER

DESIGN VEHICLE DYNAMIC OUTLINE DIAGRAM
TANGENT TRACK
EXHIBIT 05651-B

SCALE: NONE

DATE: JANUARY 2001

05651-13



WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DE LEUW, CATHER & COMPANY
SECTION DESIGNER

RECORD OF C.W.R. LAYING
EXHIBIT 05651-C (PART 1 OF 2)

SCALE: NONE

DATE: JANUARY 2001

05651-14

GENERAL INFORMATION

STRING: (String Number) _____
TRACK: (Inbound or Outbound) _____
RAIL: (Right or Left) _____
BEGINNING STATIONING: _____
ENDING STATION: _____
STRING LENGTH (L): _____

LAYING DATA

DATE LAID: _____
TIME LAID: _____
AIR TEMP: _____
CWR STRING TEMP (T): _____
COMPUTED GAP REQUIRED AT FREE END (G): _____
ACTUAL GAP LEFT AT BEGINNING END (G OR Q): _____
JOINT TYPE TO BE INSTALLED AT BEGINNING END (Q): _____

JOINING DATA

BEGINNING END CLOSURE END (WHEN NEEDED)
DATE JOINED: _____
TIME JOINED: _____
AIR TEMP: _____
CWR TEMP: _____
GAP AT START: _____
METHOD OF ADJUSTING GAP FOR BEGINNING END JOINT: _____
(A = CUT IN/OUT PIECE; B = MOVE ENTIRE STRING)

DESTRESSING/ANCHORING DATA

DATE DESTRESSED/ANCHORED: _____
TIME DESTRESSING STARTED: _____
AIR TEMP AT START: _____
CWR TEMP (T) AT START: _____
MOVEMENT FOR DESTRESSING (D)
COMPUTED MEASURED (ACTUAL)
1/4 POINT: _____
1/2 POINT: _____
3/4 POINT: _____
FREE END: _____
CWR TEMP AT COMPLETION: _____
AIR TEMP AT COMPLETION: _____
TIME ANCHORING COMPLETED: _____
CONTRACTOR'S REPRESENTATIVE: _____
ENGINEER'S REPRESENTATIVE: _____
DATE SUBMITTED: _____

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DE LEUW, CATHER & COMPANY
SECTION DESIGNER

RECORD OF C.W.R. LAYING
EXHIBIT 05651-C (PART 2 OF 2)

SCALE: NONE

DATE: JANUARY 2001

05651-15

END OF SECTION

SECTION 05652

BALLASTED TRACK CONSTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. The work in this Section shall include the construction of ballasted yard track as indicated on the drawings and as specified in these specifications.
- B. The construction of ballasted track shall include:
 - 1. Preparation of subgrade and placement of subballast and ballast.
 - 2. Hauling of construction materials.
 - 3. Distribution and spacing of ties.
 - 4. Laying, de-stressing and joining of continuous welded rail (CWR) strings
 - 5. Construction of ballasted track
- C. The above construction is encompassing and includes all pertinent trackwork related items associated with track construction such as the standard and insulated joints; rail cutting and stress adjustment; tamping, surfacing lining and gauging and all other operations necessary to construct an acceptable completed track structure.
- D. Unless otherwise shown or specified, trackwork within limits of ballasted special trackwork units is not included in this Section.

1.02 RELATED SECTIONS

Section 02726 - Subballast.
Section 02727 - Ballast.
Section 05091 - Rail Welding.
Section 05651 - General Track Construction.
Section 05654 - Special Trackwork Construction - Ballasted.
Section 05656 - Rail.
Section 05658 - Track Appurtenances and Other Track Material.
Section 05660 - Restraining Rail and Lubricators.
Section 06130 - Timber Ties.
Section 06132 - Timber Grade Crossing.

1.03 REFERENCES

- A. Codes and regulations of the jurisdictional authorities.
- B. American Railway Engineering and Maintenance-of -Way (AREMA), Manual for Railway Engineering, herein referred to as the AREMA Manual are as follows:
 - 1. Chapter 4, Part 1, Rail Drilling, Bar Punching and Track Bolts.
 - 2. Chapter 5, Part 4, Specifications for Track Construction.

1.04 SUBMITTALS

- A. Submittals shall be specified in Section 01330, Submittals. The following submittals shall be made by the Design-Builder:

1. Top of subgrade survey and calculations demonstrating minimum subballast and ballast thicknesses can be in place when the track is set with alignment tolerances.
2. Top of subballast survey and calculations demonstrating minimum ballast thicknesses can be in place when the track is set with alignment tolerances.
3. Detailed descriptions of construction procedures required for the work specified in this Section.
4. Samples required for the work specified in this Section.
5. Test results required for the work specified in this Section.
6. Working Drawings showing the proposed method for temporary fastening of rail during installation.
7. Required rail temperature record forms for rail laying and rail fastening operations.
8. Five thermometers as specified in Section 05651, General Track Construction, Article 3.12, Laying Continuous Welded Rail.

1.05 QUALITY ASSURANCE

- A. Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.
- B. In order to determine the acceptability of the installation, the Design-Builder shall make a survey of the completed track, and provide the Authority Representative with a copy for review. Deviations from the drawings which exceed tolerances specified in Section 05651, General Track Construction, shall be corrected by the Design-Builder at no additional cost to WMATA.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The following track materials shall be furnished by the Design-Builder and any additional items necessary to construct an acceptable, completed track structure.
 1. Subballast
 2. Ballast
 3. Ties
 4. Special Trackwork
 5. Running Rail
 6. Track Appurtenances and Other Track Material
 7. Restraining Rail and Lubricators (as required)
 8. Bumping Posts (as required)

PART 3 - EXECUTION

3.01 GENERAL

- A. All ballasted yard track shall be constructed with Pandrol spring clips, elastic fastener tie plates punched for four 15/16 inch screw spikes.
- B. Track within the limits of ballasted special trackwork units shall be constructed as specified for Special Trackwork Construction.

- C. Ballasted track construction includes constructing new yard tracks to join existing yard tracks and new shop tracks as specified and shown in the contract documents. Also includes smoothing the existing track alignment where the new tracks join.
- D. Ballasted track construction includes placing subballast and ballast, distributing and lining ties; installing, anchoring, and joining CWR strings, raising and lining track; and other incidentals as required and as specified for in Section 05651, General Track Construction, except as modified herein.

3.02 TOLERANCES FOR BALLASTED TRACK

- A. Deviation from the gauge, cross level, horizontal alignment and vertical alignment shall not exceed the tolerance specified.

3.03 PLACEMENT OF SUBBALLAST

- A. Subballast shall be distributed, placed and compacted in accordance with Section 02726, Subballast.
- B. Prior to placement of subballast all trash and debris shall be removed from subgrade.
- C. Subgrade shall be clear and void of tire ruts, large stone or other deleterious objects before placement of subballast.
- D. Subgrade shall be dry and not frozen before placement of subballast.
- E. Prior to placement of subballast, the Design Builder shall survey the top of subgrade and shall prepare and submit to the Authority Representative for approval calculations demonstrating the top of subgrade permits minimum sub-ballast and ballast thicknesses to be in place when the track alignment is within the specified tolerances.

3.04 INITIAL LAYER OF BALLAST

- A. An initial layer of ballast shall be uniformly distributed over the finished subballast and compacted before tie distribution. The ballast shall not be distributed on the roadbed until the subballast has been approved. Subballast fouled or distributed by the Design-Builder's operations shall be repaired by the Design-Builder at no additional cost to the Authority. Subballast shall be dry and not frozen when ballast is placed.
 - 1. Prior to placement of initial layer of ballast, the Design Builder shall survey the top of subballast and shall prepare and submit to the Authority Representative for approval calculations demonstrating the top of subballast permits minimum ballast thickness to be in place when the track alignment is within the specified tolerances.
- B. The initial layer of ballast shall be limited to a total compacted depth that will establish the track top of rail surface at least four inches below final profile and cross slope, with further provision that each compacted lift shall be a maximum depth of four inches.
- C. The ballast depth shall conform to the cross sections shown. Each lift of ballast shall be uniformly spread. Each lift of ballast shall be fully compacted by a self-propelled pneumatic-tired roller or a vibrating compactor.

- D. The self-propelled pneumatic-tired roller shall have a minimum gross weight of nine tons and the vibratory compactor shall have a minimum weight of 5,000 pounds capable of applying a dynamic load of 18,000 pounds or more. The equipment selected by the Design-Builder shall be subject to approval by the Authority Representative.

3.05 DISTRIBUTION AND SPACING OF TIES

- A. All ties shall be carefully distributed and properly spaced on the initial layer of ballast with every fourth tie being a contact rail tie unless otherwise specified or shown.
- B. Care shall be exercised in the placement of contact rail ties to ensure the proper offset for contact rail supports.
- C. Unnecessary handling, distribution and reloading of ties shall be avoided. To the extent practicable, ties shall be distributed in proper position for use without further handling. They shall be unloaded in a manner that will not damage the ties. In no case shall ties be dropped. Ties shall be moved only with tie tongs or by leverage with a bar.
- D. Ties shall be installed radially on curves and at right angles to the centerline of tangent track at the designed spacing prior to rail installation. The lined side can be either side on tangent track but shall be the same side for the full length of a tangent. The line side shall be to the outside of curves. The line ends of timber track ties are offset 4 feet 3 inches from the centerline of track.
- E. Contact rail ties shall be installed to properly support the contact rail on the side of the track as shown on the traction power drawings prepared by the Design Builder. When the contact rail is on the same side as the line side, the contact rail tie end shall be offset 18 inches from the line ends of the timber ties. When the contact rail is on the other side, the ends of the contact rail ties on the line side shall align with the line ends of the track timber ties. The line end shall be lined with the adjacent ties.
- F. Ties damaged as a result of improper handling by the Design-Builder and rejected by the Authority Representative shall be removed and replaced with new ties.
- G. Timber ties shall be adzed only with the Authority Representative's approval.
- H. Timber ties shall be installed with the heartwood face down.
- I. Tie Boring:
 - 1. All timber ties shall be bored in the field. Timber tie boring shall be performed with the heartwood face down. For Pandrols 15/16" diameter screw spikes, 6 inches long to under the washer face, the ties shall be bored with a 3/4 inch pilot hole 5 1/2 inches deep. Holes for the four screw spikes holes in Pandrols standard tie plate shall be bored. Holes for all of the screw spike holes in the special trackwork plates shall be bored. Boring of holes in excess of the number of spikes used will not be permitted.
 - 2. A tolerance of plus or minus 1/16 inch will be permitted in the distance between spike holes. The spike holes shall be located in such a manner that each tie plate will be centered on the tie at a right angle to the rail when the spikes are driven into place. A tolerance of 1/8 inch in the centering of the holes across the width of the tie will be permitted. Timber tie holes shall be treated with pentachlorophenol oil or creosote immediately after boring.

- J. Tie Spacing
 - 1. Ties shall be spaced at 30 inches center-to-center, except where the radius is less than 350 feet, then ties shall be spaced at 24 inches center-to-center.
 - 2. Tie spacing at approach slabs shall be as shown on the design drawings.
 - 3. In curves the tie spacing shall be measured at the outside rail.
 - 4. Tie spacing tolerance shall be of plus or minus 1 inch with no fewer than 41 ties in 100 feet when 30 inch spacing and no fewer than 51 ties in 100 feet when 24 inch spacing.

3.06 LAYING CONTINUOUS WELDED RAIL (CWR)

- A. Laying, anchoring and joining CWR shall be as specified in Section 05651, General Track Construction.
- B. Zero Thermal Stress Temperature
 - 1. The rail shall be anchored at a temperature of 85 deg. F plus 5 deg. for minus 10 deg. F (30 deg. C plus 3 deg. C or minus 6 deg. C).
 - 2. The temperature of opposite rails when anchored shall be within 5 deg. F (3 deg. C) of each other.
- C. Fastening Rail To Ties
 - 1. Materials for fastening rail to ties shall be as specified for Track Appurtenances and OTM.
 - 2. Tie plates shall be installed under running rails on all ties. Spiking pattern shall be 4 screw spikes for each standard Pandrol tie plate. All screw spike holes in special track work plates shall receive screw spikes except for the guard rail plates that receive only 4 screw spikes.
 - 3. Prior to installing tie plates, the contact surfaces of the tie plates shall be cleaned to allow full bearing of the tie plate upon the tie. Tie plates shall be centered on the tie and placed normal to the centerline of the rail so that the outside shoulder of the plate will have full bearing against the base of rail.
 - 4. Spikes shall be started vertically and square and driven straight. Straightening of spikes will not be permitted. Spikes bent during driving shall be withdrawn and the holes plugged with treated tie plugs as specified for Track Appurtenances and OTM.
- D. Rail Anchoring - Installation of Pandrol spring clips shall be considered as anchoring the rail.

3.07 SURFACING AND LINING

- A. Ballasting
- B. Following the assembly of the track, ballast shall be unloaded in the tie cribs and shoulders of the track structure to restrain movement or buckling of the track due to temperature changes. Such ballast unloading shall provide an adequate amount of ballast for the track raise with sufficient surplus to continue to hold the track after the raise.
- C. Surfacing
 - 1. Track surfacing shall be done by methods which will prevent undue bending of the rail or straining of the joints.
 - 2. The amount of track lift shall not exceed four inches nor endanger the horizontal or vertical stability of the track. The track shall be given at least two raises of not less

than one inch nor more than three inches each raise. The maximum amount special trackwork shall be raised is 2 inches.

3. All ties pulled loose during surfacing shall be replaced to full bearing against the rail and properly secured.
4. Track surfacing shall not be permitted until the cribs are filled with ballast and with sufficient surplus to continue to hold the track after the track raise.
5. Track surfacing shall not be permitted and shall cease when the ambient temperature is higher than 95 deg. F.

D. Tamping

1. Tamping of ballast shall be done with approved power tamping equipment of the vibratory squeeze or hydraulic type. Control or cycling of the power tamper shall provide the maximum proper compaction of ballast uniformly along the track.
2. The ballast shall be thoroughly tamped on both sides of the tie from a point 15 inches inside the rails to the ends of the tie, with the exception of contact rail ties where tamping shall be only to a point opposite the ends of the adjacent cross tie. Tamping will not be permitted at the center of the tie outside of the above stated limits. For each tie, tamping shall proceed simultaneously inside and outside both running rails on both sides of the tie.

E. Final Surface and Alignment

1. The final surface and alignment of all track shall be within the specified ballasted track construction tolerances, executed by machines with automatic lining equipment or with combined lifting, lining and tamping equipment. Final tamping and lifting shall be effected by equipment fitted with tamping heads between axles or of arch -bar construction.
2. After the final surfacing and alignment of track is completed the ballast shall be dressed to conform to the ballast section shown and as directed by the Authority Representative. The portion of subballast outside the toe of slope of the ballast shall have a smooth, even surface, sloped as shown.
3. A manual dressing, as directed by the Authority Representative will be required to ensure a one inch clearance between the base of rail and top of ballast.

F. Ballast Compaction

1. Following tamping and lining, but prior to installation of contact rail and insulators, the crib and shoulders of all track shall be compacted by a machine specifically designed to compact the crib and shoulders simultaneously. The compactor shall operate on all shoulders and in those cribs where special trackwork components do not interfere with the operation of the machine. After compaction of ballast no further shaping of the ballast section will be permitted except as directed by the Authority Representative.
2. The crib compacting tool work faces shall measure nine inches by 14 inches with the nine-inch dimension parallel to the rail. Crib compacting tool work faces shall appear as flattened V's when viewed normal to the nine-inch dimension and the depth of the V shall be 3/4-inch plus or minus 1/16-inch. There shall be a minimum of eight crib compacting tools, two on each side of each rail. The shoulder compacting tool work faces shall conform to the designed ballast section outline from 1-1/2 inches beyond the tie ends horizontally to the beginning of the 2:1 shoulder slope, continuous to within six inches of the ballast toe at the subballast. The length of work faces in the direction of travel shall not be less than 33 inches, with flared ends in the direction of travel to avoid plowing of ballast shoulders.

3. The compacting tool work faces shall vibrate with a frequency between 2200 and 3000 Hertz. The vibrational amplitude shall be between 0.058 inch and 0.117 inch. The vibrating work faces shall apply a pressure between 14 psi and 21 psi to the surface of the ballast. The pressure applied shall be the same for all operations and remain constant throughout the job, and shall be monitored by a permanently affixed calibrated pressure gauge. The compacting tools shall be applied to both crib and shoulders for a period of between three and six seconds duration at each crib successively.
- G. Ballast Inspection - The Design-Builder, shall remove a maximum of one percent of the ties, selected at random by the Authority Representative, to allow inspection of the ballast compaction beneath the ties to determine the variables of each piece of tamping and compaction equipment and for spot checking of the production work.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

- A. No separate measurement of work regarding Ballasted Track Construction is specified in this section.

4.02 PAYMENT:

Compensation for work specified in this Section will be included in the price of the work of which it is a part.

END OF SECTION

THIS PAGE NOT USED

SECTION 05654

SPECIAL TRACKWORK CONSTRUCTION - BALLASTED

PART 1 - GENERAL

1.01 SECTION INCLUDES

The work in this Section shall include the construction of ballasted special trackwork as indicated on the Design Drawings and as specified.

1.02 RELATED SECTIONS

Section 02726 - Subballast
Section 02727 - Ballast
Section 05091 - Rail Welding
Section 05651 - General Track Construction.
Section 05652 - Ballasted Track Construction
Section 05656 - Rail
Section 05658 - Track Appurtenance and Other Track Material
Section 05659 - Special Trackwork
Section 06130 - Timber Ties

1.03 REFERENCES

Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering herein referred to as AREMA Manual.
- B. American Railway Engineering and Maintenance-of-Way Association (AREMA), Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio.

1.04 SUBMITTALS

- A. The Design-Builder shall develop and submit for the Authority Representative's approval a detailed installation plan, including sketches, for all special trackwork installation. Particular emphasis should be placed on alignment and clearances, and methods of checking each.
- B. Submittals shall be as specified in Section 01330, Submittals. The following submittals shall be made by the Design-Builder:
 - 1. The name(s) of the suppliers and manufacturers for the special trackwork components.
 - 2. Shop drawings for the various types of special trackwork and supporting drawings.
 - 3. Installation and maintenance instructions by the manufacturer for the various trackwork components.
 - 4. Detailed description of construction procedures required for the work specified in this Section submitted at least 30 calendar days before beginning the work.
 - 5. Test results required for the work specified in this Section and related work specified elsewhere.

1.05 QUALITY ASSURANCE AND SAFETY

- A. Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.
- B. In order to determine the acceptability of the installation, the Design-Builder shall make a survey of the special trackwork and provide the Authority Representative with a copy of the report. Deviations from the drawings or specifications which exceed tolerances specified shall be corrected by the Design-Builder at no additional cost to the Authority.
- C. Switch points shall mate and rest under the undercut stock rail and provide a continuous contact with stock rail the length of the machined point rail face adjacent to the stock rail.
- D. Switch points shall bear on all slide plates as shown by grease marks and feeler gauges in the thrown operating position.
- E. Operation of switch point shall be unrestricted and allow for smooth switch machine operation with current draw to suit standard switch machine.
- F. Design-Builder's Work Trains
 - 1. The Design-Builder's work trains shall not operate over special trackwork until it has been assembled, lined and surfaced, and secured in place to the satisfaction of the Authority Representative.
 - 2. Switch points shall be secured to the satisfaction of the Authority Representative before work trains or other on-track equipment are passed over turnouts.

1.06 DELIVERY, STORAGE AND HANDLING

The Design-Builder shall handle all special trackwork materials in such a manner as to prevent damage during loading, transporting, unloading, storing, installing, and other construction activities until the Authority accepts the track.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The Design-Builder shall supply the special trackwork turnouts and restraining rail as listed on the Design Drawings, including all materials necessary to provide a complete installation.
- B. The following materials in accordance with the bills of materials on the drawings for special trackwork and general track construction shall be furnished as described, including but not limited to:
 - 1. Subballast
 - 2. Ballast
 - 3. Running Rail
 - 4. Track Appurtenances and Other Track Material
 - 5. Special Trackwork
 - 6. Timber Ties
- C. Other materials:
 - 1. Switch stands, connecting rods and associated hardware as shown on the Drawings.
 - 2. Furnish a dry graphite lubricant for application to the riser plates. The lubricant shall have low electrical conducting properties.
 - 3. Furnish switch machines, operating rods and switch machine mountings for power operated turnouts, as described in Division 16 of the Contract Specifications.

4. Furnish all additional track materials required within the special trackwork limits to construct an acceptable, completed special trackwork structure as specified herein.

PART 3 - EXECUTION

3.01 GENERAL

- A. Construction of special trackwork on ballasted track shall be as specified herein and shall comply with the applicable portions of Section 05652, Ballasted Track Construction.
- B. Ballasted special trackwork will be factory assembled on all switch ties. After Authority inspection and approval, the switch will be shipped in one piece, except for long ties.
- C. The remainder of the unit will be disassembled and the switch ties banded into bundles identified as to turnout, crossing and location in accordance with the special trackwork installation drawings prepared by the fabricator.
- D. Lubrication
 1. At the time of installation all sliding surfaces of special trackwork assemblies shall be lubricated with an approved dry-film graphite lubricant.
 2. Vertical switch rod clips shall be greased in accordance with the manufacturer's recommendations.
 3. The specified lubrication shall be maintained as necessary to ensure proper operation of all components throughout the duration of this Contract.
- E. Adjustments
 1. The Design-Builder shall make all mechanical adjustments, including those required for train control and switch machine installation, prior to the final acceptance of special trackwork to ensure that special trackwork units are in alignment to their plates and proper operating condition.
- F. Switch Machine: Switch machines and operating rods will be furnished and installed by the Design-Builder.
- G. Switch Rods: Adjust for throw shown.
- H. Rail Ends: Rail ends to be connected to CWR will be drilled in the field.
- I. Joints
 1. All joints, standard or insulated, to assemble the turnout and to connect a turnout to other trackage shall be furnished and installed by the Design-Builder.

3.02 SUBBALLAST

Subballast shall be as specified in Section 02726, Subballast.

3.03 BALLASTING

- A. Ballast shall be uniformly tamped under both sides of each tie, directly under each running rail and for a distance of 15 inches on both sides of the rail.
- B. The top of the ballast section shall be one inch below the base of rail throughout special trackwork units except in the cribs between the point and heel of the switch rails, where the ballast level shall be three inches below the base of the rail.

- C. Additional clearance at vertical switch rods shall be provided as needed to allow unrestricted movement. The width and slope of the shoulders shall be as shown.

3.04 SWITCH TIES

- A. Switch ties shall be spaced and lined as shown.
- B. Ties shall be lined at right angles to the centerline of the tangent track.
- C. The line side for all turnout units is the side on which the straight stock rail is located. Tie end on the line side are the line ends.
- D. Switch tie spacing shall have a tolerance of plus or minus 1/2 inch with the exception of the switch machine ties which shall have a tolerance of plus or minus 1/4 inch.
- E. Ties shall be adzed only with approval of the Authority Representative.
- F. All ties will be bored for 15/16" screw spikes.
- G. The Design-Builder will adz switch timbers to compensate for minor warpage and thereby provide correct rail surfacing only at the Authority Representative's direction. Adzing shall be at no additional cost to the Authority.

3.05 PLATES

- A. All plates shall be located as shown.
- B. Elastic Fastener (Pandrol plate TPL-P26M or equal) tie plates as specified in Section 05658, Track Appurtenances and Other Track Materials, shall be used at all support locations not having special frog, switch, gauge, guard rail or restraining rail plates.
- C. All plates shown within the limits of ballasted special trackwork will be factory assembled on the switch ties.
- D. Ties will be bored to accommodate all spike locations in all plates except for guard rail plates. Only 4 holes shall be bored for guard rail plates.
- E. Where plates span two or more ties, spikes shall not be installed if the plates will be shipped separate from the ties.
- F. All plates occupying one tie including standard tie plates shall be spiked to the tie.

3.06 SPIKING

Spiking of ballasted special trackwork shall be as specified for ballasted track construction with the following additional requirements:

- A. All spikes holes shall be pre-bored except only four shall be prebored for the guard rail plates.
- B. A sufficient number of 15/16 " screw spikes are to be furnished with each turnout to complete its field assembly.

3.07 ANCHORING

Special trackwork units shall be considered anchored when all Pandrol spring clips are installed and unanchored when no spring clips are installed. When some spring clips are installed, the special trackwork shall be considered as neither anchored nor unanchored.

3.08 TOLERANCE

- A. Tolerances shall conform to the AREMA Portfolio and Manual, unless modified by these specifications and drawings.
- B. The gauge, cross level, and horizontal and vertical alignment of ballasted special trackwork shall be as shown and specified.
- C. Tolerances shall be as specified for ballasted track construction.
- D. Switch points in normal position shall be square within 5/8 inch.
- E. At the Authority Representative's direction, the Design-Builder shall be required to provide some spike lining in the pre-plated tolerances. Minor spike lining will be allowed only after the Design-Builder has demonstrated that the switch points and frogs have been correctly oriented. This shall be at no additional cost to the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

No separate measurement of work specified in this Section shall be made.

4.02 PAYMENT:

Compensation for work specified in this Section will be included in the price of the work of which it is a part.

END OF SECTION

THIS PAGE NOT USED

SECTION 05656

RAIL

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies manufacture and delivery of standard and high strength (head hardened or fully heat treated) 115RE steel running rail and 132 RE guard and restraining rail for use in transit track.

1.02 RELATED SECTIONS

Section 05091 - Rail Welding
Section 05651 - General Track Construction
Section 05652 - Ballasted Track Construction
Section 05654 - Special Trackwork Construction - Ballasted
Section 05658 - Track Appurtenances and Other Track Material (OTM)
Section 05659 - Special Trackwork

1.03 REFERENCE STANDARDS

Work shall be performed in accordance with the following applicable Codes, Regulations, Reference Standards and Specifications.

- A. The American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering, herein referred to as the AREMA Manual, Volume 1, Chapter 4, Rail
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM E10 Standard Method of Brinell Hardness for Metallic Materials
 - 2. ASTM A578 Ultrasonic Testing

1.04 SUBMITTALS

- A. Mill Inspection:
 - 1. Make specified tests and inspections at the mill prior to shipment.
 - 2. Submit to the Engineer all information required of AREMA Form 401D.
 - 3. Provide free access for the Engineer to all fabrication and test facilities where work is being performed for this Contract.
- B. Provide rail test records, including mechanical properties tests, hardness measurements, ultrasonic test records and all other required test documentation, for informal review during the in-plant inspection.

1.05 QUALITY CONTROL

- A. Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.
- B. Develop and maintain a quality control program regulating methods, procedures, and processes to ensure compliance with standards of quality required by the Contract Documents.

- C. Records of all inspection work by the Design-Builder shall be kept complete and available to the Authority Representative during the performance of the Contract; and to such other agencies and for longer periods as may be specified elsewhere in the Contract.
- D. Perform all tests and analyses specified in Chapter 4 of the AREMA Manual and submit the results in accordance with this Section.
- E. Ultrasonically test all rail for internal defects in accordance with ASTM A578.
- F. Testing shall conform to the requirements of the AREMA Specifications for Steel Rails
- G. Make all rail tests and inspections at the mill prior to shipment. Assume full responsibility for all testing indicated. Give the Authority Representative sufficient notice when testing in any form is proposed so that the Authority Representative may witness the tests.
- H. Provide the Authority Representative free entry at all times to the manufacturer's mill to inspect the processing and testing of rail while work on this Contract is being performed.
- I. Perform all tests specified herein at no additional cost.
- J. Testing must be witnessed and certified by a qualified independent testing firm or individual.

1.06 DELIVERY, HANDLING AND STORAGE

- A. Handle rails carefully to avoid damage.
- B. Load rail head up with the branding on all rails facing in the same direction.
- C. Sort and load rails together according to their markings. Do not intermix rails of different markings in loading. If there are not sufficient rails of one marking for a full car, smaller groups consisting of tiers of different markings may be loaded onto one car.
- D. Load all rails of the same radius together in the same or adjacent tiers.
- E. Load rails with adequate wood strips between the tiers or rail to prevent damage in transit.

PART 2 - PRODUCTS

2.01 RAIL

- A. Standard Rail
 - 1. Rail Section and Weight shall be new 115 RE rail section, and shall be in conformance with AREMA Recommended Rail Sections, 115 RE Rail Section and Specifications for Steel Rails
 - 2. Rail shall be suitable for joining into continuous welded strings using both electric flashbutt and exothermic welding methods.
 - 3. The steel shall be cast by a continuous casting process, or by other methods approved by the Authority Representative.

4. Length:
 - a. The standard length of rails shall be either 78 or 80 feet.
 - b. Up to 10 percent of the total tonnage accepted for each individual rolling will be accepted for each individual rolling will be accepted in shorter lengths of 79, 78, 77, 75, 70, 65 and 60 feet.

- B. High Strength (Head Hardened or fully heat treated) Rail - shall meet all of the requirements of Standard Rail and as follows:
 1. shall be either head hardened or fully heat treated.
 2. shall conform to all requirements for high strength rail and for sectional tolerances for trackwork rail specified in the AREMA Manual for Railway Engineering, Chapter 4.
 3. shall have a Brinell Hardness in the range of 341 to 388. A maximum hardness of 388 BHN may be exceeded provided a fully fine pearlitic structure is maintained.
 4. minimum tensile strength: 140,000 psi.
 5. minimum yield strength: 95,000 psi.

PART 3 - EXECUTION

3.01 GENERAL

A mill certificate shall be furnished to the Authority Representative containing the following data:

- The identity of each rail in a charge by heat, ingot and letter.
- The identity of each equivalent sample by heat.
- The dates of all phases of heat treatment for each charge.
- A listing of the accepted and rejected rail in each charge.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

No separate measurement of work specified in this Section will be made.

4.02 PAYMENT

Compensation for work specified in this Section will be included in the price of the work of which it is a part.

END OF SECTION

THIS PAGE NOT USED

SECTION 05658

TRACK APPURTENANCES AND OTHER TRACK MATERIAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the installation of track appurtenances as shown and specified. The Work specified herein consists of furnishing and installing bonded insulated joints, bumping posts, tie plates with resilient rail clips, spikes, tie plugs, switch stand, and other track materials required for track construction.
- B. All track appurtenances and other track material (OTM) shall be new and conform to the requirements shown and specified. All materials shall conform to the dimensional requirements for 115 RE rail, as recommended by current AREMA Specifications or as specified.

1.02 RELATED SECTIONS

Section 05651 - General Track Construction
Section 05652 - Ballasted Track Construction

1.03 REFERENCES

- A. Association of American Railroads (AAR) - Signal Manual
- B. American Railway Engineering and Maintenance-of-Way Association (AREMA)
 - 1. AREMA Manual for Railway Engineering
 - 2. AREMA Portfolio of Trackwork Plans
- C. American Society of Testing and Materials (ASTM)
ASTM A66
- D. National Electrical Manufacturers Association (NEMA) - NEMA LI 1 Industrial Laminated Thermosetting Products
- E. American Institute of Steel Construction - Manual of Steel Construction.

1.04 QUALITY ASSURANCE

- A. Quality Assurance Program - Refer to Section 05651, General Track Construction, and conform to the requirements of the Quality Assurance Program.
- B. Testing Laboratory Services - Refer to Section 01410, Testing Laboratory Services
- C. Before permanently installing bonded insulated joints, prequalify each crew and its foreman by testing two samples of each type of bonded joint in accordance with the Longitudinal Compression Test specified herein. Prepare test samples in track. The bonded insulated joints tests shall be performed with one sample using high strength rail and the other sample using standard rail.
 - 1. The two sample joints shall have a 1/4-inch gap between the rail ends.
 - 2. The joints shall be tested in compression. A load shall be applied longitudinally in increments of 25,000 pounds. Each load increment shall be maintained constant until

the longitudinal deflection of the rail ceases before increasing the load to the next increment.

3. The load shall be increased in these increments until a total load of 650,000 pounds is attained or failure occurs. At each increment of loading, the load and differential movement of the rail and joint bars shall be measured to 0.0001 inch and recorded.
 4. The assembled joints may be sawn in half where the rails are butted together. The sawing shall be done in such a manner as to prevent overheating or damage to the bond and the cut shall be perpendicular to the centerline of the top of the rail with a tolerance of plus or minus one degree. A device shall be fabricated so that the reaction at the sawn ends occur only on the face of the joint bars.
 5. At no time shall any of the bonded standard rail joints show any indication of slippage before a compressive load of 650,000 pounds is applied to the joint, nor shall the magnitude of the differential movement be more than 1/8-inch in any direction. At the completion of the test, after the load in the rail has been released, the relative position of rail and joint bar shall be within 1/32-inch of its original value.
 6. The test shall be performed by an approved independent laboratory. Should any sample joint fail to meet the specified requirements of the test, another joint may be tested or a different manufacturers product may be tested as directed by the Authority Representative. For qualification testing, materials required shall be furnished by the Design-Builder at no additional cost to the Authority.
 7. Failure of any test sample disqualifies the responsible foreman for permanent installation work. Assign a new foreman and repeat procedure and test.
 8. Bonded insulated joint bar to conform to:
 - a. Fishing height: plus or minus 1/64 inch
 - b. Length: plus or minus 1/8 inch
 - c. Straightness, as determined by a 36-inch straightedge: plus or minus 1/32 inch
 - d. End post thickness: plus or minus 1/64 inch
 - e. Projection below base of rail - 1/16 inch
 - f. Bolt hole location - as specified in AREMA Manual for Railway Engineering, Chapter 4, for 36-inch joint bar modified to receive 1-1/8 inch bolt.
- D. Equipment: Use equipment that is specifically designed to fasten proprietary bolts in bonded joint installation. Use the same equipment for field installation of bonded joints and for assembling test samples.
- E. Tolerances - Other track material (OTM) to conform to tolerances as per AREMA and as noted below.
1. The Pandrol spring and standard tie plate tolerances shall be such that when two clips and a plate are assembled with a piece of 115 RE rail rolled with zero tolerances in the rail base, the toe load for the spring clips is 2750 +/- 250 pounds.

1.05 SUBMITTALS:

- A. Refer to Section 01300, Submittals.
- B. Certificates of Compliance for materials specified in Part 2, Products
- C. Shop Drawings on:
 1. Bonded insulated joints
 2. Standard joints
 3. Proprietary bolts and fasteners
 4. Hydraulic bumping posts

5. Tie plates
 6. Rail clips
 7. Screw spikes
- D. The Design-Builder, shall in accordance with Specification Section 01300, Submittals, submit shop drawings or detailed catalog cuts of track appurtenances and OTM not fully shown or not in conformance with AREMA Portfolio of Trackwork Plans and Specifications.
- E. Product data on
1. Bonded insulated joints and adhesives
 2. Proprietary bolts and fasteners
 3. Tie plates, rail clips, and screw spikes
 4. Corrosion preventing oil or grease
- F. Certificates and procedure reports
1. Certificates of product conformance
 2. Qualification tests for bonded insulated joints joints
 3. Crew qualification tests for bonded joint installation
 4. Negative return bonding installation procedure
- G. Record of field connections
1. of each bonded insulated joint shall be submitted.

PART 2 - PRODUCTS

2.01 BOLTED JOINTS (INSULATED AND STANDARD)

General Requirements: Johnson "Blue" Vulca Bond, or approved equal, with the following requirements

- A. Insulated joints shall be highly resistant to abrading, cracking, cutting, spalling and fatigue failure under impact loads, and shall exhibit deflection characteristics comparable to standard bolted joints.
- B. Joint bars shall be quenched and tempered carbon steel in accordance with the AREMA Manual.
- C. Joint bars shall be 36 inches in length.
- D. Joint bars shall have six, 1 $\frac{1}{8}$ inch diameter bolt holes.
- E. Joint bars shall provide full web contact. Inside face of insulated joint bars shall have the insulating material pre-bonded and shall be smooth with no stamping or branding.
- F. End posts shall project 1/4 inch, plus or minus 1/16 inch, below the base of rail.
- G. All insulated joints shall be furnished complete with bars, end posts, bushings, washer plates, bolts, nuts and washers.
- H. Bolts and nuts shall conform to the material requirements of current AREMA Specifications for Heat-Treated Carbon-Steel Track bolts and Carbon-Steel Nuts.

- I. Track bolts shall be oval necked and have a nominal diameter of 5½ inches in length in conformance with current AREMA Design for Track Bolts and Nuts.
- J. Spring washers shall be single coil, helical spring washers for 1 inch bolts and shall conform to current AREMA Specifications for Spring Washers.
- K. Flat washers shall be 2¼ inches OD, 1-3/16 inch ID and 1/8 inch minimum thickness and shall conform to current AREMA Specifications.

2.02 BUMPING POSTS

- A. Maintenance Vehicle Bumping Post
 - 1. Steel bumping post, Type WA, Western-Cullen-Hayes, Inc., or approved equal.
 - a. Shock-absorbent head of multiple-spring-and-shockpad design.
 - b. Permit installation by bolting to running rails without anchorage to cross-ties or concrete invert.
 - c. No part extending more than two inches below base of rail.
 - 2. Install at the end of M/W tracks in accordance with the manufacturers requirements.
 - 3. Provided with one coat of manufacturer's standard shop coat applied to exterior surfaces after complete removal of all foreign matter.
 - 4. Furnish the product of an established manufacturer regularly engaged in the production of bumping posts.

2.03 STANDARD TIE PLATES

- A. Pandrol tie plate TPL-P26M for Pandrol Spring Clip e2056 and 5½ inches rail base. Plate shall provide a 40 to 1 rail cant, a width of 7 3/4", minimum length of 15 3/16", a minimum thickness at the rail centerline of 11/16", and four one inch diameter round holes for 15/16" screw spikes as manufactured by Pandrol, Inc., or approved equal.
 - 1. Welding shall not be permitted to fabricate tie plates.
 - 2. The smallest diameter for the screw spike holes shall be at the bottom of the plate.
 - 3. The screw spike holes shall have a one inch diameter at the base of the plate.
 - 4. The tie plate design shall provide a rail clip load of 2750 pounds when assembled with the Pandrol spring clip and a piece of 115 RE rail rolled with zero tolerances on the rail base.

2.04 SPIKES

- A. Screw spikes, as manufactured by Pandrol, Inc., Bridgeport, NJ, or approved equal, shall be 7" in length , 15/16" diameter, hot forged, made from medium carbon steel to meet ASTM A66. The head shall be configured for use with a 7/8" socket.
- B. Cut track spikes shall be 6 inches by 5/8 inch with reinforced throat, and shall conform to current AREMA "Specifications for Soft-Steel Track Spikes" and "Design for Cut Track Spikes".

2.05 TIE PLUGS

Tie plugs shall be treated, five inches in length and conform to current AREMA Specifications for Tie Plugs for 5/8-inch spikes.

2.08 SWITCH STAND

Switch stand for installation on hand throw switch shall be Foster Parallel-Throw, Low-Type, Design 51A as manufactured by L. B. Foster Company, or approved equal.

2.09 SPRING CLIPS

- A. Pandrol type e2056
- B. Two per tie plate

PART 3 - EXECUTION

3.01 PREPARATION

- A. Bolted Joints (Bonded joint and standard joint installation)
 - 1. End-harden rail ends of standard rail as specified in Section 05651, General Track Construction.
 - 2. Remove rail brands which are located in joint bar rail contact areas. All rail brands shall be removed from the rail by grinding for the entire length of the joint bar.
 - 3. Rail welds shall be at least eight feet from the center of the joint.
 - 4. Drill rail holes in conformance with the design drawings, AREMA Specifications and manufacturer's printed instructions using a template as the drilling guide. Debur field drilled holes.
 - 5. Calibrate bolt-tightening equipment by testing three typical bolts in a device capable of indicating actual bolt tension.

3.02 INSTALLATION

- A. Joints
 - 1. Bonded insulated joints shall be installed at all insulated joint locations shown. The exact location will be coordinated with the Design-Builders signal designer.
 - 2. The bonded insulated joint shall be supported by the tie plate arrangement shown in the design drawings.
 - 3. Additional preparation and the installation shall be in accordance with the manufacturer's recommendations. The manufacturer's recommendations will include procedures for sandblasting of rail and heat curing of assembled joints.
 - 4. All bonded joints shall be installed under the direct supervision of a qualified foreman.
 - 5. Bolted Standard Joints
 - a. Standard joints shall be assembled with a full complement of bolts, nuts and spring washers. Before installing joint bars, rail surfaces to be covered by the bars shall be cleansed and coated with an oil or grease approved by the Authority Representative to prevent corrosion.
 - b. Bolts shall be installed and the nuts threaded finger tight.
 - c. Bolt tension shall then be increased to 20,000 to 30,000 lbs. by use of a track wrench or power torque wrench. Bolts shall be tightened starting from the center bolts and working to the end bolts.
 - d. Bolts shall be tightened twice; first, after the track has been brought to approximately true alignment; second, immediately before the completion and final acceptance of the trackwork. Retightened track bolts shall be brought to a tension of 15,000 to 25,000 lbs.

- e. Bolted standard joints used to connect CWR strings shall be installed with negative return bonds as specified in this Section's article for Negative Return Bonding.
6. Bolted Insulated Joints:
- a. Installation shall be in accordance with the manufacturer's recommendations and as directed by the Authority Representative.
 - b. Rail surfaces within the insulated joint bars shall be clean and free of oil, dirt, rust and metal filings.
 - c. Joint Resistance Testing will be as specified in this Section's article for Insulated Joint Resistance Test.
7. Insulated Joint Resistance Test - All testing shall be done by the Authority Representative.
- a. Equipment - The insulated joint resistance test shall be conducted using the following Authority test equipment (See **Exhibit 05658-A**):
 - 1) General Railway Signal (GRS) Track Quality Meter (TQM) 20182-36 GR.1.
 - 2) Standard Resistance Test Fixture.
 - 3) Acceptance Criteria: The insulated joint shall have a minimum resistance of 5,000 ohms.
8. Negative Return Bonding
- a. The Design-Builder shall furnish and install negative return bonds as specified and shown at all bonded standard joints used to join CWR strings.
 - b. Negative Return Bonds: shall include two web type at each location.
 - c. Web Bond: Manufactured Bond, 500 KCMIL, stranded copper, single conductor, 2000 volt, UL Type RHW, 48 inches long insulated, as manufactured by Erico Products, Inc., fastened to rail web with 5/8" compression fastener, Huck Manufacturing Co. C50LR-BR20-16 and terminal lug, Bundy Type, YA34-L, each end.
 - d. The Design-Builder shall install all negative return bonds in accordance with the manufacturer's instructions.
 - e. The Design-Builder shall submit installation procedures for approval.
 - f. The contact surfaces of the running rail web shall be cleaned on each side of mill scale, oil, grease or other foreign matter to near white finish.
 - g. Any raised lettering from the steel mill shall be ground flat with the adjacent surface.
 - h. Each negative return bond shall be installed with sufficient amount of slack to accommodate expansion or contraction.
9. Electrical Testing of Negative Return Bonding
- a. The bond resistance of each negative bonded joint shall be tested by the Design-Builder to verify that it does not exceed 0.000050 ohms.
 - b. The Null Balance method of testing shall be employed utilizing the four terminal arrangement, two potential and two current terminals. The P1 and P2 leads shall be attached to the rail 46 inches apart and equal distance from the ends of the 500 KCMIL cable. The C1 and C2 current leads shall be attached to the rail approximately six inches outside of the P1 and P2 leads. The meter dials shall then be manipulated to achieve a balanced condition of the meter. This procedure is to be followed for each negative return bonded rail joint. The resistance of each bonded rail joint shall be recorded and submitted to the Authority Representative. Bonds which exceed 0.000050 ohms shall be removed, replaced and retested.
10. Record of Field Connections
- a. A record of each bonded standard joint shall be submitted.
 - b. This record shall be in the format shown in **Exhibit 05658-B**.

- B. Bumping Posts:
1. Prior to final acceptance, bumping posts shall be cleaned, sand blasted, primed, painted and lubricated as directed by the Authority Representative. Gauge transitions to provide the required track gauge for bumping posts installations shall be as specified for Section 05651, General Track Construction.
 2. Bumping post shall be installed where shown and specified on the Information Drawings.
 3. Insulated joints shall be installed as shown and specified.
 4. All holes in the running rails for bumping post installation shall be centered 2-7/8 inches above the base of the rail and shall be drilled in conformance with AREMA requirements.
 5. Flame cutting of holes will not be permitted.
 6. Prior to final acceptance, the Design-Builder shall make all adjustments directed by the Authority Representative to ensure that all bumping posts are in proper operating condition and ready for service.

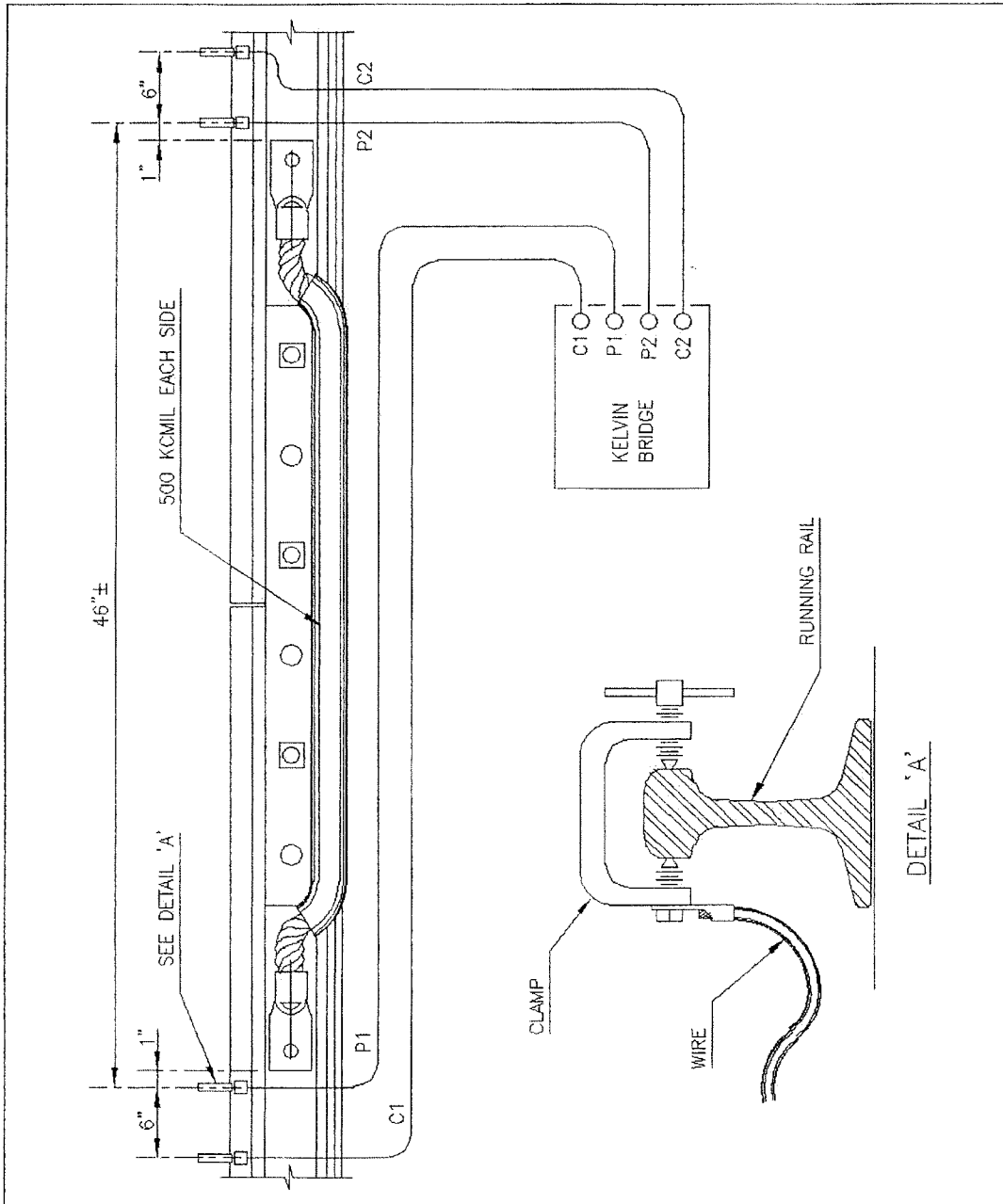
PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

No separate measurement of work specified in this Section will be made.

4.02 PAYMENT

Compensation for work specified in this Section will be included in the price of the work of which it is a part.



WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DE LEUW, CATHER & COMPANY
SECTION DESIGNER

NEGATIVE RETURN BOND
RESISTANCE TEST
EXHIBIT 05658-A

SCALE: NONE

DATE: JANUARY 2001

05658-10

RECORD OF FIELD CONNECTIONS

DATE: _____

TIME: _____

TYPE OF CONNECTION: BONDED JOINT

TRACK DESIGNATION: _____

LOCATION: STATION _____

RAIL STRING DESIGNATION: _____ AHEAD _____ BACK

MECHANICAL TEST: _____ PASSED _____ FAILED

BOND RESISTANCE: _____ OHMS

TYPE OF RAIL: HIGH STRENGTH STANDARD (CIRCLE ONE)

MANUFACTURER OF BONDED JOINT _____

AIR TEMPERATURE: _____

RAIL TEMPERATURE: _____

WEATHER CONDITIONS: _____

TRACK ALIGNMENT AND CONSTRUCTION: _____

(CURVE, TANGENT, GRADE, ETC.)

NAME OF ENGINEER OR REPRESENTATIVE PRESENT: _____

NAME OF CONTRACTOR'S FOREMAN PRESENT: _____

NAME OF MANUFACTURER'S REPRESENTATIVE PRESENT: _____

CONTRACTOR'S REPRESENTATIVE: _____

(SIGNATURE)

AUTHORITY REPRESENTATIVE: _____

(SIGNATURE)

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DE LEUW, CATHER & COMPANY
SECTION DESIGNER

RECORD OF FIELD CONNECTIONS

EXHIBIT 05658-B

SCALE: NONE

DATE: JANUARY 2001

05658-11

END OF SECTION

THIS PAGE NOT USED

SECTION 05659

SPECIAL TRACKWORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies manufacture, fabrication, shop assembly, inspection, testing, packaging and shipping special trackwork materials.
- B. Special trackwork shall include components for installations in ballasted.
- C. This Section also specifies fabricating and furnishing guarded turnouts as shown and specified.
- D. This Section specifies fabricating and furnishing restraining rail and precurved rail.

1.02 RELATED SECTIONS

Section 05651 - General Track Construction
Section 05652 - Ballasted Track Construction (BTC)
Section 05654 - Special Trackwork Construction - Ballasted
Section 05656 - Rail
Section 05658 - Track Appurtenances and Other Track Material
Section 06130 - Timber Ties

1.03 REFERENCES

Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

- A. American Railway Engineering and Maintenance-of-Way Association, Manual for Railway Engineering, herein referred to as the AREMA Manual.
- B. American Railway Engineering and Maintenance-of-Way Association, Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio.
- C. American Society of Testing and Materials (ASTM)
- D. Association of American Railroads (AAR) Signal Manual
- E. American Council of Independent Laboratories' Manual of Practice
- F. American Welding Society (AWS)
- G. Industrial Fastener Institute (IFI)

1.04 QUALITY ASSURANCE/CONTROL

- A. Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.

- B. Quality Assurance Program - Refer to Section 05651, General Track Construction, and conform to the requirements of the Quality Assurance Program.
- C. Tolerances: Conform to the AREMA Portfolio - Plan No. 1010-89, Permissible Variations in Completed Frogs; Plan No. 1011-84, Permissible Variations in Completed Switches; the AREMA Manual, Section 7, and the AREMA Manual, Section 5, in all aspects unless modified by the contract documents.
- D. Codes, Regulations, Reference Standards and Specifications:
 - 1. Except as modified in the contract documents, design, manufacture, test, assemble, inspect, ship, unload and stack special trackwork in accordance with the AREMA Portfolio and the AREMA Manual.
 - 2. Except as modified in the contract documents, use rail in the special trackwork conforming to the requirements of the AREMA Manual, Chapter 4, and Section 05656, Running Rail.

1.05 TESTING

- A. Notify the Authority in writing not less than 14 days in advance of dates scheduled for any test. The Authority retains the right to witness testing. Do not conduct test until authorized by the Authority.

B.

1.06 PRODUCTION QUALITY CONTROL TESTS OF INSULATION PIECES

- A. Test insulated gauge plates and switch rods in accordance with AAR Signal Manual, Part 14.5.3.

1.07 SUBMITTALS

- A. Refer to Section 01300, Submittals.
- B. Shop drawings for special trackwork components, including the following
 - 1. Insulated curved split switches, including stock rails.
 - 2. Insulated switch rods, including clip assemblies.
 - 3. All insulation materials, parts and assemblies.
 - 4. Closure rails.
 - 5. Frog guard rails.
 - 6. All special plates, including details of components.
 - 7. Switch panel details.
 - 8. Rail braces.
 - 9. Complete layouts and details for all types of turnouts.
 - 10. Installation drawings for each type of assembly used during construction.
- C. Product data:
 - 1. Certification of the procedure used in the depth hardening of frog castings
 - 2. Test data for the rail used in all fabrication for compliance with AREMA and these specifications.
- D. Refer to Section 01322, Certificates and Reports, and submit the following:
 - 1. Certificates of material compliance required by AREMA and this Specification.
 - 2. Test reports of chemical analyses, Brinell hardness, electrical insulation, and other tests required by AREMA and this Specification.
 - 3. Frog depth hardening results

- E. A certified copy of reports on the analyses and tests required by referenced ASTM specifications.
- F. Design-Builder's method for locating all special plates, not in the switch panel, which span two or more ties, drilling the ties and holding the plates in place during shop assembly and inspection.
- G. Configuration and method of fabrication for switches.
- H. Check list or measurement report for all switches and frogs approved by the Authority Representative. This shall show the design size and allowable tolerance required by AREMA, or as shown and specified in these contract documents, as well as the actual size.
- I. Detailed description of the procedure for bonded insert and bonded joint installation approved by the Authority Representative.
- J. Method of packaging and loading each unit approved by the Authority Representative.

1.08 PREASSEMBLY

- A. Completely assemble, prior to shipment, the turnouts in the Design-Builder's fabrication shop for inspection by the Design-Builder's Quality Control (QC) Staff.
- B. Fully bolt and assemble rail joints for all turnouts. For inspection, use temporary joint bars with "C" clamps for shop assembly. Install 3/8 inch end post shim where insulated joint bars are indicated. Do not apply adhesive during this process.
- C. No bracing, wedging, or support blocking will be permitted to hold components to proper gauge and alignment.
- D. Variations from the Authority reviewed shop drawings or other contract documents will constitute noncompliance and will not be accepted for shipment unless or until proper modification are made and reviewed by the Authority.
- E. Make available to the Authority, without charge, the facilities and assistance to examine the work during its progress, and when the product is finished, to satisfy the Authority that the finished product will comply with the contract documents. Provide templates and one yard straight edge or longer, as necessary, to check flangeways, rail end drilling, switch rail planing, and other features of the Work usually checked by templates.
- F. Present material for inspection in a safe area away from excessive noise and manufacturing activities. Provide labor to facilitate inspection of the top, side and bottom of frogs and switches.
- G. With minimal bar pressure acting on the switch rail at rod number 1, 25% or more of the switch point contact length, starting from the tip of the point, shall make positive, firm contact with the ball of the stock rail.
- H. With no pressure acting on the switch rail, the maximum allowable spring back between the switch point and the ball of the stock rail shall be 3/16 inch, measure six inches back from the tip of the point.

- I. For inspection and review, match mark rails in appropriate colors, and sequentially number fasteners or switch ties, in accordance with the Authority reviewed System. Submit the match marking and numbering system on the Contracting Drawings for the Design-Builder's QC Staff before match marking and numbering commences.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Special trackwork materials, including oval-neck track bolts of one-inch nominal diameter, nuts and spring washers, and special trackwork assemblies shall be in accordance with AREMA except as modified on the drawings and specifications.
- B. Rail, switches, frogs and other track material shall be in accordance with AREMA dimensional requirements for 115 RE rail section except as modified on the drawings and specifications. Guard rails and restraining rail shall be in accordance with AREMA dimensional requirements for 132 RE rail section except as modified on the drawings and specifications.
- C. Special trackwork rail shall be high-strength rail (fully heat treated or head hardened) per AREMA requirements and shall meet AREMA sectional tolerances for trackwork rail.
- D. Heel ends of switch rails, and ends of stock, closure and connecting rails shall be beveled in accordance with AREMA requirements.
- E. Cut all rail ends in accordance with AREMA requirements except that tolerance to be taken up in the rail base.
- F. Drill rail ends to receive 36-inch, six-hole joint bars in accordance with AREMA and as shown. Standard joints shall be drilled to allow butting of rail ends. Insulated joints shall be drilled to allow for a 3/8-inch end post. Drill holes in accordance with joint manufacturers instructions, plus or minus 1/32-inch.
- G. All rail shall be in accordance with Section 05656, Running Rail.
 1. Guard and restraining rails: 132 RE section.
 2. All other rail: 115 RE section.
- H. Drill and ream holes with edges beveled.
- I. All joints required for installation shall be new material.
- J. Supply all ties in accordance with Section 06130, Timber Ties.

2.02 STOCK RAILS, CLOSURE RAILS AND CONNECTING RAILS

- A. Length: As shown plus or minus 1/8-inch.
- B. All ends drilled except ends to be connected to CWR which shall be drilled in the field.

2.03 FROGS

- A. Railbound manganese steel construction as shown
- B. Frog casting

1. Depress heel of manganese frog casting in accordance with AREMA Plan 617-89.
2. Depth-harden impact areas of manganese frog castings.

C. Frog inserts

1. Cast inserts of carbon steel in accordance with AREMA Specification M3.
2. Provide inserts of one-piece construction.
3. Provide inserts having full-face contact conforming to configuration of 115 RE rail.
4. Provide available bonding area per inch of length equivalent to that available for bonded standard joints where applicable. Adjust dimensions of bonded inserts to allow for glue and fabric.
5. Ensure the inserts are smooth and straight and do not exceed the following permissible variations:
 - a. Width between rail webs: Plus or minus 1/32-inch of that shown.
 - b. Depth of flangeway groove: Plus or minus 1/16-inch of that shown.
 - c. Length of insert: Plus or minus 1/8-inch of that shown.
 - d. Straightness of all portions of inserts adjacent to rail using 36-inch straightedge: Plus or minus 1/32-inch.
 - e. Finishing height variance of inserts from that required for bonding area: Plus or minus 1/64-inch.

D. Assembly: Prior to delivery, assemble frogs as shown.

1. Bonding adhesive: As manufactured for bonded joint bars by Allegheny Drop Forge Company, Portec, Inc. or equal, applied as directed by the manufacturer to all contact surfaces between inserts and rail.
2. Secure frog, except for insert, with 1-3/8 inch diameter high strength bolts in accordance with AREMA requirements.
3. Assemble inserts with 1-1/8 inch diameter high-strength bolts, ASTM A490, and lock nuts. Position bolt holes in accordance with AREMA Plans 621-89 and 1010-89 and as shown. Bolt holes 1-3/8 inches in diameter plus or minus 1/32- inch.
4. Flat washers: ASTM F436.
5. Equip bolts as shown with one beveled or flat headlock washer and one flat or beveled washer to provide square bearing and to permit tightening of nuts by wrench.
6. Lock nuts: IFI-100 and IFI-101, ASTM A563, Grade C.
7. Tension bolts to between 75 percent and 85 percent of proof load. Exact value as directed by the Authority Representative. Ascertain bolt tension by means of torque wrench. Determine desired torque by test similar to that described in IFI-101.

2.04 FROG GUARD RAILS

A. Length:

1. No. 6 Guarded Turnout - 12' - 6"
2. No. 8 Turnout - 14' - 0"

B. Complete with blocks and bolts as shown.

2.05 SWITCHES

A. Switch Rails: As shown.

1. Switch rails and stock rails: In accordance with Section 05656, Running Rail, and AREMA Plan 221-62, Detail 5100.
 - a. Switch rails may be thick web or constructed with reinforcing bars.
 - b. Stock rail lengths: as shown or as required for switch panel..
2. Bolts, rivets, fittings and spring washers in accordance with Appendix A of the AREMA, Portfolio.

- a. Fabricate five bolt heel joint assembly in accordance with AREMA Plan 221-62 and AREMA Manual.
 - b. Fabricate forged steel rail stops in accordance with AREMA requirements.
- B. Drill stock rails for ballasted special trackwork as shown for switch heaters.

2.06 SWITCH RODS

- A. Switch rods and clips of vertical design, Type MJS, modified as shown.
- 1. Insulated construction.
 - 2. Assembled.
 - 3. Test in accordance with AAR requirements.
 - 4. Length: As shown.
- B. Switch rods must be capable of at least one (1) inch plus/minus adjustment after the initial specified 5 inch throw for No. 8 turnouts and 3-3/4 inch throw for the No. 6 guarded turnout has been set.
- C. Design-Builder's shop drawings shall provide the required spread measurement for each switch rod which are needed to support the specified throw.

2.07 RAIL BRACES

- A. Boltless adjustable brace equal to those formerly manufactured by Bethlehem Steel, modified to permit installation of one inch diameter electric switch heaters on rail web of ballasted turnouts. The hole in the rail brace shall provide 3/26 inch clearance to the one inch diameter heater tube, and shall be of sufficient size to allow the disconnect terminal and anti-creep collar to pass through.
- B. Shop weld rail brace backing blocks to switch plates.
- C. Rail brace backing blocks to permit mounting on 3/4-inch thick flat plates. Allow for modification to fit 1/4-inch recessed gauge plates. Ensure that distance from rail base to horizontal bearing surface of backing block is the same in each case to permit use of standardized wedge.
- D. Clearance between backing block and rail base: Determined by design of selected brace.
- E. Brace shall use left-hand Pandrol spring clips e2056.

2.08 PLATES

- A. Furnish special trackwork units with special plates as shown, fabricated of 3/4-inch thick steel except for the gauge plates and restraining rail plates fabricated of 1 inch thick steel. Steel plates shall be fabricated from ASTM A36 steel in accordance with AREMA requirements.
- B. Plates complete with specified rail base backing blocks, riser plates, rail stops and rail clamp blocks welded thereon.
- C. Riser plates and rail stops fabricated of ASTM A36 steel as shown and as specified.
- D. Punch holes in each plate perpendicular to face. Cut clean without torn or ragged edges.

- E. Straighten plates cold in press or roller until surface and line requirements are met. The following tolerances are not cumulative.
1. Plate thickness: Plus or minus 1/32-inch.
 2. Middle ordinate: Place plate on horizontal support. Place straightedge or wire string from one end of plate to the other on the concave side. Measure distance between plate surface and straightedge or stringline. Distance not to exceed 0.001 inch per inch of length with surface upsweep or downsweep uniform.
 3. Plate thickness of dual rail stops, single rail stops and riser plates: Plus or minus 1/32-inch.
 4. Straightness of edge of dual rail stops, single rail stops and riser plates parallel and adjacent to base of running rail: Plus or minus 1/32-inch.
 5. Transverse dimension of dual rail stops: Plus or minus 1/32-inch.
 6. Tolerances other than those specified: Plus or minus 1/8-inch.
 7. Spike hole locations for ballasted special trackwork: Plus or minus 1/8-inch.
- F. Identification of plates:
1. Stamp with suitably sized characters not less than 1/2-inch in height, located on top surface and plainly visible when assembled.
 2. Include Contract Number and identification designation as shown.
- G. Fillet weld rail braces, rail stops, riser plates and rail clamps to their respective plates as shown in accordance with AWS D1.1.
- H. In special trackwork fabricated for ballasted trackwork, seven and three-quarter inch wide elastic fastener tie plates suitable for e2056 Pandrol spring clips shall be used at all support locations not having special frog, switch, gauge, guard or restraining rail plates.

2.09 GAUGE PLATES

- A. Switch gauge plates as shown and as specified for plates.
- B. Insulation shall be a four hole 7-1/2" x 8" x 3/4" epoxy fiberglass splice block fastened to the plate with Huck type compression fasteners. The insulating material shall have a tensile strength of 70 ksi, compressive strength of 100 ksi and a tensile modulus of 3.4×10^6 .

2.10 TURNOUT GUARD RAIL

- A. Length: As shown.
- B. Complete with blocks and bolts as shown.
- C. Type: 132 RE rail.
- D. Planned in accordance with AREMA Plan No. 504-89.

2.11 RAIL JOINTS

- A. Furnish all standard and insulated joints within the turnout

2.12 GUARDED TURNOUTS

- A. Guard Rail Stop:
1. Ductile Iron: ASTM A536, Grade 65-45-12 to fit 115 RE rail and as supplied for NYCTA guarded turnouts.

- a. Ballasted Turnouts:
 - 1) Ductile iron rail stops shall be attached to the tie and plate; three studs with nuts and washers per rail stop. Cast rail stops and house chairs shall be fastened through the ties with 7/8 " diameter double end threaded studs, flat washers and heavy hex nuts. The nuts and washers shall be fastened to the stud on the underside of the tie and on top of the casting similar to NYCTA guarded turnouts.
 - 2. The rail stop shall be backed with a 6" x 2" x 1/2" steel block welded to the rail plate.
- B. Manganese Housing Assembly:
 - 1. Cast manganese steel: AREMA Manual.
 - 2. Housing: Similar to that manufactured for the NYCTA.
 - a. Ballasted track - 5' - 5" long.
 - 3. Housing Chairs: Ductile Iron ASTM A536 Grade 65-45-12, as manufactured for NYCTA.
 - a. Ballasted housing chairs shall be fastened to ties, steel plates and gauge plates similar to ductile iron rail stops.
 - b. The first housing chair number shall be configured for bolting to a 132 RE guard rail which continues ahead of the point of switch as shown.
 - 4. No part of the housing shall extend more than 1-1/2 inches above the top of rail.

2.13 Rail Precurving

- A. All rail before precurving shall be straight.
- B. Perform precurving of rail to conventional railroad industry frog and switch shop procedures in accordance with the track centerline radii shown on the Design Drawings and approved Shop Drawings.
- C. Precurved running rail shall be produced in a manner that final track construction tolerances can be achieved.
- D. The rail shall be uniformly curved such that the deviation of the mid-ordinate offset from the theoretical offset is within the tolerances for straight rail using the appropriate chord distances required in the AREMA Manual Chapter 4, Part 2, Section 2.1.13, Workmanship.
- E. Rail ends shall be cropped as necessary to meet the AREMA tolerances.
- F. After curving, the precurved rail shall be set for inspection on the type of plates (tie, restraining rail or switch plates) and at the plate spacing for which the rail was designed. The bottom of the plates shall be in one plane with no shimming. With no rail fasteners applied, the base of the precurved rail shall lay flat on the plates. Rail fasteners shall not be used to draw the base down flat on the plate nor the plate up flat against the plate.
- G. Identify precurved rail with painted identity numbering per approved shop drawing code at end of each rail. Paint identity number at the top of the base near the web.

2.14 Restraining Rail

- A. Restraining rail shall be fabricated in 40 foot maximum and 20 foot minimum sticks of new high strength 132 RE rail manufactured to trackwork rail section tolerances.
- B. The toe of the restraining rail shall be cut off as shown.

- C. Restraining rail shall be precurved to match each curve as shown on the drawings where centerline radius is less than 350 feet.
- D. Precurved restraining rail shall be marked in accordance with these specifications indicating matching radius of curvature and curve number.
- E. Restraining rail joints shall be furnished complete with 12 inch long filler block and reinforcing bars, 1/2 inch thick per AREMA Plan 325-58 for 115 RE rail and for 132 RE.
- F. One reinforcing bar shall be sized to lock the square bolt heads.
- G. Head locks, spring washers, and nuts shall be included. Washers and headlocks shall bear fully against the rail web and provide a flat bearing surface for the nut and the bolt head.
- H. Headlocks shall be sized to lock the square bolt head.
- I. Washers and headlocks shall be in accordance with AREMA Specifications.
- J. Restraining rail joint, end block and separator block assemblies shall be furnished with filler blocks, shims, appropriate reinforcing bars or washers and headlocks wired together to prevent loss of parts.
- K. Restraining rail tie plates for wood ties shall be fabricated as shown.

PART 3 -EXECUTION

3.01 INSTALLATION

- A. Ballasted Special Trackwork Fabrication
 - 1. Fabrication of special trackwork for ballasted track shall be as specified and shall comply with the applicable related Sections:
 - a. General Track Construction (GTC), Section 05651.
 - b. Ballasted Track Construction (BTC), Section 05652.
 - c. Special Trackwork Construction - Ballasted, Section 05654.
 - d. Track Appurtenances and Other Track Material, Section 05658
 - e. Timber Ties, Section 06130
 - 2. Tolerances
 - a. The gauge, cross level, and horizontal and vertical alignment of ballasted special trackwork shall be as shown and specified. Tolerances shall be as specified for ballasted track construction for BTC. Switch points in normal position shall be square within 5/8 inch
 - b. Prebored holes in ties for screw spikes shall be 3/4 inch diameter and not less than five inches nor more than six inches deep.
 - c. Tolerance of plus or minus 1/16 inch shall be maintained for the distance between screw spike holes.
 - d. Tolerance of plus or minus 1/8 inch shall be maintained in the centering of screw spike holes across the width of the tie.
 - 3. Ties shall be bored for screw spikes, and only screw spikes will be permitted in special trackwork.
 - 4. The number and locations of holes shall conform to the location and number of screw spikes shown for each special plate.
 - 5. Elastic fastener tie plates shall have four screw spikes, one at each corner.
 - 6. Boring of holes in excess of those required will not be permitted.

7. Boring in timber ties shall be performed with the heartwood face down. Holes bored in timber ties shall be treated with pentachlorophenol oil immediately after boring.
8. Holes shall be located so that each tie plate will be centered on the tie at a right angle to the rail.
9. Prior to installing tie plates, the surface of the tie shall be swept clean to allow full bearing of the plate on the tie.
10. Boring and spiking will ensure that the outside shoulder of the plates will have full bearing against the rail base when the rails are at proper line and gauge.
11. Spikes shall be started vertically and square, and shall be installed straight. Straightening of spikes will not be permitted. Spikes bent during installation shall be withdrawn and the holes plugged (with treated tie plugs if wood, as per manufacturers instruction if composite). Screw spikes shall be installed firmly to the top surface of the plates.
12. All special plates, not in the switch panel, which span two or more ties shall not be spiked during shop assembly to preclude un-spiking for disassembly and packaging. The Design-Builder's method for locating these plates, drilling the ties and holding the plates in place during shop assembly and inspection shall be approved by the Authority Representative.

B. Identification Numbers:

1. As shown on the drawing, each turnout has an identification number. This number shall be stamped on a metal tag and the tag affixed to each panel and separate component bundle.
2. Tags shall be made of corrosive-resistant metal such as anodized aluminum or brass. Fastening nails shall be of the same material as the tags. Numbers shall be stamped in characters 1/2 inch minimum in height. Tags shall be a minimum of .050 inches thick, 1-1/4 inches wide and two inches long.

C. Package and label parts and replacement materials in moisture-proof containers suitable for shipment and storage.

D. Attach copies of shipping list in the package and so that the list is readable from the exterior of the package.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

No separate measurement of work specified in this Section will be made.

4.02 PAYMENT

Compensation for work specified in this Section will be included in the price of the work of which it is a part.

END OF SECTION

SECTION 05660

RESTRAINING RAIL AND LUBRICATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnish, fabrication and installation a restraining rail system.
- B. Furnish and install the lubricators to include concrete pads, lubrication distribution system, track connections and testing.
- C. Furnish and install all required electrical work for the lubrication system.

1.02 RELATED SECTIONS

- A. Section 05651- General Track Construction
- B. Section 05652 - Ballasted Track Construction
- C. Section 05656 - Rail
- D. Section 05658 - Track Appurtenances and Other Track Material (OTM)
- E. Division 16 - Contact Rail Sections

1.03 REFERENCES

- A. Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.
 - 1. American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering, herein referred to as the AREMA Manual.
 - 2. American Railway Engineering and Maintenance-of-Way Association (AREMA), Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio.
 - 3. American Society for Testing and Materials (ASTM):
 - 4. National Electric Code (NEC) and regulations of the jurisdictional authorities.
 - 5. Insulated Cable Engineers Association (ICEA)
 - 6. National Electrical Manufacturers Association (NEMA)
 - 7. Institute of Electrical and Electronics Engineers (IEEE)
 - 8. Underwriters Laboratories (UL)
 - 9. Military Specifications (MIL or MILSPEC)

1.04 SUBMITTALS

- A. Submittals shall be as specified in Section 01330, Submittals.
- B. Submit the following to the Authority Representative for approval.

1. Shop drawings for restraining rail components including but not limited to separator blocks, end blocks, shims, bolts, washers, nuts, etc.
 2. The marking scheme for restraining rail identification for installation.
- C. Lubricator Electrical Work:
1. Submit shop drawings and manufacturer's literature.
 2. Submit descriptions and wiring diagrams of equipment.
 3. Submit field test procedures for cable.
 4. Submit flame retardance and smoke density test reports and data for tests performed not more than 12 months prior to submittal, for cables which are identical to the cable furnished.
 5. Provide certified test reports demonstrating that the cable complies in all respects with the requirements of the referenced Standards and Tests, and as modified herein.
 6. Provide certificate of conformance to specified wire requirements. Include certificate with submittal of shop drawings and with each cable shipment.

1.05 QUALITY CONTROL

- A. Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.
- B. Develop and maintain a quality control program regulating methods, procedures, and process to ensure compliance with standards of quality required by the Contract Documents.

1.06 DELIVERY, HANDLING AND STORAGE

- A. Restraining rail shall be stacked and banded for shipment according to normal practice. Brackets shall be palletized.
- B. Package small loose parts, i.e. bolts, washers and nuts in secure shipping boxes and kegs.
- C. Lift restraining rail at two points, with the rail weight evenly distributed to each lift point. Handle carefully to avoid damage.
- D. Load restraining rail with adequate wood strips between the tiers of rail to prevent damage in transit.

PART 2 - PRODUCTS

2.01 RESTRAINING RAIL SYSTEM

- A. Rail: 132 RE in accordance with Section 05656 RAIL
- B. Separator Block: Cast Ductile Iron
- C. Shims: ASTM A36

- D. Bolts: 1-3/8" diameter, square head, Type 3, ASTM A325
- E. Nut: Hexagonal, Grade C3, ASTM A563
- F. Steel Base Plate and Stop Block: ASTM A36
- G. Spring Washer: AREMA Manual, Section 4
- H. Flat Washer: Hardened weathering ASTM F436 steel
- I. Screw Spike: As specified in Section 05658, Track Appurtenances and OTM
- J. Pandrol Shoulders: As manufactured by Pandrol, Inc. or approved equal
- K. Joints: As shown; and as specified in Section 05658, Track Appurtenances and OTM
- L. Rail Brace: Boltless adjustable brace similar to those formerly manufactured by Bethlehem Steel for use with left-hand Pandrol Spring Clips, e2056

2.02 LUBRICATORS

- A. Portec AC Protector IV - 800 electric wayside lubricator including all hoses, clamps, fittings and lubricant distribution system. (No substitute or "or Equal" lubricator will be approved).
 - 1. The lubricator housing shall have two mounting brackets on each side to provide for anchoring with 1/2" expansion anchors into a concrete base pad.
 - 2. No electrically conductive materials that are a part of the lubricator system shall be installed closer than two feet to any running rail. Non-conducting grease fittings shall be installed on all grease hoses.
- B. Concrete: ASTM C94, 3500 psi with entrained air.
- C. Steel Rebar: ASTM 615, Grade 60.
- D. Cast Iron: ASTM A532.
- E. Ductile Iron: ASTM A536
- F. Malleable Iron: ASTM A47.
- G. Stainless Steel 304: ASTM A240, A276.

2.03 LUBRICATOR ELECTRICAL WORK

- A. Liquid-tight Flexible Conduit and Fittings: Applicable requirements of UL 360, flexible galvanized steel core, extruded liquid-tight neoprene or PVC jacket overall.
 - 1. Sizes up to 1-1/4 inch provided with continuous copper bonding conductor, spiral wound between convolutions.
 - 2. Sizes 1-1/2 inch and above provided with separate grounding conductor.
- B. Conduit Connector Fittings:
 - 1. UL 514B, material and finish similar to that of conduit with which they are to be used.
 - 2. For enclosures, cabinets, boxes and gutters in electrical rooms: Threaded nylon

insulated bushing and locknut.

C. Cable:

1. UL-labeled as Type RHW-2 or XHHW-2, 600 volts; copper, size as shown; 10AWG and smaller, solid or stranded; 8AWG and larger, Class B stranded.
2. Standards: Except as modified, cable complying in all respects with ICEA S-68-516, NEMA WC8 or ICE S-66-524, NEMA WC7, as appropriate.
3. Nonmetallic Jacket: Chlorosulfonated polyethylene, cross-linked polyolefin or heavy-duty neoprene, as follows:
 - a. Chlorosulfonated polyethylene complying with ICEA S-68-518, NEMA WC8.
 - b. Cross-linked polyolefin or heavy-duty neoprene with the following requirements when tested in accordance with Part 6 of ICEA S-68-516.
 - 1) Tensile strength: 1800 psi minimum.
 - 2) Elongation at rupture: 150 percent minimum.
 - 3) After air oven aging of 168 hours at 100 deg. C, tensile strength at least 100 percent of unaged value and elongation at least 80 percent of unaged value.
 - 4) After immersion for 18 hours in ASTM D471 Oil No. 2 at 121 deg. C, tensile strength and elongation at least 80 percent of original values.
 - c. Jacket material free of PVC and PVC-based compounds.
4. Flame Retardancy: Cable passing vertical flame test as described in IEEE 383. Cable size for testing: Smaller than #1/0. Comply with UL and ICEA S-68-516.
5. Smoke Generation: Single and multi-conductor cable jacket materials demonstrating low-smoke generation when tested in accordance with ASTM E662.
6. Applied Voltage Testing:
 - a. All cable to be given applied voltage dielectric strength test, after six-hour water-immersion test in accordance with the following test procedures:
 - 1) Polyethylene insulated conductors: In accordance with the paragraphs 6.14.1, 6.14.2, 6.14.5 and 3.5.2 of ICEA S-66-524.
 - 2) Other conductors: In accordance with paragraphs 3.5.2, 6.27.1, and 6.27.2 of ICEA S-68-516.

D. Connectors and Terminal Lugs: UL 486 with the following additional requirements:

1. For 10 AWG and smaller conductor cable: Pressure type tin-plated copper connectors having nonflammable and self-extinguishing insulation grip with temperature rating equal to that of the conductor insulation.
2. For 8 AWG to 4/0 AWG conductor cable: Compression type tin-plated copper connectors and terminal lugs having nylon insulating sleeve or heat shrinkable insulator for insulation grip.
3. Hardware: High strength silicon, bronze, corrosion resistant, non-magnetic, and electrolytic action free when in contact with copper.

E. Bundling Straps: Self-locking steel barb on one end, with tapered strap of self-extinguishing nylon, temperature rating minus 65 deg. F to plus 250 deg. F.

F. Insulating Tape:

1. Plastic tape: Vinyl plastic with rubber-based pressure-sensitive adhesive, pliable at zero degree F with the following minimum properties when tested in accordance with ASTM D1000
 - a. Thickness: 8.5 mils.
 - b. Breaking strength: 20 pounds per inch width.
 - c. Elongation: 200 percent.

- d. Dielectric breakdown: 10,000volts.
 - e. Insulation resistance, indirect method of electrolytic corrosion: 1,000,000 megohms.

- G. Grounding and Bonding Equipment: UL 467, IEEE 80, with the following additional requirements:
 - 1. Grounding conductor: Insulated conductor, size as shown and in accordance with NEC Tables 250-94 and 250-95 as applicable. Insulated conductor complying with the requirements specified for single conductor cable.
 - 2. Terminal lugs:
 - a. For 4/0 AWG and smaller conductors: Copper compression terminal lugs.
 - 3. Ground connector:
 - a. Type as shown or equal.
 - b. Copper alloy body and silicon bronze bolt, nut and lock washer with interlocking clamp.
 - 4. Jumpers: Copper braided or leaf-type flexible jumper, size as necessary.

- H. Sealing compound:
 - 1. FS TT-S-227, two component, fast-setting, polymeric sealing compound to provide watertight seal between concrete and conduit, between cable and conduit.
 - 2. Pour-type for horizontal and gun-grade for vertical or overhead application.
 - 3. When cured, sealant to have rubber-like flexibility allowing minimum movement of conduit and cable in temperature range of minus 40 deg. F to plus 150 deg. F without loss of watertight seal.
 - 4. Pot life: 15 minutes.
 - 5. Minimum ambient temperature for application: 35 deg.F.
 - 6. Initial cure: 15 minutes.
 - 7. Final cure: Seven days.
 - 8. Hardness, Durometer A: 20-35.
 - 9. Seal between conduit and single-conductor cable to withstand water pressure of 70 psi without leakage.
 - 10. Fox Industries, Type FX-571-G or equal.

- I. GFI Circuit Breaker:
 - 1. NEMA AB1.
 - 2. Ground fault interrupter circuit breaker: As shown (see Information Drawing TW-19-RR) and as specified. Overcurrent trip device coordinated to provide selective tripping under overload conditions.

- J. Expansion Bolt Anchors: Stainless Steel 304 in accordance with ASTM A276.

- K. Grounding stud: Manganese bronze, ASTM B138, Alloy No. 675 hard, 3/8 inch high; Evedur GSI, American Brass Company or Equal.

- L. Cable splice and tap-insulating/sealing kit: Suitable for use on 600-volt, 90C cables, material compatible with cable insulation and jacket, meeting the seal test requirements of ANSI C119.1.
 - 1. Heat-shrinkable tubing UL-approved, flame-retardant, corrosion-resistant thick-wall tubing with factory-applied sealant for field insulation on in-line splices and taps to provide a watertight seal and insulating encapsulation, with the following additional requirements:
 - a. Material: Cross-linked polyolefin.

- b. Shrink ratio: 3 to 1 (min.)
- c. Physical properties:
 - 1) Ultimate tensile strength: 2,350 psi, ASTM D41
 - 2) Ultimate elongation: 350% minimum, ASTM D412
 - 3) Hardness, Shore D: 42, ASTM D2240.
 - 4) Water absorption: 0.02%, ASTM D570, Method 6.1.
 - 5) Specific gravity: 1.2, ASTM D792.
- d. Electrical properties:
 - 1) Dielectric strength: 450 volts per mil, ASTM D149.
 - 2) Volume resistivity: 1×10^{15} ohm cm, ASTM D257.
- e. Thermal properties:
 - 1) Continuous operating temp.: -55 to +135 deg. C.
 - 2) Air oven aging (14 days @ 175 deg. C):
 - a) Tensile strength: 2,680 psi.
 - b) Elongation: 375%.
 - 3) Low temperature flexibility (4 hours @ -55 deg. C): No cracking when flexed.
 - 4) Heat shock (4 hours @ 250 deg. C): No cracking, flowing or dripping.
- f. Chemical properties:
- g. Corrosivity: Non-corrosive, MIL-I-23053/15.
- h. Fungus resistance: Non-nutrient, ASTM G21.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Restraining Rail System
 - 1. Shop weld rail brace stop block and Pandrol shoulders to restraining rail plate.
 - 2. Install restraining rail system where shown. Install one restraining rail plate and brace on each tie between the end limits of the restraining rail.
 - 3. Fasten plate to the ties in accordance with the requirements of Section 05653, Ballasted Track Construction using four screw spikes.
 - 4. Drill the running rail and restraining rail for the spacer blocks and joints when both rails are at the same temperature between 70 and 85 F. The prescribed drilling may be made when the running rail is fully anchored providing the running rail has been thermally adjusted as specified.
 - 5. Holes shall be cylindrical, of the diameter shown and drilled with an approved rail drill.
 - 6. Use an approved template as a guide for drilling holes.
 - 7. All holes drilled in the 115 RE running rail and 132 RE restraining rail for spacer blocks or joints shall be cold worked using the Railroad Cold Expansion process by Fatigue Technology, Inc., Seattle, Washington, or approved equal. The process shall be performed in accordance with the manufacturer's instructions by a crew whose supervisor has been trained by the manufacturer.
 - 8. Cut rail only as necessary to meet the following criteria:
 - a. The rail length between an insulated joint and a standard joint shall be 20 feet.
 - b. The minimum length between two standard joints is 20 feet and the maximum length is 40 feet.
 - c. The minimum rail length adjacent to an end section shall be 15 feet.
 - d. The number of 40foot rail lengths shall be maximized.
 - 9. Rails shall be cut square and clean by means of rail saw or abrasive cutting disks. Rail end beveling shall be performed at all rail cuts and shall be in accordance with

- current AREMA Manual requirements for Beveling or Slotting of Rail Ends and AREMA Portfolio Plan No. 1005.
10. Locate restraining rail insulated joints between the same fastener plates as the insulated joints in the adjacent running rail. Join rail as shown.
 11. Assemble all non-insulated joints as shown.
 12. Install bolts and nuts finger tight before tensioning bolts to 20,000 to 25,000 pounds by use of a track wrench or power torque wrench, starting from the center bolts and working to the end bolts. Immediately before the completion and acceptance of work, retighten track bolts to a tension of 15,000 to 25,000 pounds.
 13. Insulated joints shall be assembled with all components shown without rail gaps.
 14. Install the restraining rail so that the flangeway is 1-7/8 inches plus or minus 1/8 inch measured 5/8 inch below the top of the running rail. Tighten the restraining rail hold down bolts to 75 percent of the proof load for the size of the bolt used.

B. Lubricators

1. Install lubricator in accordance with the manufacturer's recommendations where shown and as specified herein.
2. Mount lubricator to the concrete using expansion anchors and 1/2 " diameter bolts.
3. Install track assemblies and grease distribution system to the inbound track and outbound track in accordance with the manufacturer's recommendations.
4. The train detection system that initiates the release of lubricant shall be configured to release to the appropriate restraining rail when the train is moving in the normal direction.
5. Install grease hoses in accordance with the manufacturer's recommendations. Anchor hoses to ties with appropriate clips at a minimum spacing of 10 feet.
6. Perform electrical work as specified in the technical specification for electrical work.
7. At the completion of installation, the Lubricator Reservoir shall be filled with an appropriate lubricant approved by the Authority Representative.
8. Test lubricator system for proper application of lubricant as specified by the manufacturer and approved by the Authority Representative.

C. Lubricator Electrical Work:

1. The Design-Builder shall carefully examine all contract drawings and specifications and be responsible for the proper fitting of materials and equipment at each location as indicated, without substantial alteration. In as much as the drawings are generally diagrammatic and because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Furnishing such fittings and accessories as may be required to meet such conditions shall be at no additional cost to the Authority.
2. The Design-Builder shall verify exact location , size and extent of all existing utilities, obstructions, and/or other conditions which may affect the proposed work under the project. The Design-Builder shall take every precaution to prevent damage to existing work and shall repair any damage as a result of this Work.
3. Conduit:
 - a. Install conduit and fittings where conduit runs are shown.
 - b. Install exposed conduit parallel or perpendicular to the running rails as shown and avoid interference with existing work.
 - c. Thread and ream the ends of field-cut conduit to remove rough edges. Use locknuts and bushings at conduit entrance to boxes, cabinets and equipment enclosures.
 - d. Bend conduit so that bends are free from cuts, dents and other damage.
 - e. Support horizontal conduit with one-hole pipe straps or individual pipe hangers.

- f. Apply lead -free conductive antiseize compound to threaded conduit joints.
 - g. Use minimum of 18-inch long liquid -tight flexible conduit connection to equipment subject to vibration.
 - h. Rod and swab conduit after installation, removing water and foreign matter.
 - i. Waterproof conduit connections.
4. Cable:
- a. Install cable as shown.
 - b. Use nylon straps to bundle and secure wire and cable in panelboards.
 - c. Use a minimum bending radius 12 times outer diameter of cable. Where shown, use shorter bending radius as permitted by NEC, Appendix H of ICEA S-66-524, NEMA WC7 and cable manufacturer.
 - d. To facilitate pulling cable, use UL-listed lubricant recommended by cable manufacturer.
 - e. Connect cables to equipment using integral mechanical connectors or compression connectors.
 - f. Identify feeder terminations to lubricators using nonmetallic fiberboard tags or plastic labels.
 - g. Attach tags to cable with slip-free plastic lacing or nylon bundling straps. Tags shall designate the panelboard name and circuit numbers serving lubricators.
 - h. Splicing of power cables is not permitted. An exception may be granted by the Authority Representative only in extraordinary conditions. Authorization for such an exception must be obtained from the Authority Representative in advance of making a splice. Any such exception must be fully documented and recorded on as-built drawings. The splice must be made watertight as shown.
5. Wire connection accessories:
- a. Secure connections or terminal lugs to the conductor to engage all strands equally.
 - b. Do not rupture insulation nor expose bare conductors.
 - c. Install compression connectors and terminal lugs using tools and pressure recommended by the manufacturer. Indent mark connectors and terminal lugs with number of die used for installation.
 - d. Apply anticorrosion joint compound to connectors, terminal lugs and bolting pads before installation.
6. Grounding and bonding:
- a. Ground Connections:
 - 1) Use terminal lug to connect grounding conductor to equipment enclosure.
 - 2) Use continuous grounding conductor without splices.
 - b. Equipment grounding conductor: Provide equipment grounding conductor for single-phase branch circuits.
 - c. Bond metallic ac equipment enclosures to equipment grounding conductor in ac power feeder.
7. Connect branch circuit wires as shown.
8. Make power cable connections to circuit breakers, new molded case circuit breakers and neutral and ground bus bars in panelboards and enclosed circuit breakers by means of integral mechanical connectors as shown. If such items are not furnished with integral mechanical connectors, make connections using compression connectors.
9. On cable splices, taps and terminations cover connectors with electrical putty , wrapped with three layers of plastic tape or final layer or rubber tape and then install

watertight encapsulation as follows and under the supervision of kit manufacturer's representative or using a factory-certified installation technician, proficient in field installation of heat-shrinkable sealing kits.

10. Use heat-shrinkable tubing for encapsulation of new splices, taps and terminations.
11. Field Quality Control:
 - a. After completion of installation and filling the reservoir with an approved lubricant, demonstrate proper performance of all equipment in the presence of the Authority Representative.
 - b. Test all metallic equipment enclosures, galvanized rigid steel conduits and liquid-tight flexible conduits for continuity to the grounding system.
 - c. Test nongrounded conductors for insulation resistance to ground of 10 megohms. When cable shows unsteady insulation resistance of less than 10,000 ohms, perform high potential test at 80 percent of factory ac test voltage or as recommended by cable manufacturer.
 - d. Test continuity of conductors using ohmmeter.
 - e. Test circuits for connection in accordance with the wiring diagram.
 - f. Check connections to circuit breakers for tightness.
 - g. Molded Case Circuit Breakers: Perform pole-to-pole and pole-to-ground insulation resistance tests with 1000 volt d.c. megger. Insulation resistance to be 50 megohms minimum.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

- A. Measurement of work specified in this Section will be made in the following manner:
 1. No separate measurement.

4.02 PAYMENT:

- A. Compensation for work specified in this Section will be made in the following manner:
 1. Included in the price of the work of which it is a part.

END OF SECTION

THIS FILE NOT USED

SECTION 05661

CONTACT RAIL AND APPURTENANCES FOR TRACTION POWER

PART 1: GENERAL

1.01 SUMMARY

- A. This section specifies designing, fabricating, testing and furnishing a composite contact rail system, including the composite contact rail, splice joints, expansion joints, end approaches, terminal lugs, and all appurtenances as shown and specified.
- B. Related Sections:
 - 1. Section 16127 - Contact Rail System Installation For Traction Power
- C. Payment and Measurement:

Compensation for work specified in this section will be made in the following manner:

 - 1. Work performed by the Contractor pursuant to fabricating and delivering contact rail, splice joints, expansion joints, end approaches, terminal lugs, nuts, bolts and miscellaneous hardware: Lump sum.

1.02 REFERENCES

- A. Codes, regulations, references standards and specifications:
 - 1. AREA Manual for Railway Engineering for Continuous Cast Rail.
 - 2. ANSI H35.1, Type A6101-T6
 - 3. ASTM B317, Type B.
 - 4. Steel Structure Painting Council, SSPC-SP-10.
 - 5. NEMA CC1.
 - 6. ASTM B117.
 - 7. ASTM A2, Grade 65-35.
 - 8. ASTM A47, Grade 32510
 - 9. ANSI B4.1
 - 10. ASTM A325

11. ASTM B134
12. ANSI B18.8.1
13. ASTM A153
14. ASTM A123
15. Steel Structure Painting Council, SSPC-SP-6
16. SAE No. G-18
17. ANSI C37.34

1.03 SYSTEM DESCRIPTION

A. Composite Contact Rail

1. The composite contact rail shall consist of a steel base rail, with one aluminum extrusion fastened to each side of the web area of the base rail, continuous over the finished length.

B. Appurtenances

1. Appurtenances include expansion joints, end approaches, cast parts, terminal lugs, disconnect switch, nuts, bolts, and miscellaneous hardware.

1.04 SUBMITTALS

A. Shop Drawings

1. The Contractor shall submit for approval shop drawings for fabrication of the components and assemblies of the composite contact rail and appurtenances. No fabrication or manufacture shall be performed prior to drawing approval.

B. Certification:

1. Certification that composite contact rail and appurtenances furnished meet or exceed specified requirements
2. Certified test reports.

1.05 QUALITY ASSURANCE

A. Electrical Tests

1. Splice Joint DC Resistance
 - a. Two sections of the composite rail, each 36 inches or more in length, shall

be joined together. At a constant room temperature the resistance across the joint shall be measured in accordance with NEMA CCI and compared to an equal length of unjointed composite rail at the same temperature.

- b. If the resistance across the jointed rail exceeds the resistance of the unjointed rail the joint design will be rejected.

2. Composite Rail and Splice Joint Thermal Cycle

- a. Using the same jointed and unjointed sections used in the dc-resistance test, the specimens shall be cycled thermally for a minimum of ten cycles. Each thermal cycle shall consist of lowering the rail temperature to minus 5C and measuring the resistance of the specimens, then raising the temperature of the specimens to plus 117C and measuring the resistance again for a minimum of ten cycles.
- b. If at any time the resistance of the jointed or unjointed sections exceeds the requirements of these specifications, the design will be rejected.

3. Composite Rail and Splice Joint Assembly Salt-spray Test

- a. Using the same jointed and unjointed sections used in the dc resistance test, perform a 500-hour salt-spray test in accordance with the requirements of ASTM B117.
- b. If, at the end of the test, the resistance of either specimen increases by more than five percent, the design will be rejected.

4. Electrical Characteristics

- a. The assembled composite contact rail shall have an electrical resistance not greater than 0.002 ohms per 1,000 feet at 20 degrees C.
- b. The composite rail shall be capable of conducting 5,000 amperes dc continuous with a temperature rise not to exceed 40 degrees C above 30 degrees C ambient in still air.
- c. The rail shall be capable of withstanding a fault current of 135,000 amperes dc, or equivalent ac, for 100 milliseconds without mechanical or thermal damage.
- d. The Contractor shall submit certification of the electrical characteristics of the composite contact rail.

B. Testing of Terminal Lugs

- 1. Two assemblies from each lot of terminal lugs shall be tested. Failure of any assembly to pass the following tests will cause rejection of the entire lot.
- 2. A completed compression connection shall provide electrical resistance not

greater than an equivalent length of uncut cable when measured between the distal end of the cable and the connector tongue.

3. Bare conductors shall be used for performing tests.
4. Resistance measurement shall be taken before and after the tests specified below.
5. The test connections shall then be subjected to a sustained tension of 5,000 psi of the nominal conductor cross sectional area for a period of three hours. At the end of three hours, there shall be no increase in electrical resistance of the connection beyond that specified. There shall be no slipping of the conductor in the connector nor deformity or loosening of the connection.

C. For codes, regulation, references, standards and specifications, refer to Article 1.02 above.

PART 2: PRODUCTS

2.01 MATERIALS

A. Composite Contact Rail

1. Steel Base Rail

- a. The steel base rail shall be new No. 1 or No. 2 rail conforming to the current requirements of the AREA Manual for Railway Engineering for continuous cast rail. No. 2 rails will be accepted for not more than 15 percent, by weight, of the total base rail furnished.
- b. The standard length of the steel base rail shall be 39 feet at a temperature of 60F. Shorter lengths, varying in increments of one foot from 39 to 25 feet, will be accepted for a maximum of 11 percent, by weight.
- c. A maximum variation of plus-or-minus ½ inch of the stated length for each rail will be permitted.

2. Aluminum Extrusions

- a. The aluminum extrusions shall be of a uniform cross section and shall conform to the alloy and temper requirements of ANSI H35.1, Type A6101-T6 and shall also conform to the requirements of ASTM B317, Type B.
- b. The extrusions shall be formed to permit maximum clamping force with the steel base rail and the cable terminal lugs to create the maximum electrical contact area. In addition, they shall permit rail tongs to grasp the head of the steel base rail for lifting the composite rail without damage to the aluminum extrusions.
- c. Sufficient clearance at the base shall be provided to permit mounting of the contact rail protection cover assembly, clearing insulator ears and

other appurtenances. Sufficient clearance shall be provided at the rail head to mount the specified contact rail heater supplied in other contract.

3. Splice Joint

- a. The splice joint assembly shall consist of two aluminum alloy extrusions of the same material specified for composite rail aluminum extrusion, except that the internal contour of the splice joint extrusion shall conform to the external contour of the composite rail aluminum extrusion to ensure proper vertical and horizontal alignment of the composite rail sections.
- b. The splice joint assembly shall provide ample contact surface for the transfer of electrical current across the joint and the joint shall have a resistance no greater than that of an equal length of composite rail.
- c. The splice joint extrusions shall be predrilled as shown to accept four 7/8-inch diameter steel compression fasteners, as manufactured by the Huck Manufacturing Company, or equal.
- d. The assembled splice joint shall be capable of withstanding a 25,000-pound longitudinal tension force across the joint without exceeding the yield point of its components.

B. Appurtenances

1. Expansion Joints

- a. The expansion joint assembly shall consist of the following;
 - 1) Two bars of medium carbon steel, ASTM A27, Grade 65-35 or malleable iron, ASTM A47, Grade 32510.
 - 2) Two sections of steel base rail as shown.
 - 3) Aluminum extrusions.
 - 4) Accessories as shown.
- b. The aluminum extrusions shall be bolted to each base rail to allow the attachment of a splice joint assembly on each section.
- c. The internal contour of the expansion joint bars shall conform to the external contour of the modified steel base rail sections to ensure proper alignment horizontally and vertically and to create a smooth passage across the joint for the collector shoe. The assembled modified steel base rail sections shall be predrilled as shown.
- d. The expansion joint assembly shall be designed to accommodate 12 inches of movement for each 1,000 feet of composite contact rail.

2. End Approaches

- a. The end approaches shall consist of sections of steel base rail as specified, cut and welded to provide a smooth transition for the collector shoe onto the composite contact rail as shown.
- b. The end approaches shall be supplied in lengths of five-feet six-inches. The mating end of each end approach shall contain sufficient length of aluminum extrusion bolted to the web to allow the attachment of a splice joint assembly.
- c. The end approaches shall be predrilled as shown.

3. Cast Parts

- a. Cast parts for the composite rail assembly, including expansion joints, shall be manufactured as shown and as specified.
- b. Castings shall be free of cracks, flaws, blemishes, scale, or any other defect that would be detrimental to the service for which they are intended. The finish surface shall be smooth and shall fit all adjoining parts accurately. Grinding will be permitted to ensure the specified fit.
- c. Medium Steel Castings
 - 1) Steel for casting shall be medium steel made by the open-hearth, basic oxygen or electric-furnace process, ASTM A27, Grade 65-35.
 - 2) All castings shall be fully annealed by heating to a temperature above the transformation range and, after being held for a proper time at this temperature, cooled slowly and uniformly in the furnace.
 - 3) Steel castings shall be free from defects such as cracks, machining flaws, porosity or excessive shrinkage and shall be finished to a true and homogenous surface.
- d. Malleable-iron castings
 - 1) Parts cast from malleable iron shall conform to ASTM A47, Grade 32510.

4. Terminal Lugs

- a. Terminal lugs shall be compression-type lugs compatible with 1,000-KCMIL, 427-strand cable. Terminal lugs shall be 98 percent pure copper. The entire lug shall be hot-dip, tin-coated, 0.3 mils minimum thickness. Tongues shall not be less than two inches square by ½ inch thick and drilled for a 5/8-inch diameter fastener.

5. Disconnect Switch

- a. Outdoor, moisture-resistant, single-pole, single-throw, bolted pressure type/no-load-break, manually operated mechanism for operation on 750 volts dc.
- b. In accordance with ANSI C37.34.
- c. Continuous current rating: 1200 amperes dc minimum with temperature rise not exceeding 50C over 30C ambient.
- d. Dielectric withstand voltage from switch and mounting base across open contacts: 3000 volts dc minimum for one minute.
- e. Momentary fault current rating: 160,000 amperes dc with rate of rise of 10 amperes per micro-second.
- f. Terminals equipped with lugs for connection of two 1000 KCMIL, 427 strand, copper cables on each side.
- g. Designed to prevent opening or closing by gravity or vibration or of its own accord.
- h. Insulating operating-handle mechanism with mechanical latch to prevent accidental opening or closing and capable of being padlocked in open or closed position.
- i. Enclosure:
 - 1) NEMA Type 3R in accordance with ICS 6.
 - 2) Capable of withstanding 200-pounds force without damage to switch or enclosure.
 - 3) Minimum three-inch clearance to exposed terminals of switch in open and closed positions.
 - 4) Material: Fiberglass, 1/8-inch minimum thickness.
 - 5) Size: To fit within limits imposed by yard conditions and clearances.
 - 6) Cover: Designed to provide easy access to switch. Equipped with stainless steel piano hinge and hasp.
 - 7) Cable openings: Compatible with switch terminals; furnished with Type GRE sealing bushings suitable for 1000 KCMIL cable, O.Z. Gedney Manufacturing Co., Inc., or equal.
 - 8) Flanges and mounting hardware: Furnished as necessary to

mount enclosure on concrete base and to mount switch in enclosure. Three point latching hardware for cover.

6. Nuts, Bolts, and Miscellaneous Hardware
 - a. All nuts, bolts, and flat washers shall be manufactured in accordance with ASTM A325.
 - b. The dimensional data and type hardware for all nuts, bolts and miscellaneous parts shall be as shown on drawings. Steel bolts, nuts, and washers shall be galvanized as specified below.
 - c. Cotter pins shall conform to ASTM B134, and ANSI B18.8.1
7. Galvanizing
 - a. Bolts and miscellaneous hardware to be galvanized shall be coated in accordance with ASTM A153.
 - b. Parts to be galvanized shall be hot-dip galvanized after fabrication, in accordance with ASTM A123, unless otherwise specified.
 - c. Before galvanizing, the finished parts shall be pickled or sandblasted and the scale and adhering impurities thoroughly removed. The pickling shall be done in properly diluted sulfuric acid, after which the parts shall be thoroughly cleaned in cold, running water.
 - d. Sand-blasting shall meet or exceed Steel Structure Painting Council SSPC-SP-6, except that the maximum grit size shall be SAE No. G-18.
 - e. The parts shall then be immersed in a solution of either zinc chloride or hydrochloric acid. Immediately following thorough drying, the parts shall be dipped into the zinc bath before corrosion starts again.
8. Tolerances for Fits.

Tolerances for fits shall be in accordance with ANSI B4.1.

2.02 FABRICATION

- A. Composite Contact Rail
 1. Method of Assembly
 - a. Prior to final assembly of the aluminum extrusions to the steel base rail, the contact surfaces of the steel base rail shall be sandblasted to near white finish in accordance with Steel Structures Painting Council SSPC-SP-10.
 - b. After sandblasting, the surfaces of both the steel base rail and the

aluminum extrusions shall be cleaned of all oil, grease and other foreign matter.

- c. The aluminum extrusions shall be free of aluminum oxide at the time of application of the oxide-inhibiting paste.
- d. Following the cleaning process, all mating surfaces shall receive a liberal and evenly distributed coating of oxide-inhibiting paste, Dearborn Chemical Product NO-OX-1D or equal. Oxide-inhibiting paste shall also be applied to all interface surfaces of the fasteners.
- e. After application of the oxide-inhibiting paste, the aluminum extrusions shall be permanently attached to the steel base rail on maximum 19-inch centers with 5/8-inch diameter steel compression fasteners, as manufactured by the Huck Manufacturing Company or equal.
- f. The installed fastener shall provide a minimum 19,000-pound clamping force. The fastening system shall maintain the aluminum extrusions in stable, intimate electrical contact with the steel base rail under all conditions of thermal expansion and contraction from zero degree to 150F.
- g. The assembled composite rail sections shall be predrilled on each end to accept a splice joint assembly as shown. After assembly all excess oxide-inhibiting paste shall be removed from each rail.

PART 3: EXECUTION - Not Used

END OF SECTION

THIS PAGE NOT USED

SECTION 05810

EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing expansion joint cover assemblies.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Cast-In-Place Structural Concrete: Section 03300.
- B. Expansion Joint Systems: Section 05811.
- C. Flashing and Sheet Metal: Section 07600.
- D. Seals and Sealants: Section 07900.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements specified for each:
 - 1. Product data for each type of expansion joint cover assembly specified, including manufacturer's product specifications, installation instructions, details of construction relative to materials, dimensions of individual components, profiles, and finishes.
 - 2. Shop drawings showing fabrication and installation of expansion joint cover assembly including plans, elevations, sections, details of components, joints, splices, and attachments to other units of Work.
 - 3. Samples for initial selection purposes in the form of manufacturer's color charts, actual units, or sections of units showing full range of colors, textures, and patterns available for each exposed metal and elastomeric material of expansion joint cover assembly indicated.
 - 4. Samples for verification purposes in full-size units of each type of expansion joint cover assembly indicated; in sets for each finish, color, texture, and pattern specified, showing full range of variations expected in these characteristics.
 - a. Install elastomeric material for joints samples to verify color selected.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ADA: Americans with Disabilities Act.
 - 3. AAMA: 603.8, 605.2, 606.1, 607.1, 608.1
 - 4. ANSI/UL: 263.
 - 5. ASTM: A167, B209, B221, B455, C920, D2000, E119, E1399.
 - 6. NAAMM: Metal Finishes Manual.
 - 7. NFPA: 251.
 - 8. UBC: 43-1.
- B. Single-Source Responsibility: Where practical, obtain expansion joint cover assemblies specified in this Section from one source from a single manufacturer. Coordinate compatibility with expansion joint cover assemblies specified in other sections.
- C. Fire-Test-Response Characteristics: Where indicated, provide expansion joint cover assemblies identical to those assemblies whose fire resistance has been determined per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E119, including hose stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance Ratings: Not less than the rating of adjacent construction.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Aluminum: ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 6061-T6, sheet and plate.
 - 1. Protect aluminum surfaces to be placed in contact with cementitious materials with a protective coating.
- B. Stainless Steel: ASTM A167, Type 304 with 2B finish, unless indicated otherwise, for plates, sheet, and strips.
- C. Extruded Preformed Seals: Single or multicellular elastomeric profiles as classified under ASTM D2000, designed with or without continuous, longitudinal, internal baffles. Formed to fit compatible frames, in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors.
- D. Preformed Sealant: Manufacturer's standard elastomeric sealant complying with ASTM C920, Use T, factory-formed and -bonded to metal frames or anchor members; in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors.
 - 1. Joints 2 Inches Wide and Less: Withstand plus or minus 35 percent movement of the joint width without failure.
 - 2. Joints Greater Than 2 Inches to 4 Inches Wide: Withstand plus or minus 50 percent movement of the joint width without failure.
- E. Seismic Seals: Typically for exterior application, two single-layered elastomeric profiles, one interior and one exterior, as classified under ASTM D2000; retained in a set of compatible frames, in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors. At manufacturer's option, omit interior profile for interior application.
- F. Fire Barriers: Designed for indicated or required dynamic structural movement without material degradation or fatigue when tested according to ASTM E1399. Tested in maximum joint width condition with a field splice as a component of an expansion joint cover per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E119, including hose stream test of vertical wall assemblies by a nationally recognized testing and inspecting agency acceptable to authorities having jurisdiction.
- G. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesive, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.02 EXPANSION JOINT COVER ASSEMBLIES:

- A. General: Provide expansion joint cover assemblies of design, basic profile, materials, and operation indicated on approved shop drawings. Provide units comparable to those indicated or required to accommodate joint size, variations in adjacent surfaces, and dynamic structural movement without material degradation or fatigue when tested according to ASTM E1399. Furnish units in longest practicable lengths to minimize number of end joints. Provide hairline mitered corners where joint changes directions or abuts other materials. Include closure materials and transition pieces, tee-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous joint cover assemblies.
- B. Moisture Barrier: Provide manufacturer's continuous, standard, flexible vinyl moisture barrier under covers at locations indicated on approved shop drawings.

- C. Fire-Rated Joint Covers: Provide expansion joint cover assemblies with manufacturer's continuous, standard, flexible fire barrier seals under covers at locations indicated on approved shop drawings to provide fire-resistive rating not less than the rating of adjacent construction.
- D. Coverless Fire Barrier: Provide manufacturer's continuous standard flexible fire barrier seals at locations indicated on approved shop drawings to provide fire-resistive rating not less than the rating of adjacent construction.
- E. Metal Floor-to-Floor Joint Cover Assemblies: Provide continuous extruded metal frames of profile indicated with seating surface and raised floor rim or exposed trim strip to accommodate flooring and concealed bolt and anchors embedded in concrete. Provide assemblies formed to receive cover plates of design indicated and to receive filler materials (if any) between raised rim of frame and edge of plate. Furnish depth and configuration to suit type of construction and to produce a continuous flush wearing surface with adjoining finish floor surface.
 - 1. Partially Concealed Cover: Provide one frame on each side of joint, designed to accommodate manufacturer's floor cover plate and filler.
 - 2. Exposed Cover: Provide one frame on each side of joint, designed to support floor plate and filler
 - 3. Flat Cover Plates: Provide cover plates of profile and wearing surface indicated. Extend flat plates to lap each side of joint.
 - a. Filler Insert: Furnish abrasive-resistant flexible gasket filler between edge of cover plate and raised rim of frame to accommodate required movement
 - 4. Fixed Cover Plates: Attach one side of the cover plate to a frame or finished wearing surface, with other side resting on other frame or finished wearing surface to allow free movement.
 - 5. Self-Centering Cover Plates: Concealed centering device with the cover plate secured in or on top of frames as to have free movement on both sides.
 - 6. Floor Cover Plate Wearing Surfaces: Provide cover plates with the following type of wearing surfaces.
 - a. Plain.
 - b. Fluted.
 - c. Recessed to receive full thickness of flooring material.
 - d. Abrasive plate.
 - e. Adhesive filled plate.
 - f. Adhesive strip plate.
- F. Floor-to-Wall Joints: Provide one frame on floor side of joint only. Provide wall side frame where required by manufacturer's design.
 - 1. Angle Cover Plates: Attach angle cover plates for floor-to-wall joints to wall with countersunk, flat-head exposed fasteners secured to drilled-in-place anchor shields, unless otherwise indicated, at spacing recommended by joint cover manufacturer.
- G. Wall, Ceiling, and Soffit Joint Cover Assemblies: Provide interior wall and ceiling expansion joint cover assemblies of same design and appearance. Provide exterior wall and soffit expansion joint cover assemblies of same design and appearance. Provide wall expansion joint cover assemblies compatible with floor expansion joint cover assemblies design and appearance.
 - 1. Fixed Metal Cover Plates: Provide a concealed, continuously anchored frame fastened to wall, ceiling, or soffit only on one side of joint. Extend cover to lap each side of joint and to permit free movement on one side. Attach cover to frame with cover in close contact with adjacent finish surfaces.
 - 2. Floating Metal Cover Plates: Cover plate secured in or on top of frames to permit free movement on both sides.
 - 3. Self-Centering Cover Plates: Concealed centering device with the cover plate secured in or on top of frames to permit free movement on both sides.

4. Flexible Filler: Secure the approved flexible filler between frames to compress and expand with movement.
- H. Joint Cover Assemblies with Preformed Seals: Provide joint cover assemblies consisting of continuously anchored aluminum extrusions and continuous extruded preformed seals of profile indicated or required to suit types of installation conditions shown. Furnish extrusions designed to be embedded in or attached to concrete with lugs. Vulcanize or heat-weld splices (if any) to ensure hermetic joint condition.
1. Cover Plate: Include extruded aluminum cover plate fastened to one side of joint and extend plate to lap each side of joint to permit free movement with cover in close contact with adjacent contact surfaces.
- I. Joint Cover Assemblies with Elastomeric Sealant: Provide continuous cover joint assemblies consisting of elastomeric sealant factory-bonded to extruded aluminum frames of profile indicated or required to suit types of installation conditions shown. Provide frames for floor joints with means for embedding in or anchoring to concrete without using exposed fasteners and that will result in exposed surfaces of sealant and aluminum frames finishing flush with adjacent finished floor surface without exposing anchors.
- J. Compression Seals: Preformed, elastomeric extrusions having internal baffle system in sizes and profiles shown or as recommended by the manufacturer. Provide lubricant and adhesive for installation recommended by the manufacturer.
- K. Foam Seal: Nonextruded, low-density, cross-linked, nitrogen-blown ethylene vinyl acetate polyethylene copolymer foam. Provide adhesive for installation recommended by the manufacturer.

2.03 METAL FINISHES:

- A. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes to products in factory after fabrication. Protect finishes on exposed surfaces before shipment.
- B. Aluminum Finishes: Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
1. Mill Finish: AA-M10 (unspecified mill finish).
 2. Class II, Clear-Anodized Finish: AA-M12C22A31 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, clear film thicker than 0.4 mil].
 3. Class I, Clear-Anodized Finish: AA-M12C22A41 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, clear film thicker than 0.7 mil] complying with AAMA 607.1.
 4. Class II, Color-Anodized Finish: AA-M12C22A32/A34 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, film thicker than 0.4 mil with integral color or electrolytically deposited color].
 5. Class I, Color-Anodized Finish: AA-M12C22A42/A44 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, film thicker than 0.7 mil with integral color or electrolytically deposited color] complying with AAMA 606.1 or AAMA 608.1.
 - a. Color: As selected by the Engineer from within standard industry colors and color density range.
 6. Baked Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.
 - a. Organic Coating: Thermosetting modified acrylic enamel primer/topcoat

system complying with AAMA 603.8 except with minimum dry film thickness of 1.5 mils, medium gloss

- b. Color: As selected by the Engineer from manufacturer's standard colors.
 7. High-Performance Organic Coating: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.
 - a. Fluoropolymer Two-Coat Coating System: Manufacturer's standard two-coat thermocured system, composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.
 - b. Fluoropolymer Three-Coat Coating System: Manufacturer's standard three-coat thermocured system composed of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluorocarbon topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.
 - 1) Resin Manufacturers: Subject to compliance with requirements, provide fluoropolymer coating systems containing resins produced by one of the following manufacturers:
 - a) Ausimont USA, Inc. (Hylar 5000).
 - b) Elf Atochem North America, Inc. (Kynar 500).
 - c) Or equal.
 - 2) Color and Gloss: As selected by the Engineer from manufacturer's standard choices for color and gloss. Retain below for covers in contact with masonry or concrete.
 8. Factory-Primed Concealed Surfaces: Protect concealed metal surfaces to be placed in contact with concrete or masonry with a shop coat of manufacturer's standard primer on the contact surfaces.
- C. Stainless Steel Finishes: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
1. Bright, Cold-Rolled Unpolished Finish: AISI No. 2B finish.
 2. Bright, Directional Polish: AISI No. 3 finish.
- D. Factory Finish: Manufacturer's standard factory finish.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Manufacturer's Instructions: In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for phases of Work, including preparing substrate, applying materials, and protecting installed units.
- B. Coordinate and furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in or anchored to concrete or to have recesses formed into edges of concrete slab for later placement and grouting-in of frames.
- C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary to secure expansion joint cover assemblies to in-place construction, including threaded fasteners with drilled-in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and provide for secure attachment of expansion joint cover assemblies.

3.02 INSTALLATION:

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required to install expansion joint covers. Install joint cover assemblies in true alignment and proper relationship to expansion joints and adjoining finished surfaces measured from established lines and levels. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling. Set floor covers at elevations to be flush with adjacent finished floor materials. Locate wall, ceiling, roof, and soffit covers in continuous contact with adjacent surfaces. Securely attach in place with required accessories. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches on center.
- B. Continuity: Maintain continuity of expansion joint cover assemblies with a minimum number of end joints and align metal members mechanically using splice joints. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere flexible filler materials (if any) to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- C. Extruded Preformed Seals: Install seals complying with manufacturer's instructions and with minimum number of end joints. For straight sections provide preformed seals in continual lengths. Vulcanize or heat-weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer. Apply adhesive, epoxy, or lubricant-adhesive approved by manufacturer to both frame interfaces before installing preformed seal. Seal transitions according to manufacturer's instructions.
- D. Elastomeric Sealant Joint Assemblies: Seal end joints within continuous runs and joints at transitions according to manufacturer's directions to provide a watertight installation.
- E. Seismic Seals: Install interior seals in continual lengths; vulcanize or heat-weld field splice joints in interior seal material to provide watertight joints using manufacturer's recommended procedures. Install exterior seal in standard lengths. Seal transitions and end joints according to manufacturer's instructions.
- F. Fire Barriers: Install fire barriers, including transitions and end joints, according to manufacturer's instructions so that fire-rated construction is continuous.

3.03 CLEANING AND PROTECTION:

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's instructions.

END OF SECTION

SECTION 05811

EXPANSION JOINT SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing exterior (pedestrian and vehicular) traffic joints, exterior (wall and ceiling) joints, exterior soffit joints, interior (pedestrian and vehicular) traffic joints, interior (wall and ceiling) joints and interior soffit joints.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Cast-In-Place Structural Concrete: Section 03300.
- B. Expansion Joint Cover Assemblies: Section 05810.
- C. Flashing and Sheet Metal: Section 07600.
- D. Seals and Sealants: Section 07900.

1.03 DEFINITIONS:

- A. Architectural Joint System: Any filler or cover used to span, fill, cover, or seal a joint, except expanding foam seals and poured or foamed in-place sealants.
- B. Cyclic Movement: Periodic change between widest and narrowest joint widths in an automatically mechanically controlled system.
- C. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist passage of flame and hot gases through a movement joint.
- D. Maximum Joint Width: Widest linear gap a joint system tolerates and performs its designed function without damaging its functional capabilities.
- E. Minimum Joint Width: Narrowest linear gap a joint system tolerates and performs its designed function without damaging its functional capabilities.
- F. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint opening typically expressed in numerical values (inches) or a percentage of nominal value of joint width.
- G. Nominal Joint Width: Width of linear gap indicated as representing the conditions existing when architectural joint systems will be installed or, if no nominal joint width is indicated, a width equal to the sum of maximum and minimum joint widths divided by two.

1.04 PERFORMANCE REQUIREMENTS:

- A. General: Provide factory-fabricated architectural joint systems capable of withstanding the types of loads and of accommodating the kinds of movement, and the other functions for which they are designed including those specified below, without failure. Types of failure include those listed in Appendix X3 of ASTM E1399.
 - 1. Vehicular Traffic Joints: Support vehicular traffic across joint.

2. Pedestrian Traffic Joints: Support pedestrian traffic across joint.
3. Exterior Joints: Maintain continuity of weather enclosure.
4. Joints in Fire-Resistance-Rated Assemblies: Maintain fire-resistance ratings of assemblies.
5. Joints in Smoke Barriers: Maintain integrity of smoke barrier.
6. Joints in Acoustically Rated Assemblies: Inhibit passage of airborne noise.
7. Other Joints: Where indicated, provide joint systems that prevent penetration of water, moisture, and other substances deleterious to building components or content.
8. Seismic Joints: Remain in place on exposure to seismic activity (movement).
9. Joints in Surfaces with Architectural Finishes: Serve as finished architectural joint closures.

1.05 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 1. Product Data: Include manufacturer's product specifications, construction details, material and finish descriptions, and dimensions of individual components and seals.
 2. Shop Drawings: For each joint system specified, provide the following:
 - a. Placement Drawings: Include line diagrams showing entire route of each joint system, plans, elevations, sections, details, joints, splices, locations of joints and splices, and attachments to other Work. Where joint systems change planes, provide Isometric Drawings depicting how components interconnect to achieve continuity of joint covers and fillers.
 3. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each exposed metal and elastomeric material of joint system indicated.
 - a. Include similar Samples of material for joints and accessories involving color selection.
 4. Samples for Verification: Full-size units 6 inches long of each type of joint system indicated; in sets for each finish, color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
 5. Product Test Reports: From a qualified testing agency indicating architectural joint systems comply with requirements, based on comprehensive testing of current products.

1.06 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 1. Comply with codes and regulations of the jurisdictional authorities.
 2. AAMA: 606.1, 607.1, 608.1, 2603, 2604, 2605.
 3. ADA: Americans with Disabilities Act.
 4. ASTM: A666, B36, B209, B221, B455, E119, E814, E1399, E1612, E1783.
 5. NAAMM: Metal Finishes Manual for Architectural and Metal Products.
 6. UL: 2079.
- B. Source Limitations: Where practical, obtain architectural joint systems through one source from a single manufacturer. Coordinate compatibility with adjoining joint systems specified in other Sections.

- C. Fire-Test-Response Characteristics: Where indicated, provide joint systems incorporating fire barriers that are identical to those of assemblies tested for fire resistance per ASTM E 119, ASTM E 814, or UL 2079, including hose-stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Aluminum: ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 6061-T6 for sheet and plate.
 - 1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
- B. Stainless Steel: ASTM A666, Type 304 with No. 2B finish, unless otherwise indicated, for plates, sheet, and strips.
- C. Preformed Seals: Single or multicellular extruded elastomeric seals designed with or without continuous, longitudinal, internal baffles. Formed to be installed in frames or with anchored flanges, in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors.
- D. Preformed Silicon-Foam Sealant System: Section 07900.
- E. Strip Seals: Elastomeric membrane or tubular extrusions with a continuous longitudinal internal baffle system throughout complying with ASTM E 1783; used with compatible frames, flanges, and molded-rubber anchor blocks.
- F. Compression Seals: Preformed, elastomeric extrusions having internal baffle system complying with ASTM E1612 in sizes and profiles indicated or as recommended by manufacturer.
- G. Preformed Cellular Foams: Nonextruded, low-density, crosslinked, nitrogen-blown ethylene-vinyl-acetate copolymer, Neoprene, or polyurethane extruded, compressible foam.
- H. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint.
- I. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesives, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.02 EXPANSION JOINT SYSTEMS:

- A. General: Provide joint systems of design, basic profile, materials, and operation indicated on approved shop drawings. Provide units with the capability to accommodate joint widths indicated and variations in adjacent surfaces.
 - 1. Furnish units in longest practicable lengths to minimize number of end joints. Provide hairline mitered corners where joint changes directions or abuts other materials.

2. Include closure materials and transition pieces, tee-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous joint systems.
3. Frames for Strip Seals: Designed with semiclosed cavity that provides a mechanical lock for seals of type indicated.
4. Public Arena Seals: Non-slip seals designed for installation on treads and risers and to lie flat with adjacent surfaces, and complying with ADA guidelines for public areas.
5. Cyclic-Movement-Test-Response Characteristics: No evidence of visual fatigue, inability to cycle between designated joint widths, or other types of failure as determined by testing products identical to those indicated per ASTM E 1399 including Appendix X3.
6. Fire-Resistance Ratings: Provide manufacturer's standard fire barrier with a rating not less than that of adjacent construction.
7. Moisture Barrier: Provide manufacturer's standard unit.

2.03 FINISHES, GENERAL:

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.04 ALUMINUM FINISHES:

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Mill Finish: AA-M10 (Mechanical Finish: as fabricated; no other applied finish unless buffing is required to remove scratches, welding, or grinding produced in fabrication process).
- C. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 607.1.
- D. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 607.1.
- E. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker).
- F. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 606.1 or AAMA 608.1.
 1. Color: As selected by the Engineer from the full range of industry colors and color densities.

- G. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.
 - 1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils, medium gloss.
 - 2. Color: As selected by the Engineer from manufacturer's full range.

- H. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604.
 - 2. Fluoropolymer Three-Coat System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
 - a. Color and Gloss: As selected by the Engineer from manufacturer's full range.

2.05 STAINLESS STEEL FINISHES:

- A. Remove tool and die marks and stretch lines or blend into finish.
- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- C. Bright, Cold-Rolled, Unpolished Finish: No. 2B finish.
- D. Bright, Directional Polish: No. 4 finish.
- E. Satin, Directional Polish: No. 6 finish.
- F. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.
- G. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Prepare substrates according to architectural joint system manufacturer's written instructions.

- B. Coordinate and furnish anchorages, Placement Drawings, and instructions for installing joint systems to be embedded in or anchored to concrete or to have recesses formed into edges of concrete slab for later placement and grouting-in of frames.
- C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary to secure joint systems to in-place construction, including threaded fasteners with drilled-in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of joint systems.

3.02 INSTALLATION:

- A. Comply with manufacturer's written instructions for handling and installing architectural joint assemblies and materials, unless more stringent requirements are indicated.
- B. Coordinate installation of architectural joint assembly materials and associated work so complete assemblies comply with assembly performance requirements.
- C. Terminate exposed ends of exterior architectural joint assemblies with factory-fabricated termination devices to maintain waterproof system.
- D. Install factory-fabricated transitions between building expansion joint cover assemblies and roof expansion joint assemblies to provide continuous, uninterrupted, watertight construction.
- E. Coordinate the size of joint opening at the time joint segments are set in position (distance between joint segments) with the temperature of the structure and the designed joint movement.
- F. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required to install joint systems.
 - 1. Install joint cover assemblies in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
 - 2. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling.
 - 3. Set covers in horizontal surfaces at elevations that place exposed surfaces flush with adjoining finishes.
 - 4. Locate covers in continuous contact with adjacent surfaces.
 - 5. Securely attach in place with required accessories.
 - 6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.
- G. Continuity: Maintain continuity of joint systems with a minimum number of end joints and align metal members. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere flexible filler materials, if any, to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- H. Extruded Preformed Seals: Install seals to comply with manufacturer's written instructions and with minimum number of end joints.
 - 1. For straight sections, provide preformed seals in continuous lengths.
 - 2. Vulcanize or heat-weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer.

3. Apply adhesive, epoxy, or lubricant adhesive approved by manufacturer to both frame interfaces before installing preformed seals.
 4. Seal transitions according to manufacturer's written instructions.
 5. Install foam seals with adhesive recommended by manufacturer and heat seal all splices.
- I. Joint Systems with Seals: Seal end joints within continuous runs and joints at transitions according to manufacturer's written instructions to provide a watertight installation.
 - J. Seismic Seals: Install interior seals in continuous lengths. Install exterior seal in standard lengths and vulcanize or heat-weld field splice joints to provide watertight joints using manufacturer's recommended procedures. Seal transitions and end joints according to manufacturer's written instructions.
 - K. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and end joints.

3.03 CLEANING AND PROTECTION:

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

END OF SECTION

THIS PAGE NOT USED

SECTION 06100
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies rough carpentry for wood blocking, roof sheathing, rooftop equipment bases and support curbs, miscellaneous lumber and accessories.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Wood Preservative Treatment: Section 06075.
- B. Roof Accessories: Section 07730.
- C. Flashing and Sheet Metal: Section 07600.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
- B. Product Data for metal framing anchors and construction adhesives.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
- B. Comply with codes and regulations of the jurisdictional authorities.
 - 1. ALSC: NGR.
 - 2. DOC PS20.
 - 3. AWPA C2, C9, C20, C27, M4.
 - 4. UL.
 - 5. APA.
 - 6. FS FF-N-105.
 - 7. CAB NER-272.
 - 8. ASME A153, A307, A563, A653, B18.6.1, B18.2.1

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.
 - 1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.01 LUMBER, GENERAL:

- A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by American Lumber Standards Committee's (ALSC) Board of Review.
- B. Dressed sizes of green lumber are larger than dry lumber under DOC PS 20. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

2.02 WOOD-PRESERVATIVE-TREATED MATERIALS:

- A. General: Where lumber or plywood is indicated as preservative treated or is specified to be treated, comply with applicable requirements of AWPA C2 (lumber) and AWPA C9 (plywood). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
 - 1. Do not use chemicals containing chromium or arsenic.
- B. Pressure treat aboveground items with waterborne preservatives to a minimum retention of 0.25 lb/cu. ft.. After treatment, kiln-dry lumber and plywood to a maximum moisture content of 19 and 15 percent, respectively. Treat indicated items and the following:
 - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 - 3. Wood framing members less than 18 inches above grade.
 - 4. Complete fabrication of treated items before treatment, where possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

2.03 FIRE-RETARDANT-TREATED MATERIALS:

- A. General: Where fire-retardant-treated wood is indicated, comply with applicable requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Identify fire-retardant-treated wood with appropriate classification marking of UL; U.S. Testing; Timber Products Inspection, Inc.; or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Research or Evaluation Reports: Provide fire-retardant-treated wood acceptable to authorities having jurisdiction and for which a current model code research or evaluation report exists that evidences compliance of fire-retardant-treated wood for application indicated.
- B. Interior Type A: For interior locations, use chemical formulation that produces treated lumber and plywood with the following properties under conditions present after installation:
 - 1. Bending strength, stiffness, and fastener-holding capacities are not reduced below values published by manufacturer of chemical formulation under elevated temperature and humidity conditions simulating installed conditions when tested by a qualified independent testing agency.
 - 2. No form of degradation occurs due to acid hydrolysis or other causes related to treatment.
 - 3. Contact with treated wood does not promote corrosion of metal fasteners.

2.04 DIMENSION LUMBER:

- A. General: Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.

2.05 MISCELLANEOUS LUMBER:

- A. General: Provide lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members.
- B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.
- C. Moisture Content: 19 percent maximum for lumber items not specified to receive wood preservative treatment.

2.06 ROOF SHEATHING:

- A. General: Where structural-use panels are indicated for the following concealed types of applications, provide American Plywood Association (APA)-performance-rated panels complying with requirements designated under each application for grade, span rating, exposure durability classification, and edge detail (where applicable).
 - 1. Thickness: Provide panels meeting requirements specified but not less than thickness indicated.
 - 2. Span Ratings: Provide panels with span ratings required to meet "Code Plus" provisions of APA Form No. E30, "APA Design/Construction Guide: Residential & Commercial."

2.07 FASTENERS:

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of Type 304 stainless steel.
- B. Nails, Wire, Brads, and Staples: FS FF-N-105.
- C. Power-Driven Fasteners: CABO NER-272
- D. Wood Screws: ASME B18.6.1
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

2.08 METAL FRAMING ANCHORS:

- A. General: Provide galvanized steel framing anchors of structural capacity, type, and size indicated and as follows:
 - 1. Research or Evaluation Reports: Provide products for which model code research or evaluation reports exist that are acceptable to authorities having jurisdiction and that

evidence compliance of metal framing anchors for application indicated with building code in effect for Project.

2. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

- A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
- C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.
- D. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.
- E. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. Counsel of American Building Officials: CABO NER-272 for power-driven staples, P-nails, and allied fasteners.
 2. Published requirements of metal framing anchor manufacturer.
- F. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.
- G. Use hot-dip galvanized or stainless-steel nails where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity.

3.02 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS:

- A. Install wood nailers, blocking, and sleepers where shown and where required for screeding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

END OF SECTION

SECTION 06130

TIMBER TIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. The section specifies furnishing new timber cross ties, contact rail ties and switch ties as shown and specified.

1.02 RELATED SECTIONS

Section 05651 - General Track Construction
Section 05652 - Ballasted Track Construction
Section 05654 - Special Trackwork Construction - Ballasted
Section 05659 - Special Trackwork
Section 05660 - Restraining Rail and Lubricators

1.03 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA):
 1. AREMA Manual for Railway Engineering
 2. AREMA Portfolio of Trackwork Plans
 3. AREMA Specifications for Ties
 4. AREMA Specification for Preservatives
 5. AREMA Specification for Treatment
 6. AREMA Records of Treatment and Reports of Inspection.
- B. American Wood Preserver 's Association (AWPA)
 1. AWPA Standard C6
 2. AWPA Standard M3

1.04 SUBMITTALS

- A. Submittals shall be made on accordance with Section 01300, Submittals
- B. Documentation
 1. Proposed method of delivery. Submit not late than 60 days prior to delivery.
 2. Proposed anti-splitting devices and location in tie.
 3. Proposed manner of marking treated ties to indicate compliance with specifications.
 4. Certificate of Compliance with AWPA Standard M3 for tie treatment.

1.05 QUALITY ASSURANCE

- A. Inspection:
 1. The Engineer will inspect in accordance with pertinent sections of the AREMA Manual, as modified herein.
 2. Acceptance criteria: Failure to meet any pertinent part of AREMA requirements or these specifications constitutes cause for rejection.
 3. Averaging of dimensions, with respect to measurement for size acceptance, is not permitted.

4. Provide suitable equipment, facilities and assistance required by the Engineer to effect inspections.
5. Inform the Engineer when treated wood is ready for inspection.
6. Do not deliver material until inspected and approved for shipment by the Engineer.
7. Final inspection and approval of ties will occur as a part of the final inspection of installed ballasted track.

1.06 DELIVERY, STORAGE AND HANDLING

- A. It shall be the Contractor's responsibility to make all arrangements for storage, shipment and handling of the ties.
- B. Tie stacks shall not exceed 20 layers each.
- C. Ties will be stacked with branding visible.
- D. Ties shall be handled in a manner that prevents damage.
- E. Ties shall not be dropped or dragged on the trackbed.

PART 2 - PRODUCTS

2.01 TIMBER CROSS TIES, CONTACT RAIL TIES AND SWITCH TIES

- A. Furnish timber for cross ties in accordance with AREMA Volume 1, Chapter 30 Ties, Section 1.1 and as specified in this section. Furnish timber for contact rail ties and switch ties in accordance with AREMA Volume 1, Chapter 30 Ties, Section 2.1 and as specified in this section.
 1. The kind of wood for all ties shall be Oaks.
 2. Cross ties shall be 7-inch grade.
 3. The top of all ties shall be the 9" horizontal face furthest from the heartwood so that the heartwood faces down.
 4. Crossties shall be 8' - 6" long.
 5. Contact rail ties shall be 10' - 0" long.
 6. Switch ties shall be the length shown on the contract drawings.
 7. The length tolerance for all ties after seasoning and treatment is plus 1" and minus 1/2".
 8. Tie No. 1 and Tie No. 2 shown on the contract drawings shall not be wider than 9" after seasoning and treatment.

PART 3 - EXECUTION

3.01 REQUIREMENTS

- A. General Requirements:
 1. All ties shall be new.
 2. Physical requirements in accordance with the AREMA manual, as modified herein.
 3. AREMA 7" Grade.
 4. All ties shall be Oak wood species.
 5. Sawed top, bottom and sides.
 6. Free of checks over two inches deep or extending more than eight inches from end of tie.

- B. Anti-splitting devices shall be nail plates in accordance with the AREMA Manual, as modified herein.
1. Minimum size 5 - 1/2 inches x 7 inches.
 2. Nail plates shall be installed by a method or machine that presses them into the end of the tie. Hammer installation of nail plates is not allowed and will be a cause for the rejection of the ties.
 3. Incise all sides prior to treatment to a depth of 3/4 inch. Thickness of incisor teeth shall not exceed 7/32 inch.
 4. Free of knots greater than 1/2 inch diameter for areas indicated in the AREMA Manual.
- C. Individual Requirements:
1. Cross ties:
 - a. Length: Eight feet six inches.
 - b. Straightness: A cross tie will be considered straight when a line along a side from the middle of one end to the middle of the other end is everywhere more than 2-3/4 inches from the top and bottom of the tie.
 2. Contact rail ties:
 - a. Length: Ten feet.
 - b. Free of knots greater than 1/2 inch diameter in area of contact rail insulator, i.e., 100 through 110 inches from line end.
 - c. AREMA Size 5 requirements apply to contact rail insulator area.
 - d. Straightness: A contact rail tie will be considered straight when a line along one side from the middle of one end to the middle of the other end is everywhere more than two inches from both sides.
 3. Switch ties:
 - a. Switch ties within Special Trackwork, as shown on the drawings.
 - b. Length: As shown.
 - c. Free of knots greater than 1/2 inch diameter for areas indicated in the AREMA Manual.
 - d. Straightness: A contact rail tie will be considered straight when a line along the top from the middle of one end to the middle of the other end is everywhere more than two inches from both sides.
- D. Preservative Treatment:
1. All timbers shall be bored for screw spikes. The holes shall be treated with copper naphthenate.
 2. Ties shall be treated in accordance with the requirements of AWPA Standard C6 for Cross Ties and Switch Ties. Conditioning prior to treatment shall be in accordance with Paragraph 3.2, Boulton Drying Process, of the above standard.
 3. Immediately following conditioning, the ties shall be pressure treated. Because of the environmental problems and other reasons, alternative preservative used shall be copper naphthenate. The minimum quality control requirements shall be in accordance with AWPA Standard M3. The treating company shall furnish a Certificate of Compliance with this standard, and shall certify the treatment according to the foregoing Specification.
 4. The Authority Engineer will determine when ties are ready for treatment.
 5. Use only tested and approved preservatives.
 6. Stamp each treated tie to indicate compliance with these specifications.
 7. Complete AREMA or AWPA forms for treatment of ties.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

- A. Measurement of work specified in this section will be made in the following manner:
1. No separate measurement.

4.02 PAYMENT:

- A. Compensation for work specified in this section will be in the following manner:
1. Included in the price of the work of which it is a part.

END OF SECTION

SECTION 06132

TIMBER GRADE CROSSINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. The section specifies furnishing solid timber panel grade crossings as shown on the Contract Drawings. Solid timber panel grade crossings shall be in accordance with the current requirements of the AREMA "Guidelines for the Construction or Reconstruction of Highway - Railway Crossings" except as modified herein.

1.02 RELATED SECTIONS

- A. General Track Construction: Section 05651
- B. Ballasted Track Construction: Section 05652

1.03 REFERENCES

- A. American Railway Engineering and Maintenance-of-Way Association (AREMA):
 1. AREMA Manual for Railway Engineering
 2. AREMA Portfolio of Trackwork Plans
 3. AREMA "Guidelines for the Construction or Reconstruction of Highway - Railway Crossings"
 4. AREMA Specification for Preservatives
 5. AREMA Specification for Treatment
 6. AREMA Records of Treatment and Reports of Inspection
- B. American Wood Preserver 's Association (AWPA)
 1. AWPA Standard C6
 2. AWPA Standard M3

1.04 SUBMITTALS

- A. Submittals shall be made on accordance with Section 01330, Submittals
 1. Crossing panel layout for each grade crossing location.
 2. Shop drawings of field and gauge sections, filler blocks and modified restraining rail plate. Show fit to rail, show flangeway, and show clearances to Pandrol plate, screw spikes and e-Clip.
 3. Shop drawing or product data sheets for spiraled dowel pins and washer head lag screws.
 4. Product data for mastic to fill the counter bore holes.
 5. Details for insulated joints, and track circuit and traction power connections to be located within the crossing area.
- B. Documentation
 1. Proposed method of delivery. Submit prior to delivery.
 2. Proposed manner of marking treated timbers to indicate compliance with specifications.
 3. Certificate of Compliance with AWPA Standard M3 for timber treatment.
 4. Report documenting whether conditions warrant use of geotextile fabric and drainage pipes.

1.05 QUALITY ASSURANCE

- A. Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.
- B. Inspection:
 - 1. In accordance with pertinent sections of the AREMA Manual, as modified herein.
 - 2. Acceptance criteria: Failure to meet any pertinent part of AREMA requirements or these specifications constitutes cause for rejection.
 - 3. Averaging of dimensions, with respect to measurement for size acceptance, is not permitted.
 - 4. Provide suitable equipment, facilities and assistance required by the Engineer to effect inspections.
 - 5. Inform the Engineer when treated timbers are ready for inspection.
 - 6. Do not deliver material until inspected and approved for shipment by the Engineer.
 - 7. Final inspection and approval will occur as a part of the final inspection of installed ballasted track.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Panels shall be stacked with branding visible.
- B. Panels shall be handled in a manner that prevents damage.
- C. Panels shall not be dropped or dragged on the trackbed.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Furnish timbers in accordance with the requirements, as specified in this section:
- B. Crossing timbers shall be sawed, treated oak made into panels 8 feet in length. Field side sections shall be 20 inches wide consisting of two 10 inch timbers. Gauge side sections shall be 25-1/2 inches wide consisting of three 8-1/2 inch timbers when restraining rail is not used. The gauge panel width on the restraining rail side varies as shown on the contract drawings depending upon the track gauge.
 - 1. Cut bottom corner of the field and gauge sections closest to the rail to provide clearance to the tie plate, screw spikes, and e-Clip when installed. The cut(s) shall be made in a way to minimize weakening of the section and minimizing the loading on the washer head lag screws anchoring the sections to the track tie.
 - 2. The outside ends of end sections shall be beveled. The bevel shall have dimensions of 4 inches measured horizontally and vertically.
- C. Each gauge section not next to a restraining rail shall have a filler block of such size and shape as to provide a snug fit against the rail web and provide a flangeway 2-1/2 inches wide and 3 inches deep.
- D. Each section shall be made up using three 3/4 inch spiral dowel pins. Each section shall be fabricated so that the heartwood for all of the timbers will face down and seat on the top of the timber track ties.

- E. Each section shall have 8 holes for use in anchoring the section to the ties with washer head lag screws. These holes shall be 13/16 inches in diameter and shall have a 2-5/8 inches counter bore 1-1/4 inches deep in the top side.
- F. All cuts and borings shall be made after seasoning and before preservative treatment. Each timber shall be treated with creosote preservative (AWPA P2-01) in accordance with AWPA C6 before assembly into sections. The treatment plant shall meet the requirements of AWPA M3.
- G. Each section shall be anchored in place with 12 inches long, 3/4 inch diameter washer head lag screws. After the lag screw is in place, the counter bore shall be filled with a mastic material.
- H. Sections shall be full depth with the top surface in the plane of the top of rail and the bottom of the section resting directly on the cross tie.

PART 3 - EXECUTION

3.01 REQUIREMENTS

- A. The Contractor shall design and construct the crossings as shown on the Contract Drawings.
 - 1. Grade crossings are to be constructed with new timber grade crossing panels, washer head lag screws, rail, timber ties, standard Pandrol tie plates, rail clips, screw spikes, ballast, sub-ballast, and, where conditions warrant, with geotextile fabric and perforated drain pipes.
 - a. Where restraining rail is required, a modified restraining rail tie plate as shown on the drawings shall be used under the inside rail and restraining rail.
 - 2. Where a new timber grade crossing is to be installed on existing track, new rail, ties, tie plates, rail clips, screw spikes, ballast, sub-ballast, and, where conditions warrant, geotextile fabric and perforated drain pipes shall be installed as directed by the engineer.
 - 3. The design of timber panels for crossings located on curved track shall be modified from what is shown on the drawings and as specified herein so that the flangeway is between 2 1/2 and 3 inches and the gap between abutting sections does not exceed 1/4 inch.
 - 4.
- B. Grade crossing track shall be ballasted track as specified in Section 05652, Ballasted Track Construction, with ties spaced at 19-1/4 inch centers. The 19 1/4 inch tie spacing shall extend for three ties beyond the end of the sections, which also defines the limit of the crossing area.
- C. Field welds and bolted or bonded insulated and non-insulated rail joints shall not be installed within the crossing area. Insulated joints, and track circuit and traction power connections within the crossing area shall be submitted to the Authority Representative for approval. The submittal shall include details showing at least the following.
 - 1. Modifications to the grade crossing panels.
 - 2. Provisions to assure connections are electrically isolated from ground.
 - 3. Provisions to assure insulated joint functions are not compromised by foreign materials.
 - 4. Provide access for maintenance of the connections and insulated joints.

- D. Prior to placing grade crossing timber panels, grade crossing track shall be brought to final alignment and grade and tamped within the tolerances for ballasted yard and secondary track as specified in Section 05651, General Track Construction.
 - 1. Ballast shall be added to provide full cribs and level shoulders.
 - 2. Ballast shall be compacted as specified in Section 05652, Ballasted Track Construction.
 - 3. Rail shall be thermally adjusted and anchored as specified in Section 05651, General Track Construction, and Section 05652, Ballasted Track Construction.
- E. Ties shall be swept clean of all loose ballast and debris prior to placing timbers. The timbers shall then be properly located, so that the heart wood will be on the bottom side.
- F. No shims shall be used between timbers and cross ties.
- G. The timber ties shall be prebored for the timber grade crossing panel's washer head lag screws with 5/8 inch diameter holes that are drilled to a maximum of 6 inches of depth into the timber tie.
- H. All bored holes in timber track ties shall be treated with copper naphthenate immediately after boring.
- I. Two field sections and two gauge sections shall constitute one grade crossing panel.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

- A. Measurement of work specified in this section will be made in the following manner:
 - 1. No separate measurement.

4.02 PAYMENT:

- A. Compensation for work specified in this section will be in the following manner:
 - 1. Included in the price of the work of which it is a part.

END OF SECTION

SECTION 06402

INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This Section specifies providing wood cabinets, plastic-laminate cabinets, wood countertops, plastic-laminate countertops, solid-surfacing-material countertops.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Rough Carpentry: Section 06100.
- B. Seals and Sealants: Section 07900.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - B. Product Data: For each type of product indicated, including cabinet hardware and accessories, and finishing materials and processes.
 - C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in Section 06100.
 - 2. Show locations and sizes of cutouts and holes for installed in architectural woodwork.
 - D. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material indicated.
 - 1. Plastic laminates.
 - 2. Solid-surfacing materials.
 - E. Samples for Verification: For the following:
 - 1. Plastic-laminate-clad panel products, 8 by 10 inches, for each type, color, pattern, and surface finish.
 - 2. Solid-surfacing materials, 6 inches square.
 - 3. Exposed cabinet hardware and accessories, one unit for each type.
 - F. Certification: Signed by manufacturers of woodwork certifying that products furnished comply with requirements.
 - G. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AWI: Section 400 & 700, AGS.
 - 3. Builders Hardware Manufacturer's Association (BHMA): A156.9, A256.11, A156.18, B01361, B01521, B02011, B03141, B04071, B04081, B04013, B05091, E07121, E7041, 613, 630, 640
 - 4. ANSI A208.2, Z124.3
 - 5. NEMA LD 3.
- B. Installer Qualifications: An experienced installer who has completed architectural woodwork similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Fabricator Qualifications: A firm experienced in producing architectural woodwork similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork, construction, finishes, and other requirements.
 - 1. Provide AWI Quality Certification Program certificate indicating that woodwork complies with requirements of grades specified.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.06 PROJECT CONDITIONS:

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.
 - 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.07 COORDINATION:

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General: Provide materials that comply with requirements of the AWI quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Products: Comply with the following:
 - 1. Medium-Density Fiberboard: ANSI A208.2, Grade MD-Exterior Glue.
- C. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated, or if not indicated, as required by woodwork quality standard.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
 - a. Formica Corporation.
 - b. International Paper; Decorative Products Div.
 - c. Wilsonart International; Div. of Premark International, Inc.
- D. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
- E. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with material and performance requirements in ANSI Z124.3, for Type 5 or Type 6, without a precoated finish.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Corian; DuPont Polymers.
 - b. Surell; Formica Corporation.
 - c. Fountainhead; International Paper, Decorative Products Div.
 - d. Gibraltar; Wilsonart International, Div. of Premark International, Inc.

2.02 CABINET HARDWARE AND ACCESSORIES:

- A. Butt Hinges: 2-3/4-inch, 5-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:
 - 1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
 - 2. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.
- B. Back-Mounted Pulls: BHMA A156.9, B02011.
- C. Wire Pulls: Back mounted, 5 inches long, 2-1/2 inches deep, and 5/16 inches in diameter.
- D. Catches: Magnetic catches, BHMA A156.9, B03141.
- E. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

- F. Shelf Rests: BHMA A156.9, B04013.
- G. Drawer Slides: Side-mounted, full-extension, zinc-plated steel drawer slides with steel ball bearings, BHMA A156.9, B05091, and rated for the following loads:
 - 1. Box Drawer Slides: 100 lbf.
 - 2. File Drawer Slides: 200 lbf.
- H. Door Locks: BHMA A156.11, E07121.
- I. Drawer Locks: BHMA A156.11, E07041.
- J. Grommets for Cable Passage through Countertops: 2-inch OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.
- K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated. Dark, Oxidized, Satin Bronze, Oil Rubbed: BHMA 613 for bronze base; BHMA 640 for steel base; match Architect's sample.
 - 1. Satin Stainless Steel: BHMA 630.
- L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.03 INSTALLATION MATERIALS:

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.04 FABRICATION, GENERAL:

- A. Interior Woodwork Grade: Provide Custom grade interior woodwork complying with the referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting. Retain subparagraph below if Architect will visit woodwork shop and examine work before it is shipped to Project site.
- D. Shop cut openings, to maximum extent possible, to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings.

2.05 PLASTIC-LAMINATE CABINETS AND COUNTERTOPS:

- A. Quality Standard: Comply with AWI Section 400 requirements for laminate cabinets.
- B. AWI Type of Cabinet Construction: Flush overlay.
- C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 - 1. Horizontal Surfaces Other Than Tops: HGS.
 - 2. Vertical Surfaces: HGS.
 - 3. Edges: HGS.
- D. Materials for Semiexposed Surfaces: Provide surface materials indicated below:
 - 1. Surfaces Other Than Drawer Bodies: Thermoset decorative overlay.
- E. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Provide selections from laminate manufacturer's full range of colors and finishes in the following categories:
 - a. Solid colors.
 - b. Patterns.

2.06 SOLID-SURFACING-MATERIAL COUNTERTOPS:

- A. Quality Standard: Comply with AWI Section 400 requirements for countertops.
- B. Solid-Surfacing-Material Thickness: 3/4 inch.
- C. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
 - 1. Provide selections from manufacturer's full range of colors and finishes.
- D. Fabricate tops in one piece with shop-applied backsplashes and edges, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
- E. Drill holes in countertops for plumbing fittings in shop.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Condition woodwork to average prevailing humidity conditions in installation areas before installation.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.02 INSTALLATION:

- A. Quality Standard: Install woodwork to comply with AWI Section 1700 for the same grade specified.
- B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches.
- C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces and repair damaged finish at cuts.
- D. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood, blocking, or hanging strips.
- E. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 - 3. Secure backsplashes to walls with adhesive.
 - 4. Caulk space between backsplash and wall with sealant specified in Section 07900.

3.03 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.

END OF SECTION

SECTION 07110

DAMPPROOFING

PART 1 - GENERAL

1.01 SUMMARY:

- A. This section specifies providing dampproofing.

1.02 DESCRIPTION:

- A. This section specifies providing dampproofing.
- B. Related Work Specified Elsewhere:
 - 1. Cast-in-Place Structural Concrete: Section 03300.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product data for each type of product specified, including data substantiating that materials comply with requirements for each dampproofing material specified. Include recommended method of application, recommended primer, number of coats, coverage or thickness, and recommended protection course.
- B. Certification:
 - 1. Certification that materials furnished meet specified requirements and are compatible with each other.
 - 2. Certification by dampproofing manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. ASTM: D41, D449.
- B. Demonstration Area:
 - 1. Prepare 100-square foot specimen of typical dampproofing application using specified methods and materials.
 - 2. Location of demonstration area as directed. Dampproofing will be visually and physically examined by the Engineer.
 - 3. If demonstration area is disapproved, prepare additional demonstration area. Do not proceed with dampproofing until demonstration area has been approved. Approved demonstration area will serve as the standard of quality and workmanship for dampproofing work specified in this section.
- C. Installer Qualifications: Engage an experienced Installer who has completed bituminous dampproofing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to the jobsite in their original unopened containers clearly labeled with manufacturer's name, brand designation, referenced specification number, type and class, as applicable.
- B. Store products in approved dry area, protected from contact with soil and from exposure to the elements. Keep products dry.
- C. Handle products so as to prevent breakage of containers and damage to products.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. Application of dampproofing to unprotected surfaces in wet weather or to surfaces on which ice, frost, water or dampness is visible is prohibited.
 - 2. Application of dampproofing when ambient temperature is below 40F is prohibited.
- B. Substrate: Proceed with dampproofing only after substrate construction and penetrating work have been completed.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Asphalt Primer: ASTM D41.
- B. Asphalt: ASTM D449, Type A.
- C. Portland Cement Grout: Section 04050.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Do not start dampproofing until requirements for curing concrete have been completed and surfaces have thoroughly dried.
- B. Clean surfaces to be dampproofed of loose and foreign material, concrete fins and dirt.
- C. Moisten and point holes, honeycombs, cracks, cavities and concrete fill with portland cement grout and allow to cure completely before covering. See Section 03300 for curing and protection.

3.02 APPLICATION:

- A. Apply dampproofing, consisting of two prime coats and one seal coat of dampproofing materials, to surfaces shown to receive dampproofing.
 - 1. Apply two coats of primer to surfaces to be dampproofed at rate of one gallon per 100 square feet. Allow first coat to dry thoroughly before second coat is applied.
 - 2. Do not heat prime-coat material for application.

3. After second prime coat has thoroughly dried, brush one coat of hot asphalt as applicable over primed surface at minimum rate of 15 pounds per 100 square feet of surface; fill cracks, voids and crevices.
4. Do not heat asphalt in excess of 400F.
5. Apply dampproofing coat so as to ensure continuous surface free of dull or porous spots. Give dull or porous spots additional coating of hot asphalt.
6. Perform finished work to conform to dimensions shown; do not disfigure other areas or parts of structure by dripping or spreading of materials.

3.03 PROTECTING AND CLEANING:

- A. Protect finish work during application of dampproofing and repair damage.
- B. Remove spots and spattering of the dampproofing from finish work and leave the entire work area in first-class condition.
- C. Remove dampproofing rubbish from the premises and leave spaces in broom-clean condition.

END OF SECTION

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SECTION 07125

MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing fluid-applied membrane waterproofing, rubberized-asphalt sheet membrane waterproofing and protection courses.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Cast-in-Place Structural Concrete: Section 03300.
- B. Brick: Section 04215.
- C. Concrete block: Section 04220.
- D. Mortar: Section 04050.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
- B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.
 - 1. Include joint and anchorage details, materials and description of sequence of operation.
- C. Samples: Four of each type of the following materials used in the work:
 - 1. Membrane: 12 inches square.
 - 2. Adhesive: Half-pint containers.
 - 3. Butyl gum tape: Small rolls.
 - 4. Hardboard: 12 inches square.
 - 5. Protection board: 12 inches square.
- D. Certification:
 - 1. Certification that materials furnished meet specified requirements and are compatible with each other.
 - 2. Certification that the applicator is approved by the manufacturer.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. American Hardboard Association Industry: AHAI Standard 1.
 - 3. FS: TT-S-230.
 - 4. ASTM: A123, C42, C78, C90, C171, C192, C272, C293, E96, D41, D146, D226, D412, D449, D572, D638, D790, D1621, D1668, D4586, E96, E154.
- B. Qualifications of Waterproofing Applicator:
 - 1. Use applicator who is approved by the manufacturer.

2. Employ workers who have had experience in waterproofing of specified type on jobs of similar size and comparable structures. Have approved full-time superintendent or foreman supervise and direct waterproofing operations.
 3. Inform the Engineer of proposed schedules and locations of waterproofing work.
- C. Obtain waterproofing materials, sheet flashings, and protection course through one source from a single manufacturer.
- D. Pre-installation Conference: Conduct conference at Project site. Review requirements for waterproofing, including surface preparation specified under other Sections, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to job site in original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type and class, as applicable.
- B. Store products in approved dry area with roll goods standing on ends. Protect from contact with soil and from exposure to the elements. Keep products dry.
- C. Handle products so as to prevent breakage of containers and damage to products.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
1. Application of waterproofing to unprotected surfaces in wet weather or to surfaces on which ice, frost or dampness is visible is prohibited.
 2. Unless otherwise approved, application of waterproofing unless ambient temperature is at least 40F and rising is prohibited.
 3. Maintain rolls of material at a temperature of at least 50F for a period of not less than 24 hours prior to installation.
- B. Provide ventilation in accordance with specified safety requirements.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Asphalt: ASTM D449, Type A.
- B. Asphaltic Primer: ASTM D41
- C. Glass Fabric: ASTM D1668, Type I or III.
- D. Asphalt-Saturated Felt: ASTM D226, Type I.
- E. Asphalt Cement (Asbestos-Free): ASTM D4586.
- F. Waterproof Building Paper: ASTM C171, Regular.

- G. Rubberized-Asphalt Sheet Membrane Waterproofing: Tough, pliable self-adhering waterproofing sheet of polyethylene film, coated on one side with a layer of adhesive-consistency rubberized asphalt, with the following additional requirements:

Characteristic	Value	Test Method
Thickness:		
a. Polyethylene film	4 mils	-
b. Rubberized asphalt	56 mils	-
c. Rubberized asphalt membrane total	60 mils	-
Permeance	0.1 perm	ASTM E96 Method B
Pliability, 180-degree bend over 1/4-inch mandrel at minus 30F	Unaffected	ASTM D146
Peel adhesion, 7 days dry plus 7 days at 120F plus 7 days dry or 7 days wet	5.0 pounds per inch, minimum	FS TT-S-230 Modified
Cycling over crack 15F, crack opened and closed from 0 inches to 1/4 inch	No effect 100 cycles	-
Puncture resistance, membrane	40 pounds minimum	ASTM E154
Tensile strength, membrane	250 pounds per square inch minimum	ASTM D412 Die C Modified

- H. Asphaltic Mastic:
1. Solvent-base, containing synthetic rubber, asphalt and other components, suitable for troweling, as recommended by membrane manufacturer.
 2. Dry-film requirements:
 - a. Aging: No cracking, flowing, crazing, blistering, or delamination when subjected to 192 hours in oxygen bomb at 158F and 300-psi oxygen pressure in accordance with ASTM D572.
 - b. Water permeability: 0.05-perm maximum when applied 1/32-inch thick over kraft paper and tested in accordance with ASTM E96.
 - c. Stress: No cracking or delamination when 1/64-inch thick layer is applied on metal and bent five times 360 degrees at zero F on 1/16-inch mandrel.
- I. Bonding and Joining Materials for Butyl Membrane:
1. Adhesive: For bonding butyl membrane to adjacent surfaces, as recommended by manufacturer of sheeting material.

2. Butyl compound: Self-vulcanizing for splicing joints in butyl membrane, as recommended by manufacturer.
 3. Butyl gum tape: Unvulcanized butyl-gum rubber with polyethylene-backing material for splicing tape, as recommended by membrane manufacturer.
 4. Flexible butyl-sheet rubber for flashings: As recommended by membrane manufacturer and as specified.
- J. Protection Course Materials:
1. Concrete: Section 03300, class as shown.
 2. Concrete block: Section 04220, ASTM C90, Type I.
 3. Common brick: Section 04215, type and grade as shown
 4. Concrete plank: Lightweight, reinforced-concrete plank, tongue-and-groove sides and ends, 16 inches wide, two inches thick, 10 feet long.
 5. Protection board:
 - a. Semi-flexible board, five ply or more, composed of asphaltic core sealed under heat and pressure between two liners of asphalt-saturated kraft paper or felt bonded to independent waterproofing during manufacturing process. Thickness as recommended by manufacturer.
 - b. Extruded, rigid polystyrene-foam board, one-inch thick. Compressive strength 25-psi minimum, ASTM D1621; water absorption 0.1 percent, ASTM C272.
 - c. Portland-cement mortar: Section 04050.
- K. Epoxy-Injection Material for Repair of Leaks: Two-part epoxy-adhesive materials, containing 100-percent solids, having aromatic curing-agent surface M-phenylanedi-amine and meeting or exceeding the following minimum requirements:
1. Flexure strength: 400 psi in accordance with ASTM D790.
 2. Tensile strength: 1,200 psi in accordance with ASTM D638.
 3. Bond strength: ASTM C293 and as follows:
 - a. Prepare concrete-beam test specimen in accordance with ASTM C192, using concrete mix design for 1-1/2 inch aggregate.
 - b. Break concrete beam in accordance with ASTM C78.
 - c. Bond broken beam using epoxy with bond-line thickness of 20 mils and cure for seven days at constant temperature of 65F.
 - d. After curing, rebreak beam in accordance with ASTM C78.
 - e. Attain specified values of flexure and tensile strength for repaired beam.
 - f. Cores taken for testing in accordance with ASTM C42.
- L. Protection-Board Adhesive: As recommended by the protection-board manufacturer.

2.02 WATERPROOFING SYSTEMS:

- A. Fluid-Applied Membrane System:
1. Asphaltic primer.
 2. Membranes: One of the following:
 - a. Glass fabric.
 - b. Asphalt-saturated felt.
 3. Accessories:
 - a. Asphaltic mastic.
 - b. Asphalt cement.
 - c. Butyl-gum tape.
 - d. Boots.

- e. Iron clamps and bolts: Hot-dip, galvanized, ASTM A123, Grade 100; ASTM A153 Class A.
- B. Rubberized-Asphalt Sheet Membrane System:
 - 1. Asphaltic primer.
 - 2. Rubberized-asphalt membrane.
 - 3. Accessories:
 - a. Asphaltic mastic.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Place membrane waterproofing after concrete has cured as specified in Section 03300 and surface is completely dry.
- B. Keep surfaces thoroughly dry, immediately before and during application of waterproofing.
- C. Should surface of the concrete become temporarily damp, dry surface.
- D. Remove laitance, dust, dirt, projections, oil, grease and other matter by brooming, scraping, air-hosing or combination of such methods. Surface to be approved prior to application of waterproofing material.
- E. Provide one-inch asphaltic mastic cants (fillets) in internal corners.
- F. Prepare preconstructed protection of courses where shown in accordance with recommendations of membrane manufacturer. Fill holes and grooves.
- G. Treat vertical surfaces with trowel coat of asphalt cement to fill pores and irregularities and level low areas to provide smooth surface for application of membrane waterproofing.

3.02 GENERAL INSTALLATION REQUIREMENTS:

- A. Tightly fit waterproofing to structure without voids or kinks. Upon completion, allow no cuts, holes, pockets, bulges, wrinkles, folds or creases in surfaces of finished waterproofing; if such defects are present, repair by patching as specified. If waterproofing is damaged, punctured or in any way pervious and cannot be effectively patched or repaired, remove and replace to extent necessary to ensure that structure is waterproof.
- B. Mop surfaces to be waterproofed in sections. Begin waterproofing at low point. Allow sufficient fabric for suitable overlap and anchorage at upper edge.
- C. If leaks occur in areas where backfilling has not been placed, cut-out waterproofing and protection and patch as necessary to ensure watertight barrier. Where membrane is inaccessible, stop leaks with epoxy injection.
- D. Cover horizontal surfaces of membrane waterproofing on which backfill is to be placed with portland-cement concrete of class and thickness shown and as specified in Section 03300.

- E. Protect penetrations in membrane, such as pipes, conduits, piles, struts, walers and other braces. Provide sleeves, clamping rings or other approved devices at penetrations and install with counterflashing where shown and mastic tape where needed to ensure watertight joint.
- F. Where shown in concrete floors and roof, fill electrical-bonding notches with asphalt cement finished flush with top of concrete.

3.03 FLUID APPLIED MEMBRANE SYSTEM:

A. General:

1. Approximately 24 hours before first mopping is applied, cover concrete surfaces to be waterproofed with one coat of asphaltic primer at minimum rate of one gallon per 100 square feet. Work primer well into surfaces to achieve uniform coating.
2. Completely cover concrete surfaces so that no concrete is left exposed. On fabric surfaces, apply mopping sufficiently heavy to conceal weave completely. For each mopping use not less than 4-1/2 gallons per 100 square feet of surface.
3. Regulate the work so that installed membrane receives final asphalt mopping before end of day. Thoroughly seal laps.
4. Before applying membrane on exterior of expansion and construction joints, lay strip of waterproof building paper twelve inches wide; extend six inches on each side of joint and secure to surface near edges using approved method.
5. Do not permit one layer of membrane to touch another layer, or concrete surface; separate each by mopped coat of hot asphalt.
6. At edges of membrane, insert membrane into reglets as shown and caulk with approved mixture of asphalt cement, or butyl-gum tape and necessary boots to prevent water intrusion between waterproofing and surface being waterproofed.
7. Where pipes, sleeves for pipes, or drains, penetrate surfaces to be waterproofed, provide synthetic-membrane flashings and two additional plies of membrane extending at least one-foot beyond edge of flashing, set in place with hot moppings of asphalt. Where flashing sleeves are not shown, flash membrane onto pipe or conduit with hot moppings of asphalt and secure with galvanized-iron clamps and bolts or by other approved methods.

B. Heating of Asphalt:

1. Heat asphalt to flow freely not exceeding 350F; stir frequently to avoid local overheating. Provide heating kettles of quality, number and capacity to service work adequately. Keep spare serviceable burners available at site for immediate replacement of malfunctioning burners. Keep kettleman in attendance during operation to ensure that maximum specified temperatures are not exceeded.
2. Employ kettle operators experienced in operating and maintaining type of equipment being used. Provide large metal pans at least one-inch deep under kettle to prevent drippings or fuel leaks from falling on prepared concrete or membraned surfaces. Ensure that each kettle is continuously equipped with calibrated thermometer.
3. Collect strippings from drums daily and remove from site. Set up kettles immediately adjacent to work in progress to reduce carrying distance of hot buckets.
4. Lower hot asphalt with extreme care to avoid endangering workmen in trench or excavation.

C. Two-Ply Work:

1. For first strip of membrane, use half-width; for second, use full-width, lapped full width of first strip.

2. For each succeeding strip, use full-width and overlap so that entire area has two layers of membrane except at joints. Lap joints two inches minimum, producing three plies at such overlaps.
 3. Give entire surface final mopping of hot asphalt. When protective covering is shown, place covering on final mopping of asphalt while still hot.
- D. Three-Ply Work:
1. Proceed as for two-ply work, except use 1/3-width for first strip; for second strip use 2/3-width; and for the third and succeeding strips use full-width. Overlap strips at least two inches, resulting in surface being completely covered by three plies, with four plies at overlaps.
- E. More Than Three-Ply Work:
1. Build in shingle fashion similar to three-ply work by adding as many plies as are shown. In joining membrane waterproofing to waterproofing in place, clean and heat in-place waterproofing before joining new waterproofing to that previously laid and overlap such joints one-foot minimum.
 2. At intersections of walls with horizontal surfaces, and at other locations, lap the greater number of plies of membrane over the other plies a minimum of one foot.
 3. Reinforce waterproofing at angles and expansion joints and at other locations where membrane may be subjected to unusual strain. Reinforce by means of two additional plies of saturated fabric and alternate moppings of asphalt. At angles between floor and wall provide reinforcing strips of sufficient width to extend six inches minimum on floor and four inches up wall. Extend strips at vertical corners five inches minimum on each side of corner.
- F. Patching:
1. Where the Engineer permits patching of defective waterproofing, extend first patching ply 12 inches minimum beyond outermost edge of defective portion.
 2. Extend second and each succeeding ply of patch three inches minimum beyond preceding ply.
 3. For patch area use at least as many new plies as specified for original membrane.

3.04 RUBBERIZED ASPHALT SHEET MEMBRANE SYSTEM:

- A. Prime concrete surfaces as recommended by membrane manufacturer. Do not prime surfaces more than 36 hours prior to applying membrane. Allow primer to dry for one hour or until tack-free. Do not prime metal surfaces, but ensure that they are dry and free of grease, oil, dust, rust and other contaminants.
- B. Apply membrane to clean primed surfaces. Lay membrane from low points or drains toward high points in shingle fashion. Overlap each strip 2-1/2 inches minimum and roll down firmly and completely.
- C. Double-cover inside and outside corners with membrane by applying initial strip of minimum 12-inch width centered along axis of corner. Mortar inside corners; round outside corners.
- D. Double-cover construction and control joints with membrane. Apply double thickness of membrane over sealed expansion joints.

- E. Provide troweled bead of asphaltic mastic as recommended by membrane manufacturer to perimeter of membrane placed in each day's operation and to outside edges of membrane after the membrane is placed.
- F. At areas around drains, posts and other protrusions, install double layer of membrane and coat liberally with asphaltic mastic.
- G. Immediately before covering membrane, inspect carefully and patch holes, tears, misaligned or wrinkled seams and other discontinuities with membrane or mastic. Conduct 24-hour flood test with minimum two-inch head of water on horizontal areas. Repair leaks, using methods recommended by membrane manufacturer.
- H. Place specified protection material on membrane within five days after application. Apply material in accordance with manufacturer's written instructions, as shown and as specified.

3.05 PROTECTION OF WATERPROOFED SURFACES:

- A. Install protection courses as soon as practicable after waterproofing is placed. Do not place loads on exposed membrane waterproofing. Traffic on such exposed membrane waterproofing is prohibited.
- B. Provide temporary protection as required pending installation of permanent protection.
- C. Exercise care in placing protection courses against waterproofing so as not to break, tear, puncture or otherwise damage waterproofing.
- D. Provide protection of waterproofing surfaces as shown and as specified.
 - 1. Concrete: Place concrete protection courses in accordance with the applicable requirements of Section 03300 and as shown.
 - 2. Concrete blocks and common brick: Lay concrete blocks and common brick in portland-cement mortar, as shown and in accordance with the related work sections
 - 3. Concrete plank: Erect concrete plank with tight tongue-and-groove joints as shown.
 - 4. Insulation board:
 - a. Apply protection-board adhesive in accordance with the manufacturer's instructions.
 - b. Fit boards carefully and neatly around pipes and projections and cover up entire surface of waterproofing.
 - 5. Protection board: Affix protection board to membrane surface by butting and taping or lapping and taping in accordance with manufacturer's written instructions and as approved.
 - 6. Backfill: At depths of 10 feet or more from top of structure, excluding reliefs, place layer of sand 12 inches thick over membrane as approved.

3.06 REPAIR OF LEAKS:

- A. Repair areas of concrete which leak, including cracks and other defective areas, and areas where membrane is inaccessible by using injected waterproofing or by repair methods that provide an impervious and watertight envelope around affected areas. Use epoxy-injection method.
 - 1. Epoxy injection:

- a. Commence epoxy-injection work after embankment or other backfill and waterproofing membrane have been placed to full required height on structure and for minimum distance of thirty feet beyond extent of repair area.
- b. Install injection work from interior side of repair areas by port-to-port method. Port spacing: Approximately 1-1/2 times thickness of receiving concrete section.
- c. Preseal intermediate joints to prevent escape of epoxy and complete each repair area for its entire length before commencing work in another area.
- d. Before proceeding, sweep space in vicinity of joint or crack receiving epoxy and leave in a generally clean condition. Remove dirt, laitance and other loose material from areas receiving epoxy by means of compressed-air jet.
- e. At joints and cracks, complete in order floors, walls and ceilings. Proceed with work from port-to-port, beginning at one end of joint. Inject epoxy by means of small nozzle held tightly against port. Continue operation until material begins to exude from next port. Repeat operations from port-to-port until entire area has been treated in one continuous operation. Seal ports as necessary to prevent drips or runout.
- f. Remove ports and finish surface of joints and cracks flush with adjacent concrete surfaces leaving no indentations or evidence of port fittings. Point joint surfaces and remove excess material from adjacent surfaces as necessary to leave joint smooth.
- g. Equip injection pumps with device to positively indicate failure to pump in proper proportions, as well as bypass valves and gauges compatible with pump.
- h. The Engineer may take cores at any location for inspection and testing. When it is determined that epoxy material has not penetrated to sufficient depth or is otherwise unsatisfactory, costs of coring and testing are the responsibility of the Contractor; where tests demonstrate that work is not substandard, costs of coring and testing will be paid by the Authority.
- i. When cores demonstrate that epoxy has penetrated less than 90 percent of crack volume within core, work will be considered defective. Repair defective work by refilling cracks at such locations to achieve at least 90-percent penetration.

END OF SECTION

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SECTION 07210

BUILDING INSULATION

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing building insulation.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Built-Up Roofing: Section 07515.
- B. Flashing and Sheet Metal: Section 07600.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Include manufacturer's material, handling, adhesive-mixing and application instructions for each type of product used in the work.
 - 2. Woodnailers, cant strips.
 - 3. Each tapered and flat roof insulation system.
 - a. Show location and spacing of wood nailers and cants that are required for securing insulation and for back nailing of roofing felts. Show a complete description for the procedures for the installation of each phase of the system indicating the type of materials thicknesses, identity codes, sequence of laying insulation, special methods for cutting and fitting of insulation, and special precautions. The drawings shall be based on installation of the insulation in conjunction with the roofing system specified in Section 07515.
- B. Samples:
 - 1. Three of each type of the following materials used in the work:
 - a. Insulation: 12- inch square units; pint container for loose fill.
 - b. Adhesive: Pint containers.
 - c. Fasteners: Six of each type.
 - d. Asphalt: Pint containers.
 - e. Vapor Barrier: 12 inches square.
 - f. Cant strip: 12 inches long.
- C. Certification:
 - 1. Submit certification from manufacturer of insulation verifying that insulation applicator is approved by manufacturer, and has successfully performed at least three satisfactory insulation installations using methods and materials similar to those specified.
 - 2. Certification that materials furnished meet specified requirements and are compatible with each other.
- D. Test Reports:
 - 1. Submit flame spread and smoke developed ratings in accordance with ASTM E84.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM: C516, C518, C549, C552, C665, C728, C1289, D41, D226, D312, D2626, D4586, E84.
 - 3. FM: A/S4470, P7825.
 - 4. FS: HH-I-1972/3.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to jobsite in their original unopened containers or wrappings clearly labeled with manufacturer's name and brand designation, referenced specification number, type, class and rating as applicable.
- B. Store products in approved dry area and protect from contact with soil, exposure to the elements and temperatures lower than 40F or higher than 150F. Keep products dry; store rolled goods standing on end.
- C. Handle products so as to prevent breakage of containers and damage to products.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. Application of roof insulation when ambient temperature is lower than 40F or when ice, frost or dampness are visible on the roof decks is prohibited.
 - 2. Maintain temperature of 55F minimum in structure for 48 hours prior to, during and 48 hours after application of wall insulation.
- B. Allowable Roof Loads:
 - 1. During insulation application do not use equipment of weight which exceeds allowable roof load.
- C. Coordinate insulation work with related roofing work.

PART 2 - PRODUCTS

2.01 ROOF INSULATION MATERIALS:

- A. General: Use roof insulation materials acceptable to the roofing manufacturer. See related roofing specifications in other sections.
- B. Insulation Board: One of the following materials for which installed thickness will produce overall average thermal resistance of R-30, including decrease in thermal resistance value due to aging; and which is labeled and classified as a roof deck construction material by UL for use in Fire-Classified metal roof deck assemblies (TGKX), or by FM for use in Class-1 metal-roof-deck construction.
 - 1. Composite polyisocyanurate (including polyurethane) board, ASTM C1289, Type III, factory faced with perlite insulation board on one side and asphalt-saturated felt on the other.

2. Perlite board, ASTM C728, Type 1; except with 35-psi compression resistance at five percent consolidation, and with integral factory-treatment designed to improve bond with built-up roofing membranes.
- C. Tapered Insulation Board: Where roof slope through the use of tapered insulation is required, use approved insulation board as specified above, but factory fabricated so as to provide smooth drainage inclines (1/8-inch, 1/4-inch and 1/2-inch per 12 inches), as shown.
 - D. Asphalt Primer: ASTM D41.
 - E. Steep Asphalt: ASTM D312, Type III, or IV.
 - F. Asphalt-Saturated Felt: ASTM D226, Type I.
 - G. Asphalt Base Sheet: ASTM D2626.
 - H. Asphalt Cement (Asbestos-Free): ASTM D4586.
 - I. Asphalt for Glaze Coats: ASTM D312.
 - J. Adhesive: Manufacturer's standard.
 - K. Wood Nailers and Edges: Preservation treated per Section 06075.
 - L. Cant Strips and Tapered Edge Strips: Pre-fabricated from urethane or mineral aggregate board.
 - M. Nails and Tin Caps for Vapor Barriers: 11-gauge, annular-thread, 3/8-inch head, galvanized roofing nails and flat-disc galvanized-tin caps, 1-3/8 inch minimum diameter or galvanized combination nails and caps with one-inch heads.
 - N. Insulation Nails: Types standard with insulation manufacturer.
 - O. Clips and Fasteners: Types standard with metal-roof deck manufacturer; stainless steel or zinc coated, 18-gauge minimum.

2.02 WALL INSULATION MATERIALS:

- A. Batt Insulation:
 1. Fibrous flexible blankets faced with a reinforced foil-kraft facing vapor retarder.
 2. Complies with ASTM C665, type III, Class B, Category 1.
 3. Fire hazard classification rating of 25/50 or less, per ASTM E84.
 4. Vapor Barrier Facing: Perms maximum, 0.1 when tested in accordance with ASTM C518.
 5. Thermal Resistance Minimum: R value of II except where indicated otherwise on the drawings. Thickness as indicated on drawings.
- B. Loose-Fill Insulation:
 1. Perlite: ASTM C549, Type IV (water-repellant and dust-control treated).

2.03 PERIMETER AND CAVITY WALL INSULATION:

- A. Rigid Board types of cellular glass or polystyrene insulation with 15 psi compressive strength.

1. Cellar glass (Foamglass): ASTM C552. Minimum R value: 5.0 per inch of thickness
 2. Polystyrene: ASTM C578, Minimum R value: 4.35 per inch of thickness with density of 1.0 lbs. Per cubic foot.
- B. Adhesive and Fastenings: As recommended by the manufacturer.
- C. Insulation inserts for concrete masonry units cores.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Prepare surfaces smooth, dry, clean, and free of projections, oil, grease, wax, rough mortar, debris and other substances that might prevent proper application of insulation.
- B. Allow decks and wall surfaces to dry thoroughly before application of insulation. Test for dampness per manufacturer's recommendations.
- C. Cut mortar joints flush with masonry walls. Remove fins and projections left after removal of concrete forms.
- D. Back plaster walls with cement mortar, if necessary to obtain smooth surfaces.

3.02 APPLICATION OF ROOF INSULATION:

- A. General Requirements for Application:
1. Apply insulation in direct contact with roof deck or over vapor barrier, as shown. Keep roof-insulation materials dry before, during and after application. Place perlite side of composite insulation face up.
 2. Apply insulation to deck so that continuous longitudinal joints are parallel to short dimension of roof; stagger cross joints by starting alternate courses with half-size insulation boards. Keep insulation 1/2-inch clear of vertical surfaces.
 3. When using multiple layers of insulation, stagger the joints of each succeeding layer in both directions with respect to layer below. Embed succeeding layers firmly in solid mopping of steep asphalt.
 4. Mop sufficient area to provide complete embedment of one board at a time.
 5. Except for strip-mopping on metal decks, use 25 pounds minimum of asphalt per 100 square feet of roof deck for mopping each layer of insulation in place.
 6. Provide treated-wood nailers at edges of roofs and at intersections with vertical surfaces. Provide additional treated-wood nailers at necessary intervals for nailing insulation on non-nailable decks or for nailing roofing felt.
 7. Do not heat steep asphalt above 450F. Do not heat asphalt used for glaze coats above 400F. Apply steep asphalt at no less than 350F. Apply glaze coat at no less than 325F.
- B. Application on Concrete Decks:
1. Completely cover concrete decks with asphalt primer at minimum rate of one gallon per 100 square feet of roof surface.
 2. Vapor barrier:
 - a. Provide vapor barrier consisting of two plies of asphalt-saturated felt with each ply lapped not less than 19 inches and mopped-in with steep asphalt. Vapor barrier, consisting of one layer of asphalt base sheets and weighing not less

- than 35 pounds minimum per 100 square feet, may be provided in lieu of two felt plies. Lap base sheets not less than four inches at sides and ends; solidly mop-in with steep asphalt.
- b. Mop-in vapor barriers at rate of 25 pounds minimum of steep asphalt per 100 square feet. Ensure that vapor barriers are free of wrinkles and buckles. Press air bubbles out to obtain proper adhesion between surfaces.
 - c. At walls, edges and vertical projections, extend vapor barrier six inches to form lap to be wrapped around edge of insulation.
3. Apply insulation as specified under general requirements for application.
 4. If roof slope exceeds one inch per foot, provide wood nailers for nailing insulation to roof deck. Use six nails minimum per eight square feet of insulation.
- C. Application on Steel Decks:
1. Apply insulation so that joints occur on solid bearing surfaces only rather than over open ribs. Apply insulation of the indicated thickness and as required to achieve the roof slopes indicated.
 2. Before insulation is installed, uniformly strip-coat high sections of steel deck with asphalt primer using 1/2-gallon minimum per 100 square feet of roof surface. Allow primer to dry.
 3. Strip-mop high sections of deck using not less than 12 pounds of steep asphalt per 100 square feet of roof surface. Do not permit asphalt to flow into ribs or flutes of decking.
 4. Place insulation while asphalt is still hot and fluid. When multiple layers of insulation are used, mop-in second layer and succeeding layers as specified under general requirements for application.
 5. Fastening of insulation on steel decks:
 - a. If roof slope exceeds one inch per foot, supplement asphalt moppings with mechanical fasteners. Where mechanical fastening is required, provide approved steel-deck, manufacturer's standard, nonpiercing, double-prong steel clips designed to fit into ribs of decking.
 - b. Provide fastener of length necessary to accommodate thickness of insulation and with holding power 120 pounds minimum per fastener.
 - c. Provide clips at the rate of 25 clips minimum per 100 square feet.
- D. Cant Strips and Tapered Edge Strips:
1. Cant strips:
 - a. Where shown or specified, provide 45-degree cant strips at intersections of roof with vertical surfaces extending above roof. Place cant strips on insulation and fit flush against vertical surfaces.
 - b. Where possible, nail cant strips to adjoining surfaces. For installation against non-nailable materials, place cant strips in heavy mopping of steep asphalt or set in asphalt cement.
 - c. Do not install projections, such as vent pipes and braces, through cant strips or within 10 inches from cant strips.
 2. Tapered edge strips:
 - a. Where shown or specified, provide tapered edge strips in right angle formed by junction of roof and wood nailing strips that extend above roof level. Fit strips flush against vertical surfaces of wood nailing strips.
 - b. Where possible, nail edge strips to adjoining surfaces. Where installed against non-nailable materials, apply strips in heavy mopping of steep asphalt or set in asphalt cement.

- E. Protection:
 - 1. Cover each day's application of insulation, which cannot be roofed over, with at least one glaze coat of hot bitumen.
 - 2. Protect open ends of each day's work with temporary water cut-offs; remove cut-offs when work is resumed.
 - 3. Protect open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, expansion joints and similar locations until permanent roofing and flashing is applied. Storing, walking, wheeling or trucking directly on insulation or on roofed surfaces is prohibited; provide smooth, clean board or plank walkways, runways and platforms as necessary.
 - 4. Limit storage loads on platforms and wheeling loads to 40 psf uniformly distributed. Limit size and weight of mechanical equipment used for insulation work so that deflection of roof deck under its use does not exceed 1/240 of deck span.

3.03 APPLICATION OF MASONRY-CELL WALL INSULATION:

- A. Follow manufacturer's recommended installation practices.
- B. Pour loose-fill insulation into cells of concrete masonry units as masonry work progresses. Use approved procedures to ensure complete filling of cells.
- C. Minimize free fall impact and dust formation.

3.04 APPLICATION OF BATT INSULATION:

- A. The vapor barrier facing shall face toward the warm-in-winter side of the space.
- B. Lay batts on top of soffit tightly butted together.
- C. Attach wall mounted batts with, mechanical fasteners as required for permanent installation.

3.05 APPLICATION OF PERIMETER CAVITY WALL INSULATION:

- A. Secure vertical insulation with mechanical fasteners sufficient to permanently retain all insulation in place during subsequent construction operations.
- B. Fitted with tight butt joints with openings for penetrations nearly cut for tight fit.
- C. Placed just prior to subsequent construction operations to prevent damage of insulation left exposed. Coordinate with masonry work. Prevent damage during placement of fill and compaction or concrete against insulation.
- D. Place insulation in concrete masonry unit cores at plant prior to job site delivery.

3.06 CLEAN-UP:

- A. Clean up rubbish and debris caused by this work and remove from site.
- B. Remove drippings of asphalt and adhesives in exposed places on brick, concrete, steel, metal or other surfaces.

END OF SECTION

SECTION 07412
METAL WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This section includes factory-formed and field-assembled, exposed or concealed-fastener, lap-seam metal wall panels.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. List below only products and construction that the reader might expect to find in this Section but are specified elsewhere.
- B. Delete first subparagraph below if secondary supports are inserted into this Section as part of metal wall panel manufacturers' responsibility.
- C. Division 5 Section "Cold-Formed Metal Framing" for secondary support framing supporting metal wall panels.
- D. Division 7 Section "Metal Roof Panels" for factory-formed metal soffit panels.
- E. Division 7 Section "Sheet Metal Flashing and Trim" for fasciae, copings, flashings and other sheet metal work not part of metal wall panel assemblies.
- F. Division 7 Section "Joint Sealants" for field-applied sealants not otherwise specified in this Section.

1.03 DEFINITIONS

- A. Metal Wall Panel Assembly: Metal wall panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight system.
- B. Steel Sheet Thickness: Minimum thickness of base metal without metallic coatings or painted finishes.

1.04 PERFORMANCE REQUIREMENTS

- A. General: Provide metal wall panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
- B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at a static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).
- C. Water Penetration: No water penetration when tested according to ASTM E 331 at a wind-load design pressure of not less than 6.24 lbf/sq. ft. (300 Pa) and not more than 12 lbf/sq. ft. (575 Pa).
- D. Water Absorption: Maximum 1.0 percent absorption rate by volume when tested according to ASTM C 209.

- E. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 1592 or ASTM E 330:
 - 1. Wind Loads: Determine loads based on local codes.
 - 2. Deflection Limits: Engineer metal wall panel assemblies to withstand test pressures with deflection no greater than 1/180 of the span and no evidence of material failure, structural distress, or permanent deformation exceeding 0.2 percent of the clear span.
 - a. Test Pressures: 150 percent of inward and outward wind-load design pressures.
- F. Thermal Movements: Provide metal wall panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- G. Thermal Performance: Provide insulated metal wall panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 236.

1.05 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal wall panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:10):
 - a. Flashing and trim.
 - 2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Coordination Drawings: Exterior elevations drawn to scale and coordinating penetrations and wall-mounted items. Show the following:
 - 1. Wall panels and attachments.
 - 2. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
- D. Samples for Initial Selection: For each type of metal wall panel indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.
 - 2. Include manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each sealant exposed to view.
- E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Wall Panels: 12 inches (300 mm) long by actual panel width. Include fasteners, closures, and other metal wall panel accessories.
 - a. Include four-way joint for composite panels.

2. Trim and Closures: 12 inches (300 mm) long. Include fasteners and other exposed accessories.
3. Vapor Retarders: 6-inch- (150-mm-) square Samples.
4. Accessories: 12-inch- (300-mm-) long Samples for each type of accessory.
5. Exposed Gaskets: 12 inches (300 mm) long.
6. Exposed Sealants: For each type and color of joint sealant required. Install joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of metal wall panels adjacent to joint sealants.

F. Qualification Data: For Installer.

- G. Compatibility and Adhesion Test Reports: From sealant manufacturer indicating the following:
1. Materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants.
 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

H. Field quality-control test reports.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for the following:

1. Metal Wall Panels: Include reports for air infiltration, water penetration, thermal performance, and structural performance.
2. Insulation and Vapor Retarders: Include reports for thermal resistance, fire-test-response characteristics, water-vapor transmission, and water absorption.

J. Research/Evaluation Reports: For metal-faced composite wall panels.

K. Maintenance Data: For metal wall panels to include in maintenance manuals.

L. Warranties: Special warranties specified in this Section.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Installer Qualifications: Fabricator of metal-faced composite wall panels.

1. Installer's responsibilities include fabricating and installing metal wall panel assemblies and providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
3. Engineering Responsibility: Preparation of data for metal wall panels, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

C. Fabricator Qualifications: Certified by metal-faced composite wall panel manufacturer to fabricate and install manufacturer's wall panel system.

D. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

E. Source Limitations: Obtain each type of metal wall panel through one source from a single manufacturer.

- F. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal wall panels and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

- G. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - a. Perform tests under environmental conditions replicating those that will exist during installation.
 - 2. Submit no fewer than nine pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:
 - 1. Meet with Owner, Architect, testing and inspecting agency representative, metal wall panel Installer, metal wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal wall panels including installers of doors, windows, and louvers.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal wall panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
 - 6. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
 - 7. Review temporary protection requirements for metal wall panel assembly during and after installation.
 - 8. Review wall panel observation and repair procedures after metal wall panel installation.
 - 9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
- B. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might

cause staining, denting, or other surface damage.

- D. Protect foam-plastic insulation as follows:
1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.08 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal wall panels without field measurements, or allow for field trimming of panels. Coordinate wall construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.09 COORDINATION

- A. Coordinate metal wall panel assemblies with rain drainage work, flashing, trim, and construction of adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures, including rupturing, cracking, or puncturing.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 2. Warranty Period: One year from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 10 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal wall panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Weathertight Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 1. Basis-of-Design Products: The design for metal wall panel specified is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.02 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
 2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 or AZ55 coating designation, Grade 40 (Class AZM150 or AZM165 coating designation, Grade 275); structural quality.
 3. Surface: Embossed finish.
 4. Exposed Finishes: Apply the following coil coating, as specified or indicated on Drawings.
 - a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Fluoropolymer Three-Coat System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of 1.5 mil (0.038 mm); complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:
 - a) Humidity Resistance: 1000 hours.
 - b) Salt-Spray Resistance: 1000 hours.
 5. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
 - B. Panel Sealants:
 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 2. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.
- ### **2.03 THERMAL INSULATION FOR FACTORY-ASSEMBLED METAL WALL PANELS**
- A. Isocyanurate Insulation: Modified isocyanurate foam using a non-CFC blowing agent, board or foamed-in-place type as indicated, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
 1. Closed-Cell Content: 90 percent when tested according to ASTM D 2856.

2.04 MISCELLANEOUS METAL FRAMING

- A. Steel Sheet Components, General: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized zinc coating.
- B. Subgirts: C- or Z-shaped sections fabricated from 0.0598-inch (1.5-mm) bare steel thickness, shop-painted, cold-formed, metallic-coated steel sheet.
- C. Zee Clips: 0.079-inch (2.0-mm) bare steel thickness, cold-formed, galvanized steel sheet.
- D. Base or Sill Angles and Channels: 0.079-inch (2.0-mm) bare steel thickness, cold-formed, galvanized steel sheet.
- E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 0.0312 inch (0.79 mm).
 - 2. Depth: 1-1/2 inches (38 mm).
- F. Cold-Rolled Furring Channels: 0.0538-inch (1.37-mm) bare steel thickness, with minimum 1/2-inch- (13-mm-) wide flange.
 - 1. Depth: 3/4 inch (19 mm).
 - 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch (0.79 mm).
 - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.
- G. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum bare metal thickness of 0.0179 inch (0.45 mm), and depth required to fit insulation thickness indicated.
- H. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.05 MISCELLANEOUS MATERIALS

- A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means of plastic caps or factory-applied coating.
 - 1. Fasteners for Wall Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM or neoprene sealing washer.
 - 2. Fasteners for Wall Panels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
 - 3. Exposed Fasteners for Composite Panels: Stainless steel.
 - 4. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
 - 5. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
- B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.06 FOAMED-INSULATION-CORE METAL WALL PANELS

- A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed-in-place during fabrication with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.
1. Panel Performance:
 - a. Flatwise Tensile Strength: 30 psi (200 kPa) when tested according to ASTM C 297.
 - b. Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for 7 days at 140 deg F (60 deg C) and 100 percent relative humidity according to ASTM D 2126.
 - c. Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at 200 deg F (93 deg C) according to ASTM D 2126.
 - d. Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for 7 days at minus 20 deg F (29 deg C) according to ASTM D 2126.
 - e. Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. (958-kPa) positive and negative wind load and with deflection of L/180 for 2 million cycles.
 - f. Autoclave: No delamination when exposed to 2-psi (13.8-kPa) pressure at a temperature of 212 deg F (100 deg C) for 2-1/2 hours.
 - g. Fire-Test-Response Characteristics: Class A according to ASTM E 108.
 2. Isocyanurate Insulation-Core Performance:
 - a. Density: 2.0 to 2.6 lb/cu. ft. (32 to 42 kg/cu. m) when tested according to ASTM D 1622.
 - b. Compressive Strength: Minimum 20 psi (140 kPa) when tested according to ASTM D 1621.
 - c. Shear Strength: 26 psi (179 kPa) when tested according to ASTM C 273.
- B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.
1. Basis of design product: Centria Formawall 1000
 2. Products:
 - a. Aluma Shield Industries, Inc., a Member of Metecno Group; [AW-300A Flush Wall Panel.
 - b. Coldmatic Building Systems; Thermawall 1000 HJF, 4000 HJF, or 5000 HJF.
 - c. Galvamet Inc.; Mono, Supra, or Thermal Panel.
 - d. Insulated Panel Systems, Div. of NCI Building Systems; ESP or EWP Wall Panel.
 - e. Metl-Span; CF Flat 200Wall Panel.
 - f. Steelox Systems Inc.; TW-100 Wall Panel.
 3. Facings: Fabricate panel with exterior and interior facings of same material and thickness.
 - a. Material: Zinc-coated (galvanized) steel sheet, 0.359 inch thick.
 - e. Exterior Facing Finish: Fluoropolymer.
 - 1) Color: As selected by Architect from manufacturer's full range.
 - f. Interior Facing Finish: Manufacturer's standard siliconized polyester.
 - g. Exterior Surface: Smooth, flat.
 4. Panel Coverage: 24 inches (610 mm), 30 inches (762 mm), 36 inches (914 mm), 39.37 inches (1000 mm), or 42 inches (1067 mm nominal).
 5. Panel Thickness: 2.0 inches (51 mm).
 6. Thermal-Resistance Value (R-Value): R 14.2

2.07 ACCESSORIES

- A. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
 - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 - 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Formed from 0.0179-inch- (0.45-mm-) thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

2.08 FABRICATION

- A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
 - 1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
 - 2. Fabricate wall panels with panel stiffeners as required to maintain fabrication tolerances and to withstand design loads.
- B. Fabricate metal wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Where indicated, fabricate metal wall panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.
- E. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 - 3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.

- a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.09 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.
 - 1. Examine primary and secondary wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 - 2. Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
 - 3. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
- B. Install fasciae and copings to comply with requirements specified in Division 7 Section "Sheet Metal Flashing and Trim."
- C. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal wall panel manufacturer's written recommendations.

3.03 METAL WALL PANEL INSTALLATION, GENERAL

- A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings.

Install panels perpendicular to girts and subgirts, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cutting of metal wall panels by torch is not permitted.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Pre-drill panels.
4. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
5. Install screw fasteners in pre-drilled holes.
6. Locate and space fastenings in uniform vertical and horizontal alignment.
7. Install flashing and trim as metal wall panel work proceeds.
8. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Fasteners:

1. **Steel Wall Panels:** Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized steel fasteners for surfaces exposed to the interior.
2. **Aluminum Wall Panels:** Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized steel fasteners for surfaces exposed to the interior.
3. **Copper Wall Panels:** Use copper or stainless-steel fasteners.
4. **Stainless-Steel Wall Panels:** Use stainless-steel fasteners.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

3.04 FACTORY-ASSEMBLED METAL WALL PANEL INSTALLATION

A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.

1. Fasten insulated metal wall panels to supports with fasteners at each lapped joint at location, spacing, and with fasteners recommended by manufacturer.
2. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
3. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of insulated metal wall panels.
4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of

- washer.
 - 5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
 - 6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weatherproof to driving rains.
 - 7. Apply snap-on battens to insulated metal wall panel seams to conceal fasteners.
- B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location, spacing, and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.
- 1. Install clips to supports with self-tapping fasteners.

3.05 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.06 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Water Penetration: Test areas of installed system indicated on Drawings for compliance with system performance requirements according to ASTM E 1105 at minimum differential pressure of 20 percent of inward-acting, wind-load design pressure as defined by ASCE 7, "Minimum Design Loads for Buildings and Other Structures," but not less than 6.24 lbf/sq. ft. (300 Pa).
- C. Water-Spray Test: After completing the installation of 75-foot- (23-m-) by-2-story minimum area of metal wall panel assembly, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by Architect.
- D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed metal wall panel installation, including accessories. Report results in writing.
- E. Remove and replace applications of metal wall panels where inspections indicate that they do not comply with specified requirements.
- F. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.07 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.
- B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07515
BUILT-UP ROOFING

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing built-up roofing.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Thermal insulation, nailers and cants: Section 07210.
- B. Metal counter flashing and other sheet metal: Section 07600.
- C. Roof accessories: Section 07730.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM: D41, D312, D1668, D1863, D2178, , D4586.
 - 3. National Roofing Contractor's Association (NRCA):The NCRA Roofing and Waterproofing Manual.
- B. Single Source: Provide products as produced or recommended by the roofing system manufacturer.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Include the following:
 - a. Manufacturer's material, handling, and application instructions.
 - b. Step-by-step application procedure proposed.
 - c. Show perimeter details, tapered insulation layout (as applicable), penetration details, drainage details and other typical and special conditions.
 - d. Staging plan showing access points, waste disposal, storage areas, etc.
- B. Certification:
 - 1. Submit certification from manufacturer of roofing, that roofing applicator is approved by manufacturer and has successfully performed at least three satisfactory roofing installations using materials and methods similar to those specified.
 - 2. Certification that materials furnished meet specified requirements and are compatible with each other and with adjacent materials under Related Work Specified Elsewhere.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to jobsite in their original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type, class and rating as applicable.

- B. Store products in approved dry area with roll goods standing on ends and protect from contact with soil and from exposure to the elements. Keep products dry.
- C. Handle products so as to prevent breakage of containers and damage to products.
- D. Do not exceed designed live load of roof deck when stockpiling materials in areas of work.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. Application of roofing when precipitation is occurring or when ice, frost or dampness is visible on roof decks is prohibited.
 - 2. Application of roofing when ambient temperature is lower than 40F is prohibited, unless otherwise approved.
 - 3. Maintain rolls of felt at 60F minimum 24 hours minimum prior to installation.

1.07 WARRANTY:

- A. One year in addition to the requirements of the General Provisions for a total of two years.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General:
 - 1. Insofar as practicable, furnish products produced or recommended by a single roofing system manufacturer, including roofing system products specified in other sections.
- B. Thermal Insulation, Nailers and Cants: Section 07210.
- C. Asphalt Primer: ASTM D41.
- D. Asphalt: ASTM D312.
 - 1. Type I, 135F-151F softening point for level to 1/4-inch slope (*use not permitted*)
 - 2. Type II, 158F-176F softening point for 1/4-inch to one-inch slope.
 - 3. Type III, 185F-205F softening point for one-inch to three-inch slope.
 - 4. Type IV, 210F-225F softening point for three-inch to six-inch slope.
- E. Asphalt Cement(Asbestos-Free): ASTM D4586.
- F. Asphalt-Saturated and Coated Organic Felt Base Sheet: ASTM D2626 (*use not permitted*).
- G. Asphalt-Saturated Organic Roofing Felt: ASTM D226, Type I, perforated (*use not permitted*).
- H. Asphalt Glass Felt: ASTM D2178, Type IV or Type VI.
- I. Base Flashing Cap Sheet: Roofing system manufacturer's standard asphalt impregnated and coated composite sheet, glass fiber or polyester reinforced, with or without surface granules.
- J. Aggregate for Surfacing: ASTM D1863, light-colored crushed stone, slag or gravel, opaque to ultraviolet radiation.

- K. Walkway Surface: Homogenous core of asphalt, plasticizers and inert fillers bonded by heat and pressure between two saturated and coated inorganic sheets, with the walking surface finished with gray ceramic granules. Supply in 36-inch wide by 72-inch long sheets, 1/2-inch thick minimum.
- L. Nails: 11-gauge, annular-thread, galvanized roofing nails with 3/8-inch diameter head or combination nail with head one-inch square minimum.
- M. Tin Caps: Flat discs of galvanized sheet steel 28-gauge minimum and 1-3/8 inches minimum diameter.
- N. Combination Nails: Square-head cap 11-gauge, hot-dip galvanized, annular thread with one-inch diameter cap.
- O. Glass-Fiber Fabric: Woven glass cloth, treated with asphalt, ASTM D1668, Type I.
- P. Metal Counter Flashing and Other Sheet Metal: Section 07600.
- Q. Roof Accessories: Section 07730.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION OF SURFACES:

- A. Clean substrates of dust, debris and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Examine substrates, areas, and conditions under which roofing will be applied, with installer present, for compliance with requirements.
- C. Verify proper secure placement of roof openings, penetrations, insulation, roof accessories and roof drains.
- D. Verify that substrates are smooth, dry, clean and free of projections or debris that might damage roofing materials.
- E. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

- A. General: Perform installation in accordance with the NCRA Roofing and Waterproofing Manual unless specified or shown differently.
 1. Apply roofing perpendicular to roof slope progressively and continuously. Provide starter sheets to maintain specified number of felt plies throughout roof. Extend roofing plies to tops of cant strips.
 2. Protect edges of each day's application of felt, except for coated base sheet, with glaze coat of hot Type-III asphalt. Apply glaze coat at minimum rate of 15 pounds of asphalt per 100 square feet of roof surface.
 3. Do not store materials on applied roofing. Provide sufficient crew to complete roofing work on area begun before end of each day's work.

4. Roll felt into bitumen not more than three feet behind mop; broom thoroughly with roofer's smoothing brushes to ensure thorough bonding of sheets to eliminate air pockets, wrinkling and buckling. Felt may be machine applied if approved. Do not lay plies dry and turn back laps for mopping between plies.
5. Heat Types-II, III and IV asphalts 450F maximum; do not keep heated overnight.
6. Apply asphalt at no less than 350F. Use thermometers to check temperature of asphalt during heating and application. Keep kettle operator in attendance during entire operation to ensure that maximum specified temperatures are not exceeded.
7. Provide smooth, clear, board or plank runways and platforms near supports for traffic over partially or completely finished roofing.
8. Follow commercial practice and recommendations of manufacturer and supplier for handling and use of materials, except as otherwise specified.

B. Materials Schedule:

1. Each of the following for each 100 square feet of roof area:

Materials	Specification Amount
Base sheet	1 ply
Felt	3 plies
Asphalt - on deck	25 pounds
Asphalt - between plies	60 pounds
Asphalt - top pouring	60 pounds
Aggregate: One of the following: Slag Gravel or crushed stone	300 pounds 400 pounds

2. Base flashing is additional to the quantities above.

C. Application:

1. For direct application to concrete decks, coat decks uniformly with asphalt primer using not less than one gallon per square of roof area and allow to dry thoroughly.
2. Apply hot Type-III or Type IV asphalt uniformly in a solid mopping over primer or insulation at minimum rate of 25 pounds of asphalt per 100 square feet. On roofs of precast units, apply felt strips four inches or more in width centered over joints of precast units in cold-applied asphalt cement before solid mopping. Apply base sheet in hot asphalt with ends and edges lapped four inches over preceding sheet and sealed with hot asphalt.
3. Apply hot asphalt uniformly to base sheet at minimum rate of 20 pounds per 100 square feet. Apply three felt plies in hot asphalt, shingle fashion, each sheet in each ply lapping 24-3/4 inches over preceding ply. Lap ends of sheets six inches minimum and stagger laps in adjacent courses 12 inches minimum. Mop hot asphalt full lap-width of each ply so that felt never touches felt. Apply not less than 20 pounds of asphalt per 100 square feet between successive plies.
4. On roof slopes greater than one inch per foot, nail each ply of felt on slopes as specified. Correct fishmouths, breaks, blisters and other defects before flood-coating roofing.

5. Flood coat: After felt flashing applications, repairs and corrective actions have been completed and approved, coat entire surface uniformly with hot asphalt, poured from dipper, at minimum rate of 60 pounds per 100 square feet.
 6. Aggregate surfacing: Immediately embed gravel, crushed stone or slag into hot asphalt.
 7. Double surfacing: Provide double surfacing of aggregate in addition to normal requirement under each board of walkway-surface material as follows:
 - a. Apply not less than 80 pounds of hot asphalt poured from dipper per 100 square feet of roof area.
 - b. Embed immediately into hot asphalt 200 pounds minimum of slag or 300 pounds minimum of gravel or crushed stone.
- D. Nailing On Roof Slopes Greater Than One Inch Per Foot:
1. Nail each ply of felt. Run felt perpendicular to roof slope and nail to embedded nailers parallel to slope.
 2. Nail felt to each nailer with two nails spaced approximately two and eight inches from upper edge of felt.
- E. Base Flashing: Follow NRCA Roofing and Waterproofing Manual details and roofing system manufacturer's details.
1. Provide flashing in angles formed where roof decks abut walls, curbs, ventilators, pipes and other vertical surfaces and wherever necessary to make work watertight.
 2. Prime walls and curbs; allow to dry before flashing is applied.
 3. Apply base flashing in two layers: first of asphalt glass felt and topped with base flashing cap sheet cut in strips 12 feet long maximum with reinforced fabric side toward wall.
 4. Extend flashing felt onto roof over membrane six to eight inches from toe of cant. Nail felt 1-1/2 inches from top edge of felt with roofing nails and tin caps at 10-inch maximum spacing.
 5. Seal top of flashing with strip of glass fiber fabric embedded in 1/8-inch thick asphalt cement, extending from one-inch above top of felt to one-inch below nail heads.
 6. Lap ends of felt three inches minimum, staggered in each ply, and seal watertight with asphalt cement. Apply six-inch wide strip of asphalt-saturated felt with asphalt cement to seal lower edge of flashing installation.
 7. Cement felt to underlying surfaces and to each other with asphalt cement applied not less than 1/16-inch thick or 35 pounds per 100 square feet for each coating.
- F. Stripping-In:
1. Strip-in roof-accessory aprons, pipe sleeves and metal flashings as follows:
 - a. Prime surfaces and allow to dry. Strip-in with two layers of asphalt-saturated felt cemented with asphalt cement.
 - b. Extend felt three and six inches, respectively, beyond edge of apron, flange or flashing.
 2. Gravel stops, fascias and scuppers:
 - a. Strip-in with two layers of asphalt-saturated felt, one 10-inch strip and one 12-inch strip.
 - b. Solidly mop strips with hot bitumen.
- G. Roof-Drain Flashing Application:
1. Strip-in roof drain with two layers of asphalt-saturated felt, one 10 inches wide and one 12 inches wide, set in asphalt cement or hot bitumen.
 2. Heavily coat flashing ring of drain with asphalt cement before installing felt flashing. Clamp roofing felt and felt flashing securely in drain clamping ring.

3. Apply trowel coat of asphalt cement width of trowel on top of felt around clamping ring before flood coat and application of aggregate. Embed aggregate into asphalt cement.
- H. Metal Fascias and Flashings:
1. Where metal fascias or other metal flashing extend into built-up roofing, extend felt plies under metal with first two plies turned over succeeding plies and back 12 inches.
 2. After metal flashing is placed, apply two plies of asphalt-saturated felt flashing, set in pitch-base asphalt cement, over that part of metal extending onto roof.
- I. Approval of Flashing: Obtain approval of complete flashing and connections of roofing with other work before applying final coating and surfacing materials.
- J. Traffic Surfaces: Apply walkway-surface material in hot asphalt over double-aggregate surfacing in individual boards with 10-inch separation between each board. Extend separation through top surfacing to provide drain through walkways at level of original surfacing.

3.03 FIELD QUALITY CONTROL:

- A. Tests:
1. The Engineer may cut six-inch by 24-inch test specimens from roof; one specimen for each 5,000 square feet, but not less than one specimen for each roof level or area. In the event of test cuts, immediately restore roof to its original state, using same number of plies and moppings, shingled-out not less than 26 inches on sides of cut.
 2. Should examination and test of specimens disclose lack of specified material or nonconformity to specified requirements, the Engineer may order removal of roofing and replacement as specified, order that additional materials be applied uniformly over entire surface at least to the amount of deficiency disclosed in test specimens or order other corrections to be made.
- B. Prevention of Roof-Drain System Clogging:
1. Prevent asphalt and other roofing materials from entering and clogging roof drains and conductors.
 2. Repair or replace clogged or damaged components as directed.
 3. Remove roof-drain plugs when no work is taking place or during precipitation.
- C. Correct deficiencies in or remove built-up roofing that does not comply with requirements. Repair substrates, reinstall roofing and repair flashings to a condition free of damage and deterioration.
- D. Prevent asphalt and other roofing materials from spilling or migrating onto surfaces of other construction. Clean spillage using cleaning agents and procedures recommended by manufacturer of affected construction.

3.04 CLEAN-UP:

- A. Clean up rubbish and debris caused by this work and remove from the site.
- B. Promptly remove drippings of pitch and asphalt in exposed places on brick, concrete, steel, copper and other surfaces to prevent irreparable damage to exposed finish surfaces.

END OF SECTION

SECTION 07535

ELASTOMERIC MEMBRANE ROOFING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide fully adhered EPDM roof membrane including all required flashings and terminations on new construction.
- B. Provide expansion joints at junctions with existing buildings that have both EPDM and built-up asphalt roofing.

1.02 QUALITY ASSURANCE

- A. Applicator qualifications: Manufacturer authorized Roofing Contractor
- B. Design Criteria:
 - 1. SPRI: "Wind Load Design Guide for Low Sloped Flexible Membrane Roofing Systems."
 - 2. IBC 2003, Section 1609 Wind Loads.
- C. National Roofing Contractors Association (NRCA): Roofing and Waterproofing Manual.
- D. Material Standards:
 - 1. EPDM Membrane:
 - a. ASTM-D4637, "Standard Specification for EPDM Sheet used in Single-Ply Roofing."
 - b. ASTM-D481, "Standard Specification for Non-vulcanized Rubber Sheet Used as Roof Flashing."

1.03 DESIGN RESPONSIBILITY & CRITERIA

- A. Determine the fastener type and spacing needed to resist uplift pressures based "Wind Load Design Guide for Low Sloped Flexible Membrane Roofing Systems" published by SPRI.
 - 1. Basic Wind Speed (3-sec gust, measured at 33 FT above ground, in Exposure B):
 - a. Minimum 90 MPH.
 - 2. Exposure:
 - a. "B," Urban/Suburban/Wooded.
 - 3. Importance Factor:
 - a. Category II.
 - 4. Roof Height(s) and Parapet Height(s): As indicated.
 - 5. Static Pressure of Building Interior: Less than 0.5 IN water.
- B. Fire resistance rating:
 - 1. UL 790, Class A.
 - 2. Assembly in conformance with fireproofing as specified.

1.04 SUBMITTALS

- A. Shop Drawings:
 - 1. Roof layout showing insulation thicknesses and special details.

2. Profiles of flashing assemblies.
- B. Product Data:
1. Installation Drawings and pertinent details.
 2. Indicate location of expansion joints, crickets, saddles, curbs, safety tiebacks, vents, drains and other penetrations.
 3. Indicate slope amount and direction, location of crickets, and key vertical elevation points.
- C. Samples:
1. 5 IN x 5 IN specimens of sheet goods.
- D. Project information:
1. Meeting minutes from Pre-Construction Conference.
 2. Report by manufacturer's representative that roof has been properly installed.
 3. Report showing physical properties of materials.
- E. Contract Closeout Information:
1. Warranty.
 2. Maintenance Data.
 3. Certificates.

1.05 WARRANTY

- A. 15-year warranty of weather/tightness signed by roofing materials manufacturer.
1. Warranty to include coverage for peak gusts of wind to:
 - a. 55 MPH at 33 FT above ground.
 2. Warranty to include the entire system: membrane, flashings, adhesives, sealants, counterflashings, insulation, fasteners, fastener plates, fastener strips, hard rubber or metal edging, metal termination bars, sheet metal copings and edge metal, and other materials authorized by manufacturer.
- B. 20-year warranty on 70% PVDF (Kynar 500) coatings on edge metal and copings.

1.06 PRE-CONSTRUCTION CONFERENCE

- A. Pre-construction conference, directed by General Contractor, prior to beginning of roofing work to discuss following:
1. Contract Document requirements.
 2. Roof plan.
 3. Roofing and flashing details.
 4. Drain and scupper elevations.
 5. Roofing manufacturer's specifications and details.
 6. UL requirements.
 7. Insulation manufacturer's recommendations.
 8. Available on site storage.
 9. Roof protection from damage by other trades.
- B. Attendance is recommended for:
1. General Contractor.
 2. Roofing contractor's superintendent.
 3. Roofing manufacturer's representative.

4. Sheet metal contractor performing metal flashing work.
 5. Mechanical contractor.
 6. Plumbing contractor.
 7. Deck contractor.
 8. Other trades whose work may effect roofing system.
- C. Minimum two weeks prior to conference, roofing contractor shall forward pertinent information to General Contractor for review.
1. Installation drawings.
 2. Manufacturer product data.
 3. Samples of proposed materials.
 4. Sample warranty.
 5. Other information deemed pertinent for sound and secure application.
- D. Conference shall review specifications, details, application requirements and preliminary work.
- E. Objectives of Pre-construction Conference to include:
1. Review foreseeable methods and procedures related to roofing work.
 2. Tour representative areas of roofing substrates (decks), inspect and discuss condition of substrate, roof drains, curbs, penetrations and other preparatory work performed by others.
 3. Review structural loading limitations of deck and inspect deck for loss of flatness and for required attachment.
 4. Review roofing system requirements (drawings, specifications and other contract documents).
 5. Review required submittals both completed and yet to be completed.
 6. Review and finalize construction schedule related to roofing work and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.
 7. Review required inspection, testing, certifying and material usage accounting procedures.
 8. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions, including possibility of temporary roofing.
 - a. Review notification procedures for weather or non-working days.
 9. Record discussion of conference including decisions and agreements (or disagreements) reached.
 - a. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set data for reconvening conference.
- F. Furnish copy of meeting record to each party who may be affected by roofing work, (weather or not they were in attendance) and to Owner and Architect.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver to site in original, unopened containers labeled with the manufacturer's name, brand and installation instructions.
- B. Store cleaners and adhesive products, liquid materials and uncured materials at temperatures between 32 and 90 degF.
- C. When stored at lower temperatures, liquid materials must be srestored to at least 16 degC 60 degF prior to use.

- D. Insulation, sheathing, and cover boards:
 - 1. Store on pallets off the ground.
 - 2. Cover with a breathable membrane.
- E. Lightweight materials shall be weighted down to prevent wind damage.

1.08 JOB CONDITIONS

- A. When positioning membrane sheets, exercise care to locate all field splices away from low spots and out of drain sumps.
 - 1. All field splices should be shingled to prevent bucking of water.
- B. When loading materials onto the roof, the Applicator must comply with the requirements of the Owner to prevent overloading and possible disturbance to the building structure.
- C. Proceed with roofing work only when weather conditions are in compliance with the manufacturer's recommended limitations, and when conditions will permit the work to proceed in accordance with the manufacturer's requirements and recommendations.
- D. The surface on which the insulation or roofing membrane is to be applied shall be clean, smooth, dry, and free of projections or contaminants that would prevent proper application of or be incompatible with the new installation, such as fins, sharp edges, foreign materials, oil and grease.
- E. Contaminants such as grease, fats and oils shall not be allowed to come in direct contact with the roofing membrane.

PART 2 - PRODUCTS

2.01 ROOF SYSTEM

- A. Fully adhered EPDM over Steel Deck:
 - 1. Gypsum Sheathing.
 - 2. Vapor Retarder.
 - 3. Insulation.
 - a. Mechanically fastened or adhered to deck.
 - 4. EPDM Membrane.
- B. All components products made by, or accepted as "compatible" by membrane manufacturer.
- C. Unless otherwise approved by the specifier and accepted by the membrane manufacturer, all products (including insulation, fasteners, fastening plates and edgings) must be manufactured and supplied by the roofing system manufacturer and covered by the warranty.

2.02 SHEATHING

- A. Gypsum Sheathing:
 - 1. Water-resistant gypsum core with fiberglass facings.
 - 2. Minimum Thickness:
 - a. 5/8 IN.
 - 3. Products: "Dens-Deck Roof Board" by Georgia-Pacific, or equal.

2.03 VAPOR RETARDER

- A. 2-plyes of polyethylene, bonded over one layer of scrim reinforcing.
- B. Fire retardant type, with compatible fire retardant adhesive.
- C. Products: "TX-1200 FR" by Griffolyn, or equal.
- D. Minimum Properties:

Minimum Physical Properties - Vapor Retarder		
Property	Test Method	Required Value
Puncture Propagation Tear (Min)	ASTM-D256	26 LBS
Permeance	ASTM-E96	0.036 Perm
Drop Dart	ASTM-D1709, Method B	330 g
Tensile Strength	ASTM-D882	100 LBS / 4,504 PSI
Puncture Strength	ASTM-D4833	16 LBS
Surface Burning Characteristics	ASTM-E84	Class I, Class A

- E. Seam Tape:
 - 1. Self-adhering, asphaltic mastic.
 - 2. Products: "Fab Tape" by Griffolyn, or equal.
- F. Repair Tape, for punctures and other damaged areas:
 - 1. Products: "Griff Tape" by Griffolyn, or equal.

2.04 ROOF INSULATION AND COVER BOARD

- A. General:
 - 1. Furnished by roofing manufacturer.
 - 2. UL listed for assembly indicated.
 - 3. Provide crickets and saddles as required.
 - 4. When applicable, insulation shall be installed in multiple layers with joints staggered.
 - a. The first and second layer of insulation shall be mechanically fastened or adhered to the substrate in accordance with the manufacturer's published specifications.
- B. Polyisocyanurate (PISO) roof insulation:
 - 1. Rigid, closed cell foam core bonded to heavy-duty glass fiber mat facers.
 - 2. Material complying with:
 - 3.

Minimum Physical Properties - Polyisocyanurate Insulation		
Property	Test Method	Required Value
Material Standards	ASTM-C1289	Type II, Class 1
	HH-1-1972	Class 1
Density (nominal)	ASTM-D1622	2 PCF
Long Term Thermal Resistance (LTTR) per unit thickness	CAN / ULC-S770	R greater than or equal to 6.0 per inch
Compressive Strength	ASTM-D1622	20 PSI
Dimensional Stability	ASTM-D2126	2% max., 7 days
Permeance	ASTM-E96	< 1.0 Perm
Water Absorption	ASTM-C209	< 1.5% volume
Service Temperature	-	-100 to +250 degF

3. Tapered Configurations:
 - a. Insulation Thickness (based on R-Value required):
 - 1) Provide insulation thickness as required to attain a minimum average aged RSI-Value R-Value of 19 for entire roof area.
 - 2) Minimum 1 IN thickness at roof drains.
 - b. Taper to provide slope of 1:50 1/4 IN per FT.
4. Products: "Sure-Seal Polyisocyanurate HPH" by Carlisle SynTec, or "Iso 95+ GL:" by Firestone, or equal.

2.05 ROOFING MEMBRANE

- A. EPDM Roofing membrane:
 1. Material: Ethylene propylene diene terpolymer (synthetic rubber) complying with ASTM-4637.
 2. Fire Retardant.
 3. Color: Black.
 4. Thickness: Minimum 60 mil.
 - a. Polyester reinforced, complying with ANSI/RMA IPR-2.
 5. Products: "SureSeal" by Carlisle SynTec, or "Rubergard" by Firestone, or equal.
 6. Minimum Physical Properties:

Minimum Physical Properties - Black, 60mil, Reinforced EPDM Membrane		
Property	Test Method	Required Value
Tolerance on Nominal Thickness (Max)	ASTM-D751	+/- 10%
Thickness over Scrim (Min)	ASTM-D4637	15 mil
Breaking Strength (Min)	ASTM-D751	90 LBS

Ultimate Elongation (Min)	ASTM-D751	250%
Tear Strength (Min)	ASTM-D751	10 LBS
Brittleness Point	ASTM-D2137	-49 degF

- B. Membrane flashings, fasteners, adhesives, tapes, cements and sealants: Roofing manufacturer's standard.

2.06 FASTENERS

- A. Type, spacing and quantity as recommended by manufacturer.
1. Designed to resist uplift forces generated by specified wind speed.
- B. Minimum pullout values per fastener:
1. For use with 22 GA steel decks: 350 LBS each.
- C. Fasteners shall be capable of providing a static back-out resistance of at least 10 IN-LBS.

2.07 WALKWAYS

- A. Molded Walkway Pads:
1. Molded rubber walkway pad with slip-resistant surface.
 2. Color: Black.
 3. Nominal Thickness: 2/16 IN.
 4. Length and Width: 30x30 IN.
 5. Include glue or pressure-sensitive tape as recommended by membrane manufacturer.
 6. Locate where indicated.
 - a. Do not locate within 20 FT of roof edge.

2.08 MISCELLANEOUS ITEMS

- A. Roofing accessories:
1. Use manufacturer's standard prefab accessories where available.
 2. Nailing strips: As detailed and required.
 3. Pipe flashings: Provide for each pipe penetration; include clamps, adhesive and sealants.
 4. Expansion joint covers.
- B. Adhesives, cleaners, and primers: As recommended by roofing manufacturer.
- C. Treated Wood Blocking: Specified in Section 06100.
- D. Other materials as required by manufacturer for complete system warranty.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect entire area to be roofed for acceptability.
- B. Correct, or have corrected, unsatisfactory conditions.

3.02 PREPARATION

- A. Remove standing water from area to be covered prior to starting roofing work.
- B. Install required nailers.
- C. Clear the deck of all debris, ice, water and foreign material prior to installation of any roofing materials.

3.03 INSTALLATION OF ROOFING - GENERAL

- A. Install materials in accordance with manufacturer's instructions and recommendations.
- B. Comply with the manufacturer's instructions for the installation of the membrane roofing system including proper substrate preparation, jobsite considerations and weather restrictions.
- C. Install materials in accordance with procedures required for FM and UL assemblies.

3.04 INSTALLATION OF NAILERS

- A. Install nailers at perimeter of each roof level, curbs, skylights, expansion joints, and similar penetrations.

3.05 INSTALLATION - SHEATHING

- A. Lay sheathing tightly butted and cut to fit around penetrations.
- B. Apply per UL requirements.
- C. Attach sheathing to deck in accordance with roofing manufacturer's recommendations.

3.06 INSTALLATION - VAPOR RETARDER

- A. Install in accordance with manufacturer's instructions.
- B. Ensure that surface beneath vapor retarder is smooth with no sharp projections.
- C. Do not proceed until deficiencies are corrected.
- D. Install in largest practical widths.
- E. Install continuously at locations indicated.
 - 1. Insure that no discontinuities occur, including at seams, penetrations, and edge terminations.
 - 2. Join sections of vapor retarder and seal penetrations with mastic tape.
 - 3. Lap joints 100mm 4 IN and seal with adhesive.
 - 4. Ensure that surfaces to be taped are clean and dry.
- F. Seal around pipes, conduits, curbs, safety tie-backs, and other penetrations with pipe boots in accordance with manufacturer's instructions.

- G. Maintain continuity of vapor retarder over expansion joints.
- H. Repair holes in vapor retarder with self-adhesive tape recommended by manufacturer.
- I. Protect vapor retarder from damage until covered with insulation.

3.07 INSTALLATION - WOOD BLOCKING

- A. Install where indicated or required for proper securement of roofing system.
- B. Securement of wood blocking:
 - 1. Design to resist a minimum of 200 LBS/LF in any direction per SPRI Test Method RE-1.
- C. Install so that top of blocking is substantially flush (+/- 6 mm 1/4 IN) with top of insulation.

3.08 INSTALLATION - INSULATION

- A. Where required thickness of insulation is greater than 2 IN: Install insulation in at least 2 layers.
 - 1. Stagger board joints in successive layers laterally, and longitudinally.
 - 2. Butt joints tightly, and dress top surface of joints as required to preclude ponding at seams.
 - a. Joints shall not exceed 6mm 1/4 IN.
 - b. Joints and gaps greater than 6mm 1/4 IN shall be filled with the same material.
 - 3. Cut insulation neatly to fit around roof penetrations and projections.
- B. Secure insulation to the substrate with the required mechanical fasteners or adhesive in accordance with the manufacturer's specifications.
 - 1. Cut insulation neatly to fit around roof penetrations and projections.
 - 2. Mechanically fasten (or adhere) insulation to deck to UL and FM requirements.
 - a. Fastener shall be attached through all layers of insulation.
- C. Install fasteners in accordance with manufacturer's requirements.

3.09 INSTALLATION - MEMBRANE

- A. Unroll and position membrane without stretching.
 - 1. Allow the membrane to relax for approximately 1/2 hour before bonding.
 - 2. Fold the sheet back onto itself so half the underside of the membrane is exposed.
- B. Position sheets to accommodate contours of roof deck.
 - 1. Shingle splices to avoid bucking water.
- C. Apply the bonding adhesive in accordance with the manufacturer's published instructions, to both the underside of the membrane and the substrate.
 - 1. Allow the adhesive to dry until it is tacky but will not string or stick to a dry finger touch.
 - 2. Roll the coated membrane into the coated substrate while avoiding wrinkles.
 - 3. Brush down the bonded half of the membrane sheet with a soft bristle push broom to achieve maximum contact.

4. Fold back the unbonded half of the membrane sheet and repeat the bonding procedure.
- D. Intall adjoining membrane sheets in the same manner, overlapping edges approximately 100mm 4 IN.
1. Do not apply bonding adhesive to the splice area.
- E. Membrane Splices
1. Overlap adjacent sheets a minimum of 3 IN and adhere with cement, seam tape or other method approved by manufacturer.
 2. Comply with manufacturer's instructions for splicing procedures.
- F. Perimeter Securement:
1. Secure membrane along the perimeter of each roof level, roof section, curb, skylight, interior wall, penthouse, and other penetrations as recommended by membrane manufacturer.
- G. Membrane Flashing:
1. Flash all penetrations and walls with cured EPDM membrane or flashing.
 2. Exceptions:
 - a. Uncured flahsings and pressure sensitive uncured flashing shall be limited to overlaying of vertical seams, flashing of inside and outside corners, scuppers, and other unusually shaped penetrations where the use of cured membrane flashing is.
 - b. Manufacturer's standard pre-manufactured accessories (i.e. pre-molded pipe flashings, peal-n-stock pipa boots, and inside/outside corners, etc) shall be used wherever possible in lieu of uncured flashings.
 3. Terminate base-of-wall flashings in accordance with manufacturer's approved details.
 4. Pre-flashing at sheet metal parapet copings:
 - a. Extend EPDM membrane and/or flashing over top of parapet prior to capping with sheet metal.
 5. Expansion Joints:
 - a. Install EPDM membrane at expansion joints as recommended by manufacturer.
- H. Hot or Cold Weather Procedures:
1. Comply with manufacturer's instructions.

3.10 INSTALLATION - WALKWAYS

- A. Molded Walkway Pads:
1. Install where indicated.
 2. Clean surfaces to be adhered.
 3. Adhere pads to membrane per manufacturer's instructions.

3.11 PROTECTION

- A. Prevent water from getting under installed membrane by using water cutoffs.
1. Make water cutoffs by extending membrane beyond insulation and setting end of membrane in 4 IN wide strip of water cutoff mastic.
 2. Remove temporary water cutoffs prior to proceeding with next work period; remove portion of membrane in contact with matic.

- B. Remove and replace wet insulation.

3.12 CLEAN UP

- A. All debris must be disposed of in a legally acceptable manner.
- B. A representative of manufacturer shall make an inspection and issue written report to Architect that roofing system has been installed properly.

END OF SECTION

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SECTION 07553

SELF-ADHERING MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section includes the following:
 - 1. Protected, self-adhering roofing membrane, two ply.
 - 2. Insulation.
 - 3. Aggregate ballast.
 - 4. Roof pavers.

- B. Related Sections include the following:
 - 1. Rough Carpentry: Section 06100.
 - 2. Flashing and Sheet Metal: Section 07600
 - 3. Roof Specialties: Section 07730
 - 4. Piping Systems: Section 15205

1.02 PERFORMANCE REQUIREMENTS

- A. Install self-adhering modified bituminous membrane roofing and flashing system with compatible components that will not permit passage of liquid and will withstand wind loads, flotation loads, thermally induced movement, and exposure to weather without failure.

1.03 SUBMITTALS

- A. Product Data: For each type of roofing material indicated.

- B. Shop Drawings: Show locations and extent of roofing. Include plans, sections, details, and attachments to other Work, for substrate joints and cracks, flashing sheets, roof penetrations, inside and outside corners, vertical intersections, roof slope, expansion joints, and membrane terminations.
 - 1. Show locations, extent, and details of roof pavers.

- C. Samples for Verification: For each of the following products:
 - 1. 12-by-12-inch300-by-300-mm square of flashing sheet.
 - 2. 12-by-12-inch300-by-300-mm square of board insulation.
 - 3. 10 lb4.5 kg of aggregate ballast in gradation indicated.
 - 4. Roof paver, full sized, in each color and texture required.

- D. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

- E. Qualification Data: For Installer.

- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for current formulation of self-adhering modified bituminous membrane roofing.

- G. Research/Evaluation Reports: For self-adhering modified bituminous membrane roofing.

- H. Maintenance Data: For roofing system to include in maintenance manuals.
- I. Warranties: Draft of special warranty specified in this Section.
- J. Inspection Report for Information: Copy of roofing system manufacturer's inspection report of completed roofing membrane.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain roofing membrane materials through one source from a single manufacturer.
- C. Fire-Test-Response Characteristics: Provide self-adhering modified bituminous membrane roofing with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Exterior Fire-Test Exposure: Class A; complying with ASTM E 108, for application and slopes indicated.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original containers with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
 - 1. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
- B. Protect roofing insulation materials from damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Apply roofing within the range of ambient and substrate temperatures recommended by roofing system manufacturer. Do not apply roofing to a damp or wet substrate.
 - 1. Do not apply roofing in snow, rain, fog, or mist.

1.07 WARRANTY

- A. Special Roofing Membrane Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace roofing that does not remain watertight and base flashing that does not remain watertight or that splits, tears, or separates at seams or from substrate within specified warranty period.
 - 1. Warranty also includes board insulation and roof pavers.

2. Warranty does not include failure of roofing membrane due to formation of new joints and cracks in roof deck in excess of 1/16 inch 1.6 mm wide.
3. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2.02 ROOFING MEMBRANE

- A. Self-Adhering Modified Bituminous Roofing Membrane: 50-mil-1.3-mm- thick, minimum, sheet consisting of 46 mils 1.2 mm, minimum, of rubberized asphalt laminated to a 4-mil-0.10-mm- thick, cross-laminated, high-density polyethylene film; with release liner on adhesive side.
 1. Physical Properties: As follows, measured per standard test methods referenced:
 - a. Tensile Strength (Membrane): 250 psi 1.7 MPa minimum; ASTM D 412, Die C, modified.
 - b. Ultimate Elongation: 250 percent minimum; ASTM D 412, Die C, modified.
 - c. Pliability: Pass at minus 25 deg F minus 32 deg C; ASTM D 146.
 - d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch 3-mm movement; ASTM C 836.
 - e. Puncture Resistance: 40 lbf 180 N minimum; ASTM E 154.
 - f. Water Absorption: 0.15 percent weight-gain maximum after 48-hour immersion at 70 deg F 21 deg C; ASTM D 570.
 2. Underlayment Membrane: Self-leveling, two-component, elastomeric, cold fluid-applied modified urethane.

2.03 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
 1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdiction.
- B. Concealed Flashing Membrane: Self-adhering, rubberized-asphalt composite sheet of same material, construction, and thickness as roofing membrane.
- C. Metal Counterflashing: Metal counterflashing is specified in Division 7 Section "Sheet Metal Flashing and Trim."
- D. Liquid Membrane: Trowel grade, two-component, elastomeric, cold fluid-applied urethane.
- E. Mastic and Sealant: Liquid mastic and sealant recommended by manufacturer.
- F. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum termination bars, approximately 1 by 1/8 inch 25 by 3 mm thick; with anchors.

- G. Fabric Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric mat; water permeable and resistant to UV-light degradation; of type and weight recommended by insulation manufacturer for application.

2.04 INSULATION

- A. Board Insulation: ASTM C 578; extruded polystyrene, of type, minimum density, and minimum compressive strength indicated below; fabricated with rabbeted edges and with one side having ribbed drainage channels:
1. Type VI, 1.8 lb/cu. ft. 29 kg/cu. m and 40 psi 276 kPa. Retain paragraph and selected subparagraph below if mortar-faced, extruded-polystyrene roofing insulation is required.
- B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Board Insulation:
 - a. Diversifoam Products.
 - b. Dow Chemical Company (The).
 - c. Owens Corning.
 - d. Tenneco Building Products.

2.05 AGGREGATE BALLAST

- A. Aggregate Ballast: Washed, crushed stone or smooth stone that will withstand weather exposure without significant deterioration and will not contribute to membrane degradation. Provide one of the following sizes in accordance with applicable wind load design:
1. Size: ASTM D 448, Size 5, ranging in size from 1/2 to 1 inch 13 to 25 mm.
 2. Size: ASTM D 448, Size 4, ranging in size from 3/4 to 1-1/2 inches 19 to 38 mm.
 3. Size: ASTM D 448, Size 2, ranging in size from 1-1/2 to 2-1/2 inches 38 to 63 mm.

2.06 ROOF PAVERS

- A. Roof Pavers: Heavyweight, hydraulically pressed, concrete units, with top edges beveled **3/16 inch 5 mm**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C 140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C 67; and as follows:
1. Size: 24 by 24 inches 600 by 600 mm. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch 1.6 mm in length, height, and thickness
 2. Weight: In accordance with wind load design.
 3. Colors and Textures: As selected by The Engineer from manufacturer's full range.
 4. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 5. Hanover Architectural Products, Inc.
 6. Rapid Building Systems.
 7. Roofblok, Ltd.
 8. Sunny Brook Pressed Concrete Co.
 9. Wausau Tile, Inc.; Terra-Paving Div.
 10. Westile Roofing Products.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions under which roofing will be applied, with Installer present, for compliance with requirements and other conditions affecting performance.
 - 1. Proceed with installation only after minimum concrete drying period recommended by roofing system manufacturer has passed.
 - 2. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for roofing application.
- B. Mask off adjoining surfaces not receiving roofing to prevent spillage from affecting other construction.
- C. Protect roof drains and other deck penetrations to prevent spillage and migration of roofing fluids.
- D. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- E. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- F. Prepare, fill, and treat joints and cracks in substrate. Remove dust and dirt from joints and cracks according to ASTM D 4258.
 - 1. Install roofing membrane strip and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch 1.6 mm.
- G. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through roofing and at drains and protrusions.

3.03 ROOFING MEMBRANE INSTALLATION

- A. Install roofing membrane according to roofing membrane manufacturer's written instructions.
- B. Install fluid-applied underlayment membrane to substrate over area to receive roofing membrane and base flashing. Spread over roof deck to form a uniform, seamless membrane, average 60 mils 1.5 mm thick, but not less than 40 mils 1 mm thick. Allow to cure for at least 24 hours before subjecting to foot traffic.
 - 1. Install fluid-applied underlayment membrane to extend beyond height of concealed flashing membrane.
- C. Install liquid-membrane beads at roof-deck-supported wall junctions. Install transition membrane strips centered over inside and outside corners and at roof terminations.

1. Install bead of liquid membrane on horizontal inside corners.
- D. Install self-adhering modified bituminous membrane roofing.
 - E. Two-Ply Application: Apply and firmly adhere membrane over underlayment membrane. Accurately align sheets and maintain uniform side laps of not less than 50 percent of sheet width to provide minimum coverage of 2 thicknesses of membrane. Maintain uniform 6-inch-150-mm- wide end laps. Overlap and roll seams and stagger end laps. Seal T-joints at end laps of top ply.
 - F. Apply membrane from low point to high point of roof deck to ensure that side laps shed water.
 - G. Repair tears, voids, and lapped seams in roofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with roofing membrane extending 6 inches150 mm beyond repaired areas in all directions.
 - H. Correct deficiencies in or remove roofing membrane that does not comply with requirements, repair substrates, reapply roofing membrane, and repair flashing sheets.

3.04 FLASHING INSTALLATION

- A. Install concealed flashing membrane at terminations, at roof edges, and at penetrations through roofing membrane, according to roofing membrane manufacturer's written instructions.
- B. Install concealed flashing membrane and extend up walls or parapets a minimum of 8 inches200 mm above insulation.
- C. Install termination bars and mechanically fasten to top of concealed flashing membrane at terminations and perimeter of roofing.
- D. Seal junction of roofing membrane and concealed flashing membrane with mastic or sealant fillets.

3.05 INSULATION INSTALLATION

- A. Loosely lay board insulation units over roofing membrane, with long joints of insulation in continuous straight lines and with end joints staggered between rows. Abut edges and ends between units.
- B. Install one or more layers of insulation to achieve required thickness over roofing membrane. Cut and fit to within 3/4 inch19 mm of projections and penetrations.
- C. Install fabric mat over insulation, overlapping edges and ends at least 12 inches300 mm. Do not lap ends of fabric sheets within 72 inches1800 mm of roof perimeter. Extend fabric 2 to 3 inches50 to 75 mm above ballast at perimeter and penetrations. Apply additional layer of fabric around penetrations to prevent aggregate from getting between penetration and insulation. Do not cover drains or restrict water flow to drains.

3.06 BALLAST INSTALLATION

- A. Apply ballast uniformly over fabric mat at rate required by insulation manufacturer, but not less than the following, carefully spreading aggregate to minimize possibility of damage to membrane. Apply ballast as insulation is installed, leaving roofing membrane insulated and ballasted at end of workday. Provide one of the following in accordance with wind load design:
1. Ballast: 15 lb/sq. ft.75 kg/sq. m, Size 5 aggregate within 48 inches1200 mm of roof perimeter and 24 inches600 mm of roof penetrations; 10 lb/sq. ft.50 kg/sq. m, Size 5 aggregate elsewhere.
 - a. Install one row of roof pavers in lieu of aggregate ballast to roof perimeter and penetrations.
 2. Ballast: 15 lb/sq. ft.75 kg/sq. m, Size 4 aggregate within 48 inches1200 mm of roof perimeter and 24 inches600 mm of roof penetrations; 12 lb/sq. ft.60 kg/sq. m, Size 4 aggregate elsewhere.
 3. Ballast: 12 lb/sq. ft.60 kg/sq. m, Size 4 aggregate to field of roof; lay 2 rows of roof pavers at roof perimeters and penetrations according to insulation manufacturer's written instructions.
 4. Ballast: 15 lb/sq. ft.75 kg/sq. m, Size 2 aggregate within 48 inches1200 mm of roof perimeter and 24 inches600 mm of roof penetrations; 13 lb/sq. ft.65 kg/sq. m, Size 2 aggregate to field of roof; lay 3 rows of roof pavers to corners of roof according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to first row of corner edge roof pavers.
 5. Ballast: 13 lb/sq. ft.65 kg/sq. m, Size 2 aggregate to field of roof; lay 3 rows of concrete pavers at roof perimeter, corners, and penetrations according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to first row of perimeter and corner edge roof pavers.
 6. Ballast: 15 lb/sq. ft.75 kg/sq. m, Size 2 aggregate within 24 inches600 mm of roof penetrations; 13 lb/sq. ft.65 kg/sq. m, Size 2 aggregate to field of roof; lay 4 rows of roof pavers along roof perimeter and at corners according to insulation manufacturer's written instructions. Mechanically fasten securement strapping to first two rows of perimeter and corner edge roof pavers.
 7. Walkway Pavers: Lay roof-paver walkways using roof pavers of size indicated or, if not indicated, of manufacturer's standard size.

3.07 ROOF-PAVER INSTALLATION

- A. Lay roof-paver ballast according to insulation manufacturer's written instructions.
1. Install roof pavers on pedestals set according to pedestal manufacturer's written instructions.

3.08 FIELD QUALITY CONTROL

- A. Engage a qualified testing agency to observe flood tests and to determine and report leaks.
- B. Flood Testing: Flood test each roof deck area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing, but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
1. Flood to an average depth of 2-1/2 inches65 mm with a minimum depth of 1 inch25 mm and not exceeding a depth of 4 inches100 mm. Maintain 2 inches50 mm of

clearance from top of base flashing. Water depth not to exceed load capacity of roof deck.

2. Flood each area for 24 hours.
 3. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installation is watertight.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion of roofing membrane and flashing.
1. Notify The Engineer 48 hours in advance of date and time of inspection.
- D. Correct deficiencies in or remove roofing that does not comply with requirements, repair substrates, reapply roofing, and repair flashing.
1. After flood tests, repair leaks and make further repairs until roofing installation is watertight.
- E. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with requirements.

3.08 PROTECTING AND CLEANING

- A. Protect roofing according to manufacturer's written recommendations to prevent damage and wear during application and remainder of construction period.
- B. Protect installed insulation from damage due to UV-light exposure, physical abuse, and other causes. Provide temporary coverings where insulation will be subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07600

FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing miscellaneous-waterproofing sheet metal including metal flashings, copings, exposed trim, fasciae, gravel stops, reglets, scuppers, gutters and downspouts, conductor heads, splash pans, drip edges, roof and roof-to-wall expansion joint covers, shower pans, overhead piping safety pans, metal accessories, gutter screens, strainers, red-rosin paper, solder, and related nailing strips and miscellaneous wood supports.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Brick Masonry: Section 04215.
- B. Concrete Unit Masonry: Section 04220
- C. Rough Carpentry: Section 06100.
- D. Seals and Sealants: Section 07900.
- E. Roof Accessories: Section 07730.
- F. Built-up Roofing: Section 07515.

1.03 PERFORMANCE REQUIREMENTS:

- A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.
- B. Fabricate and install flashings at roof edges to comply with recommendations of FM Loss Prevention Data Sheet 1-49 for the following wind zone:
 - 1. Wind Zone 3: Wind pressures of 46 to 104 psf.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.
- B. Shop Drawings:
 - 1. Show both shop-fabricated and site-fabricated work, indicating where each item is fabricated. Include complete details of joints, supports and fasteners, in accordance with SMACNA Architectural Sheet Metal Manual standard details where applicable.
 - 2. Show dimensions and locations of wood nailing strips, miscellaneous wood supports and details of installation.
 - 3. Fabricated Masonry Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples: Three of each type of the following materials used in the work:
 - 1. Stainless steel: 12 inches square.
 - 2. Bituminous paint: Pint containers.

3. Aluminum coping: 12-inch by 12-inch corner section.
4. Stainless steel coping: 12-inch by 12-inch corner section.
5. Reglets: 12-inch strips.
6. Expansion-joint cover: 12-inch strips.
7. Downspout and gutter: 12-inch length with anchor strap.
8. Copper-Laminated Flashing: 12 inches square.
9. Coil-coated galvanized steel: 12 inches square.
10. Metal accessories.

D. Certification.

1.05 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. SMACNA: Architectural Sheet Metal Manual.
 3. FS: QQ-L-201, UU-B-790.
 4. AAMA: 606.1.
 5. NRCA: Roofing and Waterproofing Manual.
 6. ASTM: A167, A755, B32, B101, B209, B221, B370.
 7. UL: 580 for Class 90 wind-uplift resistance.
 8. FM: Loss Prevention Data Sheet 1-49.
 9. Copper Development Association: Copper in Architecture Handbook.
- B. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to jobsite in original unopened containers clearly marked with manufacturer's name and brand designation, reference specification number, type and class as applicable.
- B. Store products in approved dry area and protect from contact with soil and exposure to the elements. Keep products dry.
- C. Handle products so as to prevent breakage of containers and damage to products.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Stainless Steel:
1. Through-wall flashing (mechanically keyed) sheets: ASTM A167, Type 304, soft annealed, minimum thickness 0.012 inch.
 2. Fascia, exposed trims, reglets, roof drain flashings, base flashings, counterflashings, flashing receivers, valley flashings, drip edges, eave flashings, equipment support flashings, roof penetration flashings, roof expansion joint covers, scuppers:

- ASTM A167, Type 304, hard tempered, minimum thickness 0.0187 inch, unless otherwise shown or indicated.
3. Copings, gravel stops, and roof-to-wall expansion joint covers: ASTM A167, Type 304, hard tempered, minimum thickness 0.025 inch, unless otherwise shown or indicated.
 - a. Backing or stiffeners required to prevent oil-canning and waviness.
 - b. Finish: No. 2D.
- B. Coil-Coated Galvanized Steel Sheet:
1. Zinc-coated, commercial quality steel sheet with thickness as specified below conforming to ASTM A755, G90 coating designation, coil coated with high-performance fluoropolymer coating of not less than 1 mil thick (0.2 mil primer and 0.8 mil fluoropolymer) each side, unless otherwise specified.
 2. Counter flashings and flashings receivers: Minimum thickness of steel sheet 0.0217 inch, unless otherwise shown or indicated.
 3. Fasciae, trims, drip edges, eave flashings, base flashings, valley flashings, and equipment support flashings: Minimum thickness of steel sheet 0.0276 inch, unless otherwise shown or indicated.
 - a. Backing or stiffeners for fasciae and trims required to prevent oil-canning and waviness.
- C. Aluminum:
1. Extruded anodized fasciae, exposed trims, copings and gravel stops: ASTM B221, Alloy 6063-T52, minimum thickness 0.125 inch.
 2. Alloy sheet anodized scuppers, roof expansion joint covers, and roof-to-wall expansion joint covers: ASTM B209, Alloy 5005-H14, minimum thickness 0.050 inch.
 3. Alloy sheet anodized drip edges, eave flashings, base flashings, counterflashings, and flashing receivers: ASTM B209, Alloy 5005-H14, minimum thickness 0.040 inch.
 4. Finish: Class I color anodized finish with anodic layer thicker than 0.7 mil, dark bronze color, per AAMA 606.1, Guide Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.
- D. Lead:
1. Flashing for plumbing vents:
 - a. Sheet lead, FS QQ-L-201, minimum 2-1/2 pounds per square foot.
- E. Miscellaneous Items:
1. Red-rosin paper:
 - a. FS UU-B-790, Type I, Style 1b, 5 lb/sq., sized building paper.
 2. Vinyl tape: As recommended by the metal product manufacturer as a dissimilar metal separator.
 3. Wood blocking: Section 06100.
 4. Bituminous Paint: As recommended by the manufacturer as a dissimilar metal separator.
 5. Solder: ASTM B32, with flux-core; of the following solder alloys. Use another alloy if it is demonstrated to the Engineer that better results, including visual as applicable, can be achieved on the particular metals being joined.
 - a. For stainless steel: Tin/silver solder, Alloy Grade Sn96, with acid flux of type recommended by stainless steel manufacturer.
 - b. For copper: 50-50 tin/lead solder, Alloy Grade Sn50, with rosin flux. For lead-coated copper: 60-40 tin/lead solder, Alloy Grade Sn60, with rosin flux.
 6. Sealant:

- a. Elastomeric: Section 07900.
 - b. Epoxy Seam Sealer: Two-part, non-corrosive, aluminum seam-cementing compound as recommended by aluminum manufacturer for exterior and interior non-moving joints including riveted joints.
 - c. Mastic Sealant: Polyisobutylene, nonhardening, nonskinning, nondrying, nonmigrating sealant.
- 7. Metal Accessories and Fasteners: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching, matching finish of exposed heads, or compatible with material being installed as approved; noncorrosive; size and thickness required for performance per approved samples.
 - 8. Gutter Screen: 1/4-inch non-corrosive hardware cloth installed in sheet metal frames.
 - 9. Adhesives: Type recommended by flashing sheetmetal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheetmetal.
 - 10. Roofing Cement: ASTM D4586, Type I, asbestos free, asphalt based.
 - 11. Asphalt Mastic for under flashing receivers and counterflashing and paint on lap seams and base flashing: SSPC-Paint 12, solvent-type mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry-film thickness per coat.

2.02 FABRICATION, GENERAL:

- A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.
- B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
- C. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
- D. Expansion Provisions: Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in the Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints or intermeshing hooked flanges, not less than one-inch deep, filled with mastic sealant (concealed within the joints).
- E. Fabricate nonmoving joints with flat-lock seams. For tin edges to be seamed, form seams and solder. For aluminum to be seamed, form seams and seal with epoxy seam sealer and rivet joints for additional strength as approved.
- F. Sealed joints: Form movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
- G. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
- H. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.

1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.03 SHEETMETAL FABRICATIONS:

- A. Downspout: Plain, rectangular, lead-coated copper in accordance with SMACNA Architectural Sheet Metal Manual standards, unless otherwise shown.
- B. Gutters: Lead-coated copper in accordance with SMACNA standards.
- C. Gutter Screen: Fabricate screen and frame of approved material
- D. Reglets:
 1. Stainless steel or lead-coated copper, matching flashing material, closed-slot, friction-type.
- E. Roof and Wall-to-Roof Expansion Joint Covers:
 1. Combination of neoprene and lead-coated copper or stainless steel, with the following additional requirements:
 - a. Cover with neoprene bonded to metal edgings by means of neoprene-based adhesive comprising primer and vulcanizing cement to produce high-strength bond.
 - b. For neoprene part of cover, cured neoprene sheet, tensile strength 1,500-psi minimum, elongation 250-percent minimum, bonded to metal with peel-pull value of 25 pounds per inch minimum at right angles; thickness and width as shown.
 - c. Edgings of metal cover, four inches wide, perforated with holes four inches on centers minimum.
- F. Coping and Gravel Stops:
 1. Extruded aluminum or stainless steel, assemblies tested for wind-uplift resistance in accordance with UL 580 for Class 90-uplift resistance, or greater as required by jurisdictional authority, with testing performed by testing agency acceptable to the Engineer.
 - a. Size: 10-foot long sections, with factory-fabricated corners and intersections, formed with no visible fasteners.
 - b. Movement joint design: Incorporate a waterproof seal using an internal weep system and rubber or vinyl seals into the non-welded joints.
 - c. Fasteners and clips: As standard with the manufacturer for required wind-uplift resistance. Where exposed, finish to match the metal finish.
- G. Flashing for Plumbing Vents:
 1. Lead, sized to extend at least four inches horizontally on roof around pipe, over pipe, and one-inch inside pipe.
- H. Strainer:
 1. Stainless-steel, 12-gauge wires spaced not greater than 1/2-inch apart, as shown and as approved.
- I. Miscellaneous-waterproofing sheetmetal flashings, fasciae, trims, drip edges, scuppers, conductor heads, shower pans, splash pans, and overhead piping safety pans:
 1. Fabricated from material as previously specified, sized as shown and as approved.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Clean dirt, debris, grease, oil and other foreign substances from surfaces that are to receive metalwork. Coordinate with work of other Sections: 04215, 04220, 07411, and 07730.

3.02 INSTALLATION:

- A. Coordinate flashing and sheet metal with the work of other trades. Shop-fabricate the work whenever possible. Provide for expansion and contraction of sheet metal.
- B. Install the work of this Section in accordance with the NRCA Roofing and Waterproofing Manual, performance requirements, manufacturers' instructions and SMACNA's Architectural Sheet Metal Manual. Anchor units securely in place by methods indicated and conceal fasteners where possible. Set units true to line and level with exposed edges folded back to form hems. Install exposed sheetmetal without excessive oil canning, buckling and tool marks. Verify shapes and dimensions of surfaces to be covered prior to fabrication and trim to fit substrates. Install work with laps, joints and seams that will be permanently watertight and weatherproof. Provide for thermal expansion of metal units. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges not less than one-inch deep and fill with mastic sealant concealed within joints. Form nonexpansion joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant. Use joint adhesive for non-moving joints specified not to be soldered. Fabricate non-moving seams in sheetmetal with flat-lock seams, except fabricate non-moving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints as approved for additional strength.. Tin edges to be seamed, form seams and solder.
- C. Perform cutting, drilling and other operations in connection with sheet metal work to accommodate work of other trades. Provide accessories as recommended by SMACNA Architectural Sheet Metal Manual.
- D. Where sheet metal abuts or interfaces with adjacent materials, join as shown on approved shop drawings. Isolate dissimilar metals by use of compatible coatings or other approved methods. Apply red-rosin paper backing for sheet metal applied to any surface to permit movement caused by expansion or to prevent galvanic action.
- E. Soldering:
 - 1. Clean surfaces to be soldered to remove oils and foreign matter. Brush liberal amount of flux on seams, solder immediately, neutralize acid and clean.
 - 2. Solder slowly, thoroughly heating seam and completely sweating solder through full width of seam. Use ample solder for full width along seams.
 - 3. Do not solder aluminum and coil-coated galvanized steel sheet. Pre-tinning is not required for lead and lead-coated copper. Do not use torches for soldering, heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
- F. Seams:

1. Flat lock: 3/4-inch wide, minimum.
 2. Solder lap: One-inch wide, minimum
 3. Unsoldered plain lap: Three-inches wide, minimum.
 4. Seams: Corresponding to direction of flow.
- G. Form flashings from material shown or specified made up from sheets eight to 10 feet long with locked and soldered seams into units of not more than 16 feet. Join units together with three-inch wide loose-locked seams filled with sealant before units are joined. Runs of flashing shorter than 16 feet will not require loose-seam joints. Miter corners and join by locked and soldered joints.
- H. Install expansion-joint covers as indicated and in accordance with manufacturer's recommendations. Splice ends of adjoining lengths of covers with neoprene tabs applied to both faces with approved adhesive. Provide prefabricated corners, intersections and crossovers.
- I. Form cap flashing at parapet walls and other vertical surfaces to extend into metal reglets built into structure and prefilled with sealant. Lap built-up roof flashings and form metal to provide spring action against roof flashings. Prior to installation, coat flashing portions to be concealed with bituminous paint.
- J. Where cants do not occur at intersections of roof decks and vertical surfaces of walls and other construction, provide flashings. Extend base flashings up vertical surfaces eight inches unless otherwise shown, behind metal cap flashing and out onto roof or horizontal surface not less than eight inches. Coat back sides of base flashing with bituminous paint and set into angle formed by roof and vertical surfaces after three plies of roofing-felt reinforcement have been laid. Nail flange with nails spaced three inches on centers and 3/4-inch from edge into wooden nailer provided in roof slab. Secure metal flashing at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.
- K. Reglets: Form reglets to reproduce detail and design shown. Form sharp, even and true profiles, bends and intersections. Lock or lap joints and solder or reinforce joints as shown on approved shop drawings or specified. Install reglets to receive counterflashings: Furnish reglets for installation under Division 3 concrete and under Division 4 masonry.
- L. Coping: Install coping in accordance with manufacturer's recommendations. Locate fasteners and clips as follows:
1. At joints and at five-foot maximum intervals.
 2. Center butt joints over anchor clips.
 3. Secure in place allowing for thermal expansion and establishing watertight joint.
- M. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashing. Install counterflashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counterflashing joints a minimum of 2 inches and bed with sealant.
- N. Roof-Drainage System: Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the item manufacturer, to drain roof in the most efficient manner. Coordinate roof-drain flashing installation with roof-drainage system installation. Coordinate flashing and sheet metal items for steep-sloped roofs with roofing installation. Install strainer at top of downspout.

- O. Equipment Support Flashing: Coordinate equipment support flashing installation with roofing and equipment installation. Weld or seal flashing to equipment support member.
- P. Roof-Penetration Flashing: Coordinate roof-penetration flashing installation with roofing and installation of items penetrating roof. Install flashing as follows:
 - 1. Turn flashing down inside vent piping, being careful not to block vent piping with flashing.
 - 2. Seal and clamp flashing to pipes penetrating roof, other than lead flashing on vent piping.
- Q. Install continuous gutter screens on gutters with noncorrosive fasteners, arranged as hinged units to swing open for cleaning gutters.
- R. Overhead-Piping Safety Pan: Suspend pans from pipe and install drain line to plumbing waste or drain line.
- S. Splash Pans: Install where downspouts discharge on low-sloped roofs, unless otherwise shown. Set in roof cement or sealant compatible with roofing material.
- T. Install sealant in accordance with Section 07900.
- U. Install wood blocking in accordance with Section 06100.

3.03 CLEAN-UP:

- A. Clean up rubbish and debris caused by this work and remove from site.
- B. Promptly remove drippings and stains of materials from exposed surfaces.
- C. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION

SECTION 07730

ROOF ACCESSORIES

PART1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing roof hatches, equipment supports, roof vents, snow guards and miscellaneous roof accessories.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Rough Carpentry: Section 06100.
- B. Seals and Sealants: Section 07900.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other Work.
- C. Coordination Drawings: Roof plans drawn to scale and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples in manufacturer's standard sizes, and of same thickness and material indicated for the Work. If finishes involve normal color or shade variations, include sample sets showing the full range of variations expected. Provide a mock-up of custom-fabricated items
- E. Certification.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NRCA: Roofing and Waterproofing Manual.
 - 3. SMACNA: Architectural Sheet Metal Manual.
 - 4. ASTM: A653, A729, A780, B209, B221, C920, C1036, D256, D4586, E527.
 - 5. UL 793, 972.
 - 6. SSPC - Paint 12
 - 7. NFPA: 204M.
 - 8. NAAMM.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to jobsite in original unopened containers clearly labeled with manufacturer's name and brand designation, type, class and rating as applicable.

- B. Store products in approved dry area and protect from contact with soil and from exposure to the elements.
- C. Handle products to prevent breakage of containers and damage to products.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL:

- A. Aluminum Sheet: ASTM B 209 for alclad alloy 3005H25 or alloy and temper required to suit forming operations, with mill finish, unless otherwise indicated
- B. Extruded Aluminum: ASTM B 221 alloy 6063-T52 or alloy and temper required to suit structural and finish requirements, with mill finish, unless otherwise indicated
- C. Galvanized Steel Sheet: ASTM A 653 with G90 coating designation; commercial quality, unless otherwise indicated.
 - 1. Structural Quality: Grade 40, where indicated or as required for strength.
- D. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792 with Class AZ-50 coating, structural quality, Grade 40, or as required for strength.
- E. Plastic Sheet: Unless additional thickness is required for light transmittances, provide glazing plastic sheet thickness required for 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loading pressures as recommended by the manufacturer for the size and shape indicated.
 - 1. Polycarbonate: Thermoformable, monolithic polycarbonate sheets manufactured by the extrusion process, burglar-resistance rated per UL 972 with average impact strength of 16 ft-lbf/in. of width when tested according to ASTM D 256, Method A (Izod)
- F. Insulation: Manufacturer's standard rigid or semirigid glass-fiber board of thickness indicated.
- G. Wood Nailers: Not less than 1-1/2 inches thick complying with Section 06100.
- H. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.
 - 1. Where removing exterior exposed fasteners affords access to building, provide nonremovable fastener heads.
- I. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.
- J. Bituminous Coating: SSPC-Paint 12, solvent-type bituminous mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry film thickness per coating.
- K. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
- L. Elastomeric Sealant: Generic type recommended by unit manufacturer that is compatible with joint surfaces; ASTM C 920, Type S, Grade NS, Class 25, and Uses NT, G, A, and, as applicable to joint substrates indicated, O and in accordance with Section 07900.
- M. Roofing Cement: ASTM D 4586, nonasbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

2.02 ROOF CURBS AND EQUIPMENT SUPPORTS:

- A. General: Provide roof curbs capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
- B. Fabrication: Unless otherwise indicated or required for strength, fabricate units from minimum 0.0747-inch thick, structural-quality, hot-dip galvanized or aluminum-zinc alloy-coated steel sheet; factory primed and prepared for painting with welded or sealed mechanical corner joints.

2.03 ROOF HATCHES:

- A. General: Fabricate units to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loading pressure. Frame with minimum 9-inch- high, integral-curb, double-wall construction with 1-1/2-inch insulation, formed cants and cap flashing (roofing counterflashing), with welded or sealed mechanical corner joints. Provide double-wall cover (lid) construction with 1-inch-thick insulation core. Provide gasketing and equip with corrosion-resistant or hot-dip galvanized hardware including pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles.
- B. Type: Single-leaf personnel access.
 - 1. For Ladder Access: 30 by 36 inches.
 - 2. For Ship's Ladder Access: 30 by 54 inches.
 - a. For Stair Access: 30 by 102 inches.
- C. Type: Double leaf for equipment access.
 - 1. Size: 72 by 96 inches.
- D. Material and Finish: Galvanized steel, baked enamel.
- E. Sloping Roofs: Where slope or roof deck exceeds 1/4 inch per foot (1:48), fabricate hatch curbs with height tapered to match slope to level tops of units.

2.04 SMOKE VENTS:

- A. General: Automatically operated roof vents for heat and smoke constructed to operate (open) without power source that could be interrupted during a fire. Custom fabricate units only to extent necessary to comply with indicated dimensions and other special requirements.
- B. Live Load and Uplift: Unless otherwise indicated, fabricate to withstand a minimum 10-lbf/sq. ft. external live load and 30-lbf/sq. ft. uplift.
- C. Regulatory Requirements: Comply with provisions of the following:
 - 1. UL 793, for construction and performance of automatically operated roof vents for heat and smoke
 - 2. NFPA 204M, for heat-and-smoke vent design constraints, operation, size, and location.\
- D. Framing: Fabricate from the following materials, with manufacturer's standard welded or sealed mechanical corner joints, including cap flashing (roofing counterflashing):
 - 1. Material: Formed sheet or extruded aluminum or galvanized steel, at Contractor's option
 - a. Finish: Baked enamel.
 - b. Finish: High-performance organic coating.
 - 2. Unit Support: Double-wall curb construction with 1-inch insulation, of height indicated or, if not indicated, for mounting with height minimum 9 inches above roof membrane.
 - a. Provide formed cants and base profile coordinated with roof type and insulation thickness.

3. Sloping Roofs: Where slope of roof deck exceeds 1/4 inch per foot(1:48), fabricate curbs with height tapered to match slope to level tops of units.
- E. Dome-Type Units: Manufacturer's standard gravity-opened, shrink-back and drop-out, acrylic or PVC sheet, dome unit for 165 deg F activation. Provide glazing system for easy replacement of activated domes and for drainage of condensation to exterior.
1. Inner Double-Dome Color: Bronze.

2.05 SNOWGUARDS:

- A. L-shaped stop-type, metal or plastic.
- B. Provide in accordance with approved mock-up sample.

2.06 FINISHES, GENERAL:

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 ALUMINUM FINISHES:

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below).
 1. Organic Coating: Air-dried primer of not less than 2.0-mil0.5-mm dry film thickness.
- C. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting. Below references AAMA standard for pigmented organic coating on extrusions. Color as selected by the Authority's representative.
- D. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 1. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight. Color as selected by the Authority's representative.

2.08 GALVANIZED STEEL SHEET FINISHES:

- A. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- B. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Comply with manufacturer's written instructions. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weather tight. Anchor roof accessories securely to supporting structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures
- B. Install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual," unless otherwise indicated,
- C. Separation: Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces, at locations of contact, with bituminous coating or providing other permanent separation.
- D. Flange Seals: Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.
- E. Cap Flashing: Where required as component of accessory, install cap flashing to provide waterproof overlap with roofing or roof flashing (as counterflashing). Seal overlap with thick bead of mastic sealant.
- F. Operational Units: Test-operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.
- G. Heat-and-Smoke Vents: Locate, install, and test according to NFPA 204M.
- H. Install wood nailers in accordance with Section 06100.
- I. Install sealants in accordance with Section 07900.
- J. Adhere snow guards to sheetmetal roofing by approved silicone sealant as specified in Section 07900. Locate and space snow guards in accordance with manufacturer's recommendations. Where snow guards are located on standing seams, provide approved mechanical fastenings.

3.02 CLEANING AND PROTECTION:

- A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION

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SECTION 07811

SPRAYED FIRE-RESISTIVE MATERIALS

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This Section includes concealed SFRM, exposed SFRM, and exposed intumescent mastic fire-resistive coating.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. List below only products, construction, and equipment that the reader might expect to find in this Section but are specified elsewhere.
- B. Division 5 Section "Structural Steel" for surface conditions required for structural steel receiving SFRM.
- C. Division 7 Section "Building Insulation" for fire-safing insulation.
- D. Division 7 Section "Board Fire Protection" for mineral-fiber-board fire protection.
- E. Division 7 Section "Through-Penetration Firestop Systems" for fire-resistance-rated firestopping systems.
- F. Division 7 Section "Fire-Resistive Joint Systems" for fire-resistance-rated joint systems.
- G. Division 9 Section "Intumescent Paints" for intumescent paints that are not fire resistive.

1.03 DEFINITIONS

- A. SFRM: Sprayed fire-resistive material.
- B. Concealed: Fire-resistive materials applied to surfaces that are concealed from view behind other construction when the Work is completed and have not been defined as exposed.
- C. Exposed: Fire-resistive materials applied to surfaces that are exposed to view when the Work is completed, that are accessible through suspended ceilings, that are in elevator shafts and machine rooms, that are in mechanical rooms, that are in air-handling plenums, and that are identified as exposed on Drawings.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Structural framing plans indicating the following:
 - 1. Locations and types of surface preparations required before applying SFRM.
 - 2. Extent of SFRM for each construction and fire-resistance rating, including the following:
 - a. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1) For steel joist assemblies, include applicable fire-resistance design designations, with each steel joist tested with the same maximum tensile stress as each steel joist indicated on Drawings or in a schedule. Design designations with steel joists tested at lower maximum tensile stress than

- those indicated are not permitted.
- b. Minimum thicknesses needed to achieve required fire-resistance ratings of structural components and assemblies.
 3. Treatment of SFRM after application.
- C. Samples for Initial Selection: For each type of colored, exposed SFRM indicated.
- D. Samples for Verification: For each type of colored, exposed SFRM, two Samples, each 4 inches (102 mm) square, of each color, texture, and material formulation to be applied. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
- E. Product Certificates: For each type of SFRM, signed by product manufacturer.
- F. Qualification Data: For manufacturer and testing agency.
- G. Compatibility and Adhesion Test Reports: From SFRM manufacturer indicating the following:
1. Materials have been tested for bond with substrates.
 2. Materials have been verified by SFRM manufacturer to be compatible with substrate primers and coatings.
 3. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for proposed SFRM.
- I. Research/Evaluation Reports: For SFRM.
- J. Field quality-control test reports.
- K. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by SFRM manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements. A manufacturer's willingness to sell its SFRM to Contractor or to an installer engaged by Contractor does not in itself confer qualification on the buyer.
- B. Source Limitations: Obtain SFRM through one source from a single manufacturer.
- C. SFRM Testing: By a qualified testing and inspecting agency engaged by Contractor or manufacturer to test for compliance with specified requirements for performance and test methods.
1. SFRMs are randomly selected for testing from bags bearing the applicable classification marking of UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Testing is performed on specimens of SFRMs that comply with laboratory testing requirements specified in Part 2 and are otherwise identical to installed fire-resistive materials, including application of accelerant, sealers, topcoats, tamping, troweling, rolling, and water overspray, if any of these are used in final application.
 3. Testing is performed on specimens whose application the independent testing and inspecting agency witnessed during preparation and conditioning. Include in test reports a full description of preparation and conditioning of laboratory test specimens.

- D. Compatibility and Adhesion Testing: Engage a qualified testing and inspecting agency to test for compliance with requirements for specified performance and test methods.
1. Test for bond per ASTM E 736 and requirements in UL's "Fire Resistance Directory" for coating materials. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
 2. Verify that manufacturer, through its own laboratory testing or field experience, has not found primers or coatings to be incompatible with SFRM.
- E. Fire-Test-Response Characteristics: Provide SFRM with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify bags containing SFRM with appropriate markings of applicable testing and inspecting agency.
1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency, FM's "Approval Guide, Building Materials," or Omega Point Laboratories Inc. Directory of Listed Building Products, Materials and Assemblies acceptable to authorities having jurisdiction, for SFRM serving as direct-applied protection tested per ASTM E 119.
 2. Surface-Burning Characteristics: ASTM E 84.
- F. Provide products containing no detectable asbestos as determined according to the method specified in 40 CFR 763, Subpart E, Appendix E, Section 1, "Polarized Light Microscopy."
- G. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Extent of Mockups: Approximately 100 sq. ft. (9 sq. m) of surface for each product indicated.
 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to SFRM including, but not limited to, the following:
1. Review products, exposure conditions, design ratings, restrained and unrestrained conditions, calculations, densities, thicknesses, bond strengths, and other performance requirements.
 2. Review and finalize construction schedule and verify sequencing and coordination requirements.
 3. Review weather predictions, ambient conditions, and proposed temporary protections for SFRM during and after installation.
 4. Review surface conditions and preparations.
 5. Review field quality-control testing procedures.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, shelf life if applicable, and fire-resistance ratings applicable to Project.
- B. Use materials with limited shelf life within period indicated. Remove from Project site and discard materials whose shelf life has expired.
- C. Store materials inside, under cover, and aboveground; keep dry until ready for use. Remove from Project site and discard wet or deteriorated materials.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply SFRM when ambient or substrate temperature is 40 deg F (4 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of SFRM. Use natural means or, if they are inadequate, forced-air circulation until fire-resistive material dries thoroughly.

1.08 COORDINATION

- A. Sequence and coordinate application of SFRM with other related work specified in other Sections to comply with the following requirements:
 - 1. Provide temporary enclosure as required to confine spraying operations and protect the environment.
 - 2. Provide temporary enclosures for applications to prevent deterioration of fire-resistive material due to exposure to weather and to unfavorable ambient conditions for humidity, temperature, and ventilation.
 - 3. Avoid unnecessary exposure of fire-resistive material to abrasion and other damage likely to occur during construction operations subsequent to its application.
 - 4. Do not apply fire-resistive material to metal roof deck substrates until concrete topping, if any, has been completed. For metal roof decks without concrete topping, do not apply fire-resistive material to metal roof deck substrates until roofing has been completed; prohibit roof traffic during application and drying of fire-resistive material.
 - 5. Do not apply fire-resistive material to metal floor deck substrates until concrete topping has been completed.
 - 6. Do not begin applying fire-resistive material until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
 - 7. Defer installing ducts, piping, and other items that would interfere with applying fire-resistive material until application of fire protection is completed.
 - 8. Do not install enclosing or concealing construction until after fire-resistive material has been applied, inspected, and tested and corrections have been made to defective applications.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form, signed by Contractor and by Installer, in which manufacturer agrees to repair or replace SFRMs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Cracking, flaking, spalling, or eroding in excess of specified requirements; peeling; or delaminating of SFRM from substrates.
 - b. Not covered under the warranty are failures due to damage by occupants and Owner's maintenance personnel, exposure to environmental conditions other than those investigated and approved during fire-response testing, and other causes not reasonably foreseeable under conditions of normal use.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 CONCEALED SFRM

- A. Available Products: Subject to compliance with requirements, products that may be incorporated

into the Work include, but are not limited to, the following:

- B. Products: Subject to compliance with requirements, provide one of the following:
1. Concealed Cementitious SFRM:
 - a. Carboline Co., Fireproofing Products Div.; Pyrolite 15 High Yield.
 - b. Grace, W. R. & Co. - Conn., Construction Products Div.; Monokote Type MK-6.
 - c. Isolatak International Corp.; Cafco 300.
 - d. Southwest Vermiculite Co., Inc.; Type 5.
 - e. Carboline Co., Fireproofing Products Div.; Pyrolite 15 Blue.
 - f. Grace, W. R. & Co. - Conn., Construction Products Div.; Retro-Gard.
 - g. Isolatak International Corp.; Cafco 300 SB
 2. Concealed Sprayed-Fiber Fire-Resistive Material:
 - a. Isolatak International Corp.; Cafco Blaze-Shield II.
- C. Material Composition: Manufacturer's standard product or either of the following:
1. Concealed Cementitious SFRM: Factory-mixed, dry formulation of gypsum or portland cement binders, additives, and lightweight mineral or synthetic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.
 2. Concealed Sprayed-Fiber Fire-Resistive Material: Factory-mixed, dry formulation of inorganic binders, mineral fibers, fillers, and additives conveyed in a dry state by pneumatic equipment and mixed with water at spray nozzle to form a damp, as-applied product.
- D. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:
1. Dry Density: 15 lb/cu. ft. (240 kg/cu. m) for average and individual densities, or greater if required to attain fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."
 2. Thickness: Minimum average thickness required for fire-resistance design indicated according to the following criteria, but not less than 0.375 inch (9 mm), per ASTM E 605:
 - a. Where the referenced fire-resistance design lists a thickness of 1 inch (25 mm) or more, the minimum allowable individual thickness of SFRM is the design thickness minus 0.25 inch (6 mm).
 - b. Where the referenced fire-resistance design lists a thickness of less than 1 inch (25 mm) but more than 0.375 inch (9 mm), the minimum allowable individual thickness of SFRM is the greater of 0.375 inch (9 mm) or 75 percent of the design thickness.
 - c. No reduction in average thickness is permitted for those fire-resistance designs whose fire-resistance ratings were established at densities of less than 15 lb/cu. ft. (240 kg/cu. m).
 3. Bond Strength: 150 lbf/sq. ft. (7.2 kPa) minimum per ASTM E 736 based on laboratory testing of 0.75-inch (19-mm) minimum thickness of SFRM.
 4. Compressive Strength: 5.21 lbf/sq. in. (35.9 kPa) minimum per ASTM E 761. Minimum thickness of SFRM tested shall be 0.75 inch (19 mm) and minimum dry density shall be as specified but not less than 15 lb/cu. ft. (240 kg/cu. m).
 5. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
 6. Deflection: No cracking, spalling, or delamination per ASTM E 759.
 7. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
 8. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) in 24 hours per ASTM E 859. For laboratory tests, minimum thickness of SFRM is 0.75 inch (19 mm), maximum dry density is 15 lb/cu. ft. (240 kg/cu. m), test specimens are not prepurged by mechanically induced air velocities, and tests are terminated after 24 hours.
 9. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning

characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

- a. Flame-Spread Index: 10 or less.
 - b. Smoke-Developed Index: 0.
10. Fungal Resistance: No observed growth on specimens per ASTM G 21

2.02 EXPOSED SFRM

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- B. Products: Subject to compliance with requirements, provide one of the following:
1. Exposed Cementitious SFRM:
 - a. Carboline Co., Fireproofing Products Div.; Pyrolite 22.
 - b. Carboline Co., Fireproofing Products Div.; Pyrocrete 239.
 - c. Carboline Co., Fireproofing Products Div.; Pyrocrete 40.
 - d. Carboline Co., Fireproofing Products Div.; Pyrocrete 240 High Yield.
 - e. Carboline Co., Fireproofing Products Div.; Pyrocrete 241.
 - f. Grace, W.R. & Co. - Conn., Construction Products Div.; Monokote Type Z106G.
 - g. Grace, W.R. & Co. - Conn., Construction Products Div.; Monokote Type Z106.
 - h. Grace, W.R. & Co. - Conn., Construction Products Div.; Monokote Type Z106/HY.
 - i. Grace, W.R. & Co. - Conn., Construction Products Div.; Monokote Type Z146.
 - j. Isolatek International Corp.; Cafco 400.
 - k. Isolatek International Corp.; Fendolite M-II.
 - l. Pyrok, Inc.; Pyrok-HD.
 - m. Pyrok, Inc.; Pyrok-MD.
 2. Exposed Sprayed-Fiber Fire-Resistive Material:
 - a. Isolatek International Corp.; Cafco Blaze-Shield HP.
- C. Material Composition: Manufacturer's standard product, as follows:
1. Exposed Cementitious SFRM: Factory-mixed, dry, cement aggregate formulation; or chloride-free formulation of gypsum or portland cement binders, additives, and inorganic aggregates mixed with water at Project site to form a slurry or mortar for conveyance and application.
 2. Exposed Sprayed-Fiber Fire-Resistive Material: Factory-mixed, dry formulation of inorganic binders, mineral fibers, fillers, and additives conveyed in a dry state by pneumatic equipment and mixed with water at spray nozzle to form a damp, as-applied product.
- D. Physical Properties: Minimum values, unless otherwise indicated, or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property as follows:
1. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 22 lb/cu. ft. (352 kg/cu. m).
 2. Bond Strength: 434 lbf/sq. ft. (21 kPa) minimum per ASTM E 736.
 3. Compressive Strength: 51 lbf/sq. in. (351 kPa) minimum per ASTM E 761.
 4. Dry Density: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 39 lb/cu. ft. (625 kg/cu. m).
 5. Bond Strength: 1000 lbf/sq. ft. (48 kPa) minimum per ASTM E 736.
 6. Compressive Strength: 300 lbf/sq. in. (2067 kPa) minimum per ASTM E 761.

7. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
8. Deflection: No cracking, spalling, or delamination per ASTM E 759.
9. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
10. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) per ASTM E 859.
11. Combustion Characteristics: Passes ASTM E 136.
12. Fire-Test-Response Characteristics: Provide SFRM with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - a. Flame-Spread Index: 10 or less.
 - b. Smoke-Developed Index: 0
13. Fungal Resistance: No observed growth on specimens per ASTM G 21.
14. For exterior applications of SFRM, provide formulation listed and labeled by testing and inspecting agency acceptable to authorities having jurisdiction for surfaces exposed to exterior.

2.03 AUXILIARY FIRE-RESISTIVE MATERIALS

- A. General: Provide auxiliary fire-resistive materials that are compatible with SFRM and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: For use on each substrate and with each sprayed fire-resistive product, provide primer that complies with one or more of the following requirements:
 1. Primer's bond strength complies with requirements specified in UL's "Fire Resistance Directory" for coating materials based on a series of bond tests per ASTM E 736.
 2. Primer is identical to those used in assemblies tested for fire-test-response characteristics of SFRM per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Adhesive for Bonding Fire-Resistive Material: Product approved by manufacturer of SFRM.
- D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required to comply with fire-resistance designs indicated and fire-resistive material manufacturer's written recommendations. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive SFRM.
- E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by manufacturer of SFRM.
- F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by manufacturer of intumescent mastic coating fire-resistive material. Include pins and attachment.
- G. Sealer for Sprayed-Fiber Fire-Resistive Material: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by manufacturer of sprayed-fiber fire-resistive material.
 1. Product: Subject to compliance with requirements, provide "Caftco Bond-Seal" by Isolatak International Corp.
- H. Topcoat: Type recommended in writing by manufacturer of each SFRM for application over concealed and exposed SFRM.
- I. Cement-Based Topcoat: Factory-mixed, cementitious hardcoat formulation recommended in writing by manufacturer of SFRM for trowel or spray application over concealed and exposed

SFRM.

1. Product: Subject to compliance with requirements, provide "Hardcoat 4500" by Carboline Co.; Fireproofing Products Div. "Cafco 800" by Isolatek International Corp.
- J. Veneer-Plaster Topcoat: Factory-mixed formulation of a latex-modified, portland cement-based veneer plaster recommended in writing by manufacturer of SFRM for trowel or spray application over concealed and exposed SFRM.
1. Product: Subject to compliance with requirements, provide "Topkrete Type TK-610L" by Grace, W. R. & Co.--Conn.; Construction Products Div.
- K. Water-Based Permeable Topcoat: Factory-mixed formulation recommended in writing by manufacturer of SFRM for brush, roller, or spray application over concealed and exposed SFRM. Provide application at a rate of 60 sq. ft./gal. (1.5 sq. m/L).
1. Product: Subject to compliance with requirements, provide "Cafco Topcoat" by Isolatek International Corp.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions; with Installer present, for compliance with requirements for substrates and other conditions affecting performance of work. A substrate is in satisfactory condition if it complies with the following:
1. Substrates comply with requirements in the Section where the substrate and related materials and construction are specified.
 2. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, incompatible paints, incompatible encapsulants, or other foreign substances capable of impairing bond of fire-resistive materials with substrates under conditions of normal use or fire exposure.
 3. Objects penetrating fire-resistive material, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
 4. Substrates are not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying fire-resistive material.
- B. Verify that concrete work on steel deck has been completed.
- C. Verify that roof construction, installation of roof-top HVAC equipment, and other related work are completed.
- D. Conduct tests according to fire-resistive material manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Cover other work subject to damage from fallout or overspray of fire-resistive materials during application.
- B. Clean substrates of substances that could impair bond of fire-resistive material, including dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, and incompatible primers, paints, and encapsulants.

- C. Prime substrates where recommended in writing by SFRM manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive SFRM.
- D. For exposed applications, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of SFRM. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.03 APPLICATION, GENERAL

- A. Comply with fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and spray on fire-resistive material, as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- B. Apply SFRM that is identical to products tested as specified in Part 1 "Quality Assurance" Article and substantiated by test reports, with respect to rate of application, accelerator use, sealers, topcoats, tamping, troweling, water overspray, or other materials and procedures affecting test results.
- C. Install metal lath and reinforcing fabric, as required, to comply with fire-resistance ratings and fire-resistive material manufacturer's written recommendations for conditions of exposure and intended use. Securely attach lath and fabric to substrate in position required for support and reinforcement of fire-resistive material. Use anchorage devices of type recommended in writing by SFRM manufacturer. Attach accessories where indicated or required for secure attachment of lath and fabric to substrate.
- D. Coat substrates with bonding adhesive before applying fire-resistive material where required to achieve fire-resistance rating or as recommended in writing by SFRM manufacturer for material and application indicated.
- E. Extend fire-resistive material in full thickness over entire area of each substrate to be protected. Unless otherwise recommended in writing by SFRM manufacturer, install body of fire-resistive covering in a single course.
- F. Spray apply fire-resistive materials to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by SFRM manufacturer.
- G. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply SFRM that differs in color from that of encapsulant over which it is applied.
- H. Where sealers are used, apply products that are tinted to differentiate them from SFRM over which they are applied.

3.04 APPLICATION, CONCEALED SFRM

- A. Apply concealed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if specified in Part 2 "Concealed SFRM" Article.
- B. Apply water overspray to concealed sprayed-fiber fire-resistive material as required to obtain designated fire-resistance rating.
- C. Cure concealed SFRM according to product manufacturer's written recommendations.

- D. Apply sealer to concealed SFRM.
- E. Apply topcoat to concealed SFRM.

3.05 APPLICATION, EXPOSED SFRM

- A. Apply exposed SFRM in thicknesses and densities not less than those required to achieve fire-resistance ratings designated for each condition, but apply in greater thicknesses and densities if indicated.
 - 1. For steel beams and bracing, provide a thickness of not less than 1 inch (25 mm).
 - 2. For metal floor or roof decks, provide a thickness of not less than 1/2 inch (13 mm).
- B. Provide a uniform finish complying with description indicated for each type of material and matching Architect's sample or, if none, finish approved for field-erected mockup.
- C. Apply exposed cementitious SFRM to produce the following finish:
 - 1. Spray-textured finish with no further treatment.
 - 2. Even, spray-textured finish, produced by rolling flat surfaces of fire-protected members with a damp paint roller to remove drippings and excessive roughness.
 - 3. Skip-troweled finish with leveled surface, smoothed-out texture, and neat edges.
 - 4. Smooth, troweled finish with surface markings eliminated and edges squared.
- D. Apply exposed sprayed-fiber fire-resistive material to produce the following finish:
 - 1. Spray-textured finish.
 - 2. Sealer.
 - 3. Topcoat.
- E. Cure exposed SFRM according to product manufacturer's written recommendations.

3.06 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspection and prepare reports:
 - 1. SFRM.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
 - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- C. Tests and Inspections: Testing and inspecting of completed applications of SFRM shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with application of SFRM for the next area until test results for previously completed applications of SFRM show compliance with requirements. Tested values must equal or exceed values indicated and required for approved fire-resistance design.
 - 1. Thickness for Floor, Roof, and Wall Assemblies: For each 1000-sq. ft. (93-sq. m) area, or partial area, on each floor, from the average of 4 measurements from a 144-sq. in. (0.093-sq. m) sample area, with sample width of not less than 6 inches (152 mm) per ASTM E 605.
 - 2. Thickness for Structural Frame Members: From a sample of 25 percent of structural members per floor, taking 9 measurements at a single cross section for structural frame beams or girders, 7 measurements of a single cross section for joists and trusses, and 12 measurements of a single cross section for columns per ASTM E 605.

3. Density for Floors, Roofs, Walls, and Structural Frame Members: At frequency and from sample size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 605 or AWC Technical Manual 12-A, Section 5.4.5, "Displacement Method."
 4. Bond Strength for Floors, Roofs, Walls, and Structural Framing Members: For each 10,000-sq. ft. (929 sq. m) area, or partial area, on each floor, cohesion and adhesion from one sample of size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 736.
 - a. Field test SFRM that is applied to flanges of wide-flange, structural-steel members on surfaces matching those that will exist for remainder of steel receiving fire-resistive material.
 - b. If surfaces of structural steel receiving SFRM are primed or otherwise painted for coating materials, perform series of bond tests specified in UL's "Fire Resistance Directory." Provide bond strength indicated in referenced UL fire-resistance criteria, but not less than 150 lbf/sq. ft. (7.2 kPa) minimum per ASTM E 736.
 5. If testing finds applications of SFRM are not in compliance with requirements, testing and inspecting agency will perform additional random testing to determine extent of noncompliance.
- D. Remove and replace applications of SFRM that do not pass tests and inspections for cohesion and adhesion, for density, or for both and retest as specified above.
- E. Apply additional SFRM, per manufacturer's written instructions, where test results indicate that thickness does not comply with specified requirements, and retest as specified above.

3.08 CLEANING, PROTECTING, AND REPAIR

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
- B. Protect SFRM, according to advice of product manufacturer and Installer, from damage resulting from construction operations or other causes so fire protection will be without damage or deterioration at time of Substantial Completion.
- C. Coordinate application of SFRM with other construction to minimize need to cut or remove fire protection. As installation of other construction proceeds, inspect SFRM and patch any damaged or removed areas.
- D. Repair or replace work that has not successfully protected steel.

END OF SECTION

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SECTION 07841

FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This Section perimeter fire containment systems and specifies through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies:
1. Floors.
 2. Roofs.
 3. Walls and partitions.
 4. Construction enclosing compartmentalized areas.
 5. Smoke barriers

1.02 RELATED WORK SPECIFIED ELSEWHERE:

1. Cast-in-Place Structural Concrete: Section 03300 for construction of openings in concrete slabs and walls.
2. Division 15 Sections specifying duct and piping penetrations.
3. Division 16 Sections specifying cable and conduit penetrations.

1.03 PERFORMANCE REQUIREMENTS:

- A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.
1. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
 2. Fire-resistance-rated floor assemblies
 3. Fire-resistance-rated roof assemblies.
- B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
1. Penetrations located outside wall cavities.
 2. Penetrations located outside fire-resistive shaft enclosures.
 3. Penetrations located in construction containing fire-protection-rated openings.
 4. Penetrating items larger than 4-inch diameter nominal pipe or 16 sq. in. in overall cross-sectional area.
- D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.
 3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- E. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.

1.04 SUBMITTALS:

- A. Submit the following for approval in accordance with the Special Conditions and with the additional requirements as specified for each:
- B. Product Data: For each type of through-penetration firestop system product indicated.
- C. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- E. Certification: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

1.05 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. ASTM E 84, E 814.
 3. UL - 1479.
- B. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:

1. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to UL in Fire Resistance Directory reference to through-penetration firestop system designations listed by the following:

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.07 PROJECT CONDITIONS:

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.08 COORDINATION:

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until the Engineer has examined each installation.

PART 2 - PRODUCTS

2.01 FIRESTOPPING, GENERAL:

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use

only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.02 FILL MATERIALS:

- A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture
- D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- H. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- I. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.
- J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

- K. **Silicone Sealants:** Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
1. **Grade for Horizontal Surfaces:** Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
 2. **Grade for Vertical Surfaces:** Nonsag formulation for openings in vertical and other surfaces.

2.03 PERIMETER FIRE-CONTAINMENT SYSTEMS:

- A. Where indicated for gaps between the perimeter edge of fire-resistance-rated floor assemblies and non-fire-resistance-rated exterior curtain walls, provide a perimeter fire-containment system with the fire-test response characteristics indicated, as determined by testing identical systems per UBC Standard 26-9 and UL 2079 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

- A. **Surface Cleaning:** Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. **Priming:** Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. **Masking Tape:** Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION:

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD QUALITY CONTROL:

- A. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.05 IDENTIFICATION:

- A. In areas not exposed to public view, identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
 - 1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb."

3.06 CLEANING AND PROTECTION:

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

3.07 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE:

- A. Where UL-classified systems are indicated, they refer to the alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Firestop Systems for Metallic and Non-metallic Conduit, Tubing, Sleeves, Cable Trays and Cables:

1. UL-1479: Fire rated for 3 hours.
 2. Type of fill materials: One or more of the following:
 - a. Silicone sealant.
 - b. Intumescent putty.
 - c. Silicone foam.
- C. Firestop Systems for Insulated Pipes: Comply with the following:
1. UL- 1479: CAJ 5087.
 2. Type of Fill Materials: Intumescent putty.
- D. Firestop Systems for Miscellaneous Mechanical Penetrations: Comply with the following:
1. UL- 1479: CAS 8033.
 2. Type of Fill Materials: Mortar.
- E. Firestop Systems for Ductwork: Comply with the following:
1. UL- 1479: WJ7007.
 2. Type of Fill Materials: Intumescent sealant.

END OF SECTION

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SECTION 07900

SEALS AND SEALANTS

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing compression seals and sealants not specified elsewhere.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Expansion joint cover assemblies and systems: Sections 05811.
- B. Sealant for metal thresholds: Section 08710.
- C. Glazing sealant: Section 08800.
- D. Acoustical sealant: Section 09255.
- E. Ceramic tile sealant: Section 09320.
- F. Caulk for painting preparation: Section 09920.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM: C920, C1193, D412, D1752, D2628.
- B. Manufacturer Qualification:
 - 1. General: Provide the products of established manufacturers. Insofar as possible, provide products from a single manufacturer.
 - 2. Sealant color-selection capability: Have color-selection capability resolved early in the submittals process to prevent delay of the work.
 - a. Where sealants are exposed, provide products of a manufacturer who can match the colors of adjacent materials by either having an acceptable range of standard colors or by factory blending custom colors as acceptable to the Engineer and at no additional cost to the Authority.
 - b. Where a manufacturer's colors are insufficient for proper color-match, use acceptable colors from another acceptable manufacturer.
 - 3. On-site representation: Use only a sealant manufacturer who has a local, knowledgeable representative who can visit the project site prior to construction and at least twice during sealant installation to observe conditions and recommend solutions at no additional cost to the Authority.
- C. Design Criteria:
 - 1. Designed width of exterior joints: Joint widths indicated on drawings are shown at their designed width. This is measured when the joint would be at the average air temperature for the year, which is approximately 50F, based on an average minimum air temperature of zero degrees F and an average maximum air temperature of 100F.
 - 2. Designed width of interior joints: Joint widths indicated on the drawings are shown at their designed width at 50F.
 - 3. Joint width at time of seal or sealant application: Make joint widths at time of installation never less than the calculated width, which at 0 degrees F is 25 percent wider than the designed width and at 100F is 25 percent narrower than the designed

width for exterior joints and 1-1/2 percent smaller than the designed width for each degree the ambient temperature exceeds 50F, and 1-1/2 percent larger than the designed width for each degree the ambient temperature is less than 50F.

- a. It is recommended that seals and sealant be installed when the average daily air temperature is 50 degrees F plus or minus five degrees, when joint should be at its designed width.
 - b. If joints are less than the calculated width at the time of proposed installation, take corrective action, which may include saw cutting of joint or other remedial measures approved by the Engineer and by the seal or sealant manufacturer.
 - c. If the joint depth is not sufficient for the designed width of the joint, sealant and backup, cut out the joint to the required depth for the sealant and backup.
 - d. Perform cutting and remedial measures that are acceptable to the Engineer. Cost of cutting and remedial measures are at no additional cost to the Authority.
4. Joint size and sealant size: Except as otherwise indicated, make sealant at least 1/4-inch wide x 1/4-inch deep. In joints 3/8 inches wide, make sealant 1/4-inch deep. In joints wider than 3/8-inch and up to 1-inch wide, make sealant depth 1/2 of the joint width. For joints wider than 1 inch, make sealant depth as recommended by the sealant manufacturer.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Samples:
1. Material samples: Four of each type of the following materials used in the work:
 - a. Compression seals: 12 inches long, plus each factory-made corner unit.
 - b. Sealant and lubricant-adhesive: Half-pint containers.
 - c. Sealant colors: Fully cured beads of each color used, each six inches long.
 - d. Backup material: 12 inches long.
 - e. Joint filler: 12 inches long.
 - f. Color chips: 12 inches long, one for each color used in the work.
 2. Demonstration samples: Make demonstration installation of each seal and sealant installation type and color. Use approved materials, installed and cured as required. Remove demonstration samples as directed. Perform testing on sealant demonstration samples as specified under Field Testing.
- B. Shop Drawings:
1. General: Submit manufacturers technical product data for each product proposed to be used, together with standard and custom color-selection samples.
 2. Compression seals: Detail correct size and placement of each type and size of compression seal in its joint.
 3. Test results: Inspection and adhesion test results performed by sealant manufacturer.
- C. Certification by each manufacturer that the products provided will perform as required and will not stain adjacent materials.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to jobsite in original unopened containers clearly marked with manufacturer's name and brand designation, referenced specification number, type and class as applicable.
- B. Store products in approved dry area and protect from contact with soil and from exposure to the elements. Keep products dry.
- C. Handle products to prevent breakage of containers and damage to products.

1.06 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. Application of seals or sealants, including their related products, when ambient temperature is lower than 40F or when there is ice, frost or dampness visible on surfaces to be sealed is prohibited.
 - 2. Comply with manufacturer's environmental recommendation.

PART 2 - PRODUCTS

2.01 COMPRESSION-SEAL MATERIALS:

- A. Preformed compression seals: ASTM D2628, rectangular design unless otherwise shown.
 - 1. Width: Size compression seals for full amount of joint movement as required, plus the thickness of the compressed seal as recommended by the manufacturer.
 - 2. Corners: Provide factory pre-molded or factory pre-cut and welded corner units for angular changes in direction, vertically as well as horizontally, including 30, 60, 45, 90, 120, 135, and 150 degrees as required by joint location.
- B. Lubricant-adhesive, general: One-part moisture-curing polyurethane as recommended by compression seal manufacturer, with the following additional requirements:

Physical Property	Requirement	ASTM Test Method
Average weight per gallon	8.00 pounds plus-or-minus 10 percent	-
Solids content	65 - 74 percent by weight	-
Adhesive	Fluid from 5F to 120F	-
Film strength	1200 psi, minimum	D412
Elongation	250 percent	D412

- C. Lubricant-adhesive for compression seal in granite: Same as above, but also tested for nonstaining over a three-month period on samples of granite to be used.

2.02 SEALANT AND ACCESSORIES:

- A. General: Provide joint sealant, backup rod, primer, and other related materials that are compatible with one another and with the joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on field experience and submitted test reports.
- B. Sealant (Polyurethane): Polyurethane-based or epoxidized polyurethane based, multi-part elastomeric sealant, ASTM C920, Type M (multi-component), Class 25 (withstands an increase or decrease of 25 percent of the joint width) as follows:
 - 1. For joints in horizontal surfaces: Grade P (pourable or self-leveling), Uses T (traffic areas), M (on masonry) or O (other than standard substrates).
 - 2. For joints in sloped surfaces: Grade NS (nonsag), Uses T (traffic areas), M (on masonry) or O (other than standard substrates).
 - 3. For joints in overhead and vertical surfaces: Grade NS (nonsag), Uses NT (nontraffic areas), M (on masonry), A (on aluminum), or O (other than standard substrates).
- C. Primer: Colorless, nonstaining liquid material of types suited to each substrate surface, as tested and recommended in writing by the manufacturer of each sealant to be used.
- D. Backup Rod: Preformed, compressible, resilient, non-waxed, non-extruding, nonstaining, closed-cell rod stock of polyethylene or polyethylene-jacketed foam which will maintain a uniform round or oval cross-sectional shape when compressed into the joint.
 - 1. Select backup rods as recommended by the manufacturer of each sealant to be used; compatible with joint substrates, sealants, primers, and other joint fillers; that will not bond with sealants and primers; and are approved for applications indicated based on field experience and laboratory testing.
 - 2. Select backup rod of the sizes and shapes to suit the various conditions and at about 30 percent wider than the joint width.
 - a. Where depth of joint is too shallow for round backup rod use 1/2-round backup rod, factory manufactured with cut surface fused by heat process so that it cannot release gas.
 - b. Where depth is too shallow for 1/2-round rod, use bond breaker tape.
- E. Bond-Breaker Tape: Polyethylene tape, as recommended by the manufacturer of each sealant to be used, for preventing sealant from adhering to joint-filler materials or joint surfaces at back of joint where such adhesion would promote sealant failure, or result in less than optimal performance. Provide tape sized properly for the joint. Provide self-adhesive tape where applicable.
- F. Cleaning Agent: Joint cleaning compound tested and recommended in writing by sealant manufacturer for cleaning joint surfaces before priming. Use only a cleaner which is nonstaining, non-harmful to masonry, does not leave oily residues, and does not have a detrimental effect on adhesion or in-service performance.
- G. Weep Tubes: Vinyl tubing, 3/8-inch diameter.
- H. Masking Tape: Nonstaining, nonabsorbent type, compatible with joint sealants and to surfaces adjacent to joints. Use only a masking tape which will easily come off entirely, including adhesive.
- I. Joint Filler for Sealant Joints : Nonstaining joint filler compatible with backer rod and sealant:

1. Sponge rubber: Preformed strips complying with ASTM D1752 Type I.
- J. Joint Filler for Pavers and Walkways: Nonstaining joint filler compatible with backer rod and sealant; one of the following. Where filler is not shown covered by sealant, see Section 03300:
1. Cork: Preformed strips complying with ASTM D1752 Type II.
 2. Self-expanding cork: Preformed strips complying with ASTM D1752 Type III.
- K. Interior Acrylic Latex Caulk per ASTM C-834. Single component, paintable.
1. For interior junctions of dissimilar materials.
- L. Silicone Caulk. White silicone per ASTM C-920. Single component, mildew resistant.
1. For interior locations, at plumbing fixtures and sinks.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION:

- A. Inspection:
1. With installer present, examine joints for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting the performance of joint seals and sealants.
 2. Have sealant manufacturer's representative visit the site and review the project joint conditions and details for sealant work of this Project and perform adhesion testing. Have sealant manufacturer representative report to the Engineer in writing the results of his inspections and tests.
 3. Do not proceed with work of this section until unsatisfactory conditions have been corrected.
- B. Preparation: Comply with the recommendations of ASTM C1193 and the following:
1. Cleaning:
 - a. Clean joint surfaces receiving seals or sealants. Ensure that they are sound, smooth, clean, dry, and free of foreign substances and contaminants, including curing compounds and release agents.
 - b. Remove factory or field-applied coatings that will be detrimental to adhesion of seals, sealants or primers.
 2. Masking: Use masking where required to prevent contact of sealant and primers with adjoining surfaces that otherwise would be stained or damaged by such contact or by cleaning methods required to remove sealant or primer smears.
- C. Priming: Unless sealant manufacturer specifically recommends in writing against priming, apply primer to prepared surfaces that will receive sealant. Apply primer on clean, dry surfaces, and prior to installation of backup rod. Completely wet both inner faces of the joint with primer.
- D. Backup rod: Install backup rod in joints (after primer is dry) to provide backup and give proper shape for sealant bead. Where there is insufficient joint depth for backup rod, install half-round backup rod or bond breaker tape as approved in lieu of backup rod.
1. Proper cross-sectional shape for sealant bead is a very slight hourglass shape with back and front faces having slight concave curvature, unless indicated otherwise. Use special blunt T-shaped tool or roller to install backup rod to the proper and uniform depth required for the sealant.

2. Install size of backup rod that will provide approximately 30 percent compression.
 3. Do not stretch, twist, braid, puncture, or tear backup rod. A broken surface will emit gas (out-gassing) that blisters the installed sealant, thereby requiring complete removal and reinstallation of primer, backup rod, and sealant.
 4. Tightly butt backup rods at joints and intersections. At outside corners, provide sufficient length of backer rod so that rod can be bent around corner rather than cut at corner, so that out-gassing will not occur.
- E. Bond breaker tape: Where space for a backup rod is inadequate, use bond breaker tape to prevent three-sided adhesion. Install bond breaker tape smoothly over back of joints so that sealant adheres to the sides of joint but not to the back of joint.

3.02 INSTALLATION:

- A. Compression Seals:
1. If adjacent surfaces are to receive waterproofing, install compression seals prior to application of waterproofing.
 2. Prime interfaces, edges and corners of joints as necessary.
 3. Prime and lubricate joints by coating both sides of joint with lubricant-adhesive to wet-film thickness of 20 mils.
 4. While lubricant-adhesive is still wet, install compression seals to depth shown.
 5. Recess exposed edges slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.
 6. Bond ends together with materials and methods recommended by manufacturer to ensure continuous watertight and airtight performance. Where factory pre-molded or pre-welded corner units are unavailable, miter-cut and bond ends at corners.
- B. Sealant:
1. Comply with ASTM C1193 and with manufacturer's recommendations, except where more stringent requirements are shown or specified.
 2. Set joint-filler units at depth or position in joint as shown to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint-filler units.
 3. Install back-up material, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application used.
 4. Install bond-breaker tape where shown and where recommended by manufacturer to ensure that sealants will perform as intended.
 5. Employ installation techniques which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete wetting of joint bond surfaces equally on opposite sides.
 - a. Except as otherwise shown, fill sealant rabbet to slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between horizontal surface and vertical surface, fill joint to form slight cove, so that joint will not trap moisture and dirt.
 - b. Fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep nor less than 1/4-inch deep.
 - c. Ensure that temperature of sealant, as well as of substrates, at time of sealant application, is as recommended by sealant manufacturer and as specified herein. Apply sealant at optimum time after primer application.
 - d. Remove masking immediately after tooling of sealant and before sealant face starts to skin over. Do not cause dislocation of sealant, or migration of sealant to adjacent surfaces when removing masking tape.

6. Spillage: Do not allow sealants or compounds to overflow from confines of joints, to spill onto adjoining work or to migrate into voids of exposed finishes. If spillage occurs, eliminate evidence of spillage to the Engineer's satisfaction.
7. Seal joints in granite work with sealant, except granite-paving joints and pylon-apron joints that are shown to be grouted. Ensure joint depths of at least 3/4 inch before placing backup. If necessary, rake-out joints to a minimum depth of 3/4 inch.
8. Weep Holes: Install weep tubes, sloping to expel water, where required to allow free drainage of hollow spaces. Where so shown, install tubes through sealant and backing to ensure an unobstructed drainage path. Do not seal over weep holes provided by other trades.

3.03 CURING AND PROTECTING:

- A. Cure sealants in compliance with manufacturer's recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.
- B. Cure and protect joint sealers during construction period, so that they will be without deterioration, soiling or damage, other than normal wear and weathering, at time of final acceptance.
- C. Cure and protect sealants so as to minimize increases in modulus of elasticity and other accelerated aging effects.
- D. Replace or restore sealants damaged or deteriorated during construction and from testing as directed. Cut out or remove damaged sealant immediately and properly prepare and reseal joint with new materials to produce sealant installation with repaired areas indistinguishable from other work.

3.04 FIELD TESTING:

- A. Sealant: Field test cured sealant installations in the presence of and where directed by the Engineer. Test each type of joint sealant for adhesion to joint substrates by hand-pull method as follows:
 1. Make knife cuts as follows: A transverse cut from one side of joint to the other, followed by parallel cuts approximately 2 inches long at each side of joint and meeting the transverse cut at the end of the 2-inch cuts. Place a mark 1 inch from the top of 2-inch piece.
 2. Use fingers to grasp the 2-inch piece of sealant just above the 1-inch mark; pull firmly away at a 90-degree angle while holding a ruler along side of sealant; pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than the distance equaling the specified maximum movement capability in extension; hold this position for 10 seconds.
 3. Report whether or not the sealant in joint (connected to pulled-out portion) failed to adhere to joint substrates or failed cohesively or adhesively. Include data on pull distance used to test each type of sealant and joint substrate.
 4. Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered acceptable, subject to certification of design and performance criteria by the manufacturer.
 5. Make a minimum of 10 such tests unless otherwise directed by the Engineer. Submit report of testing to the Engineer.

3.05 CLEANING:

- A. Immediately clean off excess primers, drippings, sealants and sealant smears as work progresses, using methods and with cleaning materials approved by manufacturer of each joint primer and sealant and by manufacturers of materials where joints occur.
- B. Use only materials and methods acceptable to the Engineer.

END OF SECTION

SECTION 08110

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing metal doors and frames.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Finish hardware: Section 08710.
- B. Glass and glazing: Section 08800.
- C. Field painting: Section 09920.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Details of construction, connections, anchors, schedules, setting diagrams and interface with work of other trades.
 - 2. Schedule of doors and frames using the same reference numbers for details and openings as those on the Contract Documents.
- B. Certification.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NFPA: 80 (Standard for Fire Doors and Fire Windows).
 - 3. UL: Building Materials Directory.
 - 4. NAAMM: Standards HMMA 861 and 862.
 - 5. SDI: 100.
 - 6. FS: TT-F-322.
 - 7. ASTM: A153, A366, A526, A569, A780, C236, C976.
 - 8. DHI (Door and Hardware Institute): A115, Recommended Locations for Builder's Hardware.
 - 9. ADA (Americans With Disabilities Act).
- B. Fire-Rated Assemblies: Where UL-listing, UL-label or UL Building Materials Directory is specified, another testing and inspection agency acceptable to the Engineer and to authorities having jurisdiction may be used.

1.05 PRODUCT, DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to the jobsite in original unopened containers or wrappings clearly labeled with manufacturer's name and brand designation, door schedule number, referenced specification number, type, class and rating as applicable.

- B. Store products in an approved dry area, protect from contact with soil and from exposure to the elements.
- C. Handle products so as to prevent breakage of containers and damage to products.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A569, free of scale, pitting or surface defects.
- B. Cold-Rolled Steel Sheets: Commercial quality, level, carbon steel, complying with ASTM A366.
- C. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A526, G60 zinc coating, mill phosphatized.
- D. Shop-Applied Primer: Rust-inhibitive baked-on primer, suitable as base for specified finish paint systems.
- E. Finish Paint Systems: Section 09920.
- F. Supports and Anchors: Sheet steel, gauge in accordance with HMMA reference standards, unless specified otherwise. After fabricating, galvanize units to be built into or attached to exterior walls, wet areas such as doors to toilet rooms and janitor's room, or attached to slabs on grade; complying with ASTM A153, Class B.
- G. Inserts, Bolts and Fasteners: Manufacturer's standard units unless specified otherwise. Hot-dip galvanized items to be used in exterior walls, wet areas such as doors to toilet rooms and janitor's rooms, or attached to slabs on grade; complying with ASTM A153, Class C or D as applicable.
- H. Metallic Filler: FS TT-F-322.
- I. Galvanizing Repair Compound: Stick form, melting point 600F to 650F, GALVABAR or equal.

2.02 FABRICATION, GENERAL:

- A. Fabricate hollow metal door and frame units to be rigid, neat in appearance, and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to ensure proper assembly at project site.
- B. Galvanize exterior door and frame assemblies, and wet area door and frame assemblies such as at toilet room and janitor's room; including but not limited to face sheets, reinforcements, closures, dust covers, mortar shields, glazing and louver beads, clips, anchor bolts, screws, rivets and welds.
- C. Exposed fasteners are not allowed on door frames and door faces; elsewhere, provide countersunk flat philips heads for exposed screws and bolts.
- D. Door Hardware Preparation:

1. Prepare and reinforce doors and frames to receive mortised and concealed hardware in accordance with final Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of DHI A115-series, Steel Door Prep Standards, for door and frame preparation for hardware.
 2. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at project site.
 3. Locate hardware as indicated on approved shop drawings or, if not indicated, in accordance with ADA requirements pertaining to operating hardware locations, and the Recommended Locations for Builder's Hardware, published by the DHI.
- E. Shop Painting:
1. Clean, treat and paint exposed surfaces of steel door and frame units, including galvanized surfaces.
 2. Chemically clean steel surfaces of mill scale, rust, oil, grease, dirt and other foreign materials before application of paint.
 3. Apply phosphate conversion pretreatment coating.
 4. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive finish paint. Apply primer immediately after surface preparation and pretreatment.
- F. Insulated Metal Assemblies: Where scheduled, provide doors and frames fabricated as thermal-insulating assemblies and tested according to ASTM C236 or ASTM C976.

2.03 FRAMES:

- A. General:
1. Fabricate frames to uniform profile as shown of full-welded unit construction, with corners mitered and reinforced. Continuously weld full depth and width of frame, except for knock-down frames.
 2. Mullions and Transom Bars: Provide closed or tubular mullions and transom bars where indicated.
 - a. Fasten mullions and transom bars at crossings and to jambs by butt welding, except for knock-down frames.
 - b. Reinforce joints between frame members with concealed clip angles or sleeves of the same metal and thickness as frame.
 3. Jamb anchors: Provide in accordance with NAAMM Standards HMMA 861 and 862:
 - a. Provide T-type anchors or strap-and-stirrup type anchors at new masonry.
 - b. Provide Z-type anchors at metal stud partitions.
 - c. Provide bolt-type anchors with pipe spacers at in-place construction.
 4. Floor anchors: Provide floor anchors for each jamb and mullion that extends to floor, formed of galvanized steel sheet, as follows:
 - a. Monolithic concrete slabs: Clip-type anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions.
 - b. Separate topping concrete slabs: Adjustable type with extension clips, allowing not less than two-inch height adjustment. Terminate bottom of frames at finish floor surface.
 5. Head anchors: Provide two anchors at head of frames exceeding 42 inches wide for frames mounted in steel stud walls.
 6. Head strut supports:
 - a. Provide 3/8-inch by two-inch vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb.
 - b. Bend top of struts to provide flush contact for securing to supporting construction above.

- c. Provide adjustable bolted anchorage to frame jamb members.
 - 7. Structural reinforcing members: Provide structural reinforcing members as a part of frame assembly, where indicated at mullions, transoms or other locations which are to be built into frame.
 - 8. Spreader bars: Across bottom of welded frames, provide removable spreader bar, tack welded to jambs and mullions.
 - 9. Door silencers:
 - a. Drill stop to receive three silencers on single door frames and two silencers on double door frames.
 - b. Install plastic plugs to keep holes clear during construction.
 - 10. Plaster guards: Provide 18-gauge steel plaster guards or dust-cover boxes (galvanized at exterior locations), welded to frame, at back of hardware cutouts, where mortar or other materials might obstruct hardware installation or operation and to close off interior of openings.
- B. Interior Hollow Metal Frames: NAAMM Standard HMMA 861, Guide Specifications for Commercial Hollow Metal Doors and Frames except as follows:
 - 1. Openings over four feet wide: 12-gauge.
 - 2. Cart-storage rooms and other doors as indicated: Use security hollow metal frames specified below.
 - 3. Knock-down frames may be used in drywall construction as specified below.
- C. Exterior and Security Hollow Metal Frames: NAAMM Standard HMMA 862, Guide Specifications for Security Hollow Metal Doors and Frames, except as follows:
 - 1. Use for exterior doors and for indicated security doors including cart-storage room.
 - 2. Cart-storage-room frame anchors: Hot-dipped galvanized anchor bolts, not less than 1/2-inch by six inches, inaccessible from the safety walk, eight per frame.
- D. Interior Knock-Down Hollow Metal Frames: SDI 100, and as follows:
 - 1. Knock-down frames may be used only in interior drywall construction.
 - 2. Openings four foot wide or less: 16-gauge.
 - 3. Openings over four feet wide: 12-gauge.

2.04 DOORS:

- A. Thermal Insulation: Provide exterior doors and panels with internal thermal insulation of fiberglass batts..
- B. Interior Hollow Metal Doors: NAAMM Standard HMMA 861, Guide Specifications for Commercial Hollow Metal Doors and Frames except for cart-storage room and other doors as indicated.
- C. Exterior and Security Hollow metal Doors: NAAMM Standard HMMA 862, Guide Specifications for Security Hollow Metal Doors and Frames.
 - 1. Use for exterior doors and for indicated security doors including cart-storage room.

2.05 FIRE-DOOR ASSEMBLIES:

- A. Where fire-rated door and frame assemblies are required for code compliance, or are otherwise indicated, provide door, frame and hardware assemblies in compliance with NFPA 80, which are labeled and listed by UL.

- B. Fabrication and assembly requirements necessary to obtain labels will take precedence over requirements shown or specified, except where requirements shown or specified exceed sizes or gauges required for labeling.
- C. Where oversized fire doors are required, furnish manufacturer's certification that assembly has been constructed with materials and methods equivalent to labeled construction.
- D. Louvers: Equip louvers in fire-rated doors with UL-listed self-closing fire dampers with fusible links.
- E. Identify each fire door and frame with permanent UL labels, indicating the applicable fire rating of both the door and the frame. Secure labels to vertical edge of doors and frames where readily visible. Protect labels from painting operations.

2.06 TRANSOM ASSEMBLIES:

- A. Removable Transom Bar: Formed as shown of same material as frame, with manufacturer's standard bolted connection.
- B. Removable Transom Panel: Formed as shown of the same construction as the door or doors below, through-bolted to frame eight inches on-center maximum.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Deliver work, ready to set up and erect in place as rapidly as general construction work permits. Set work in place in accordance with approved shop drawings, plumb and level, strongly secured against displacement and with built-in anchors. In masonry construction, set frames in advance of masonry work. Limit field-cutting, drilling and punching to minimum necessary.
- B. Anchor metal frames in accordance with NAAMM Standards HMMA 861 and 862.
- C. Anchor fire-door assemblies in accordance with NFPA 80.
- D. Install doors after masonry work has been completed; accurately fit and adjust to work properly.
- E. Maintain installation clearances and tolerances in accordance with NAAMM Standards HMMA 861 and 862.
- F. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
 - 1. Wire-brush welds and other repair areas to bright metal.
 - 2. Apply galvanizing repair compound at rate of two ounces per square foot.
- G. Touch-up shop applied primer as recommended by manufacturer for compatibility with finish paint system.
- H. Application of finish hardware: Section 08710.
- I. Glazing materials and installation: Section 08800.

3.02 CLEAN UP:

- A. Upon completion of installation, clean surfaces of doors and frames as recommended by door manufacturer.
- B. Remove from the site rubbish and debris caused by this work.
- C. Leave areas surrounding openings in broom-clean condition.

END OF SECTION

SECTION 08305

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing wall and ceiling access doors and frames, fire-rated wall access doors and frames, access hatches, tile covered access hatches and passenger emergency-egress hatches.
- B. Work Specified Elsewhere:
 - 1. Cast-In-Place Concrete: Section 03300.
 - 2. Mortar, Grout and Masonry Accessories: Section 04050.
 - 3. Brick Masonry: Section 04125.
 - 4. Concrete Unit Masonry: Section 04220.
 - 5. Structural Steel: Section 05120.
 - 6. Roof Hatches: Section 07730.
 - 7. Finish Hardware: Section 08710.
 - 8. Tile: Section 09320.
 - 9. Paver Tile: Section 09340.
 - 10. Acoustical Panel Ceilings: Section 09511.
 - 11. Field Painting: Section 09920.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For each type of door and frame indicated. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required) for access doors and frames.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, hardware, fittings, fastenings, details, and attachments to other Work. Manufacturer's standard drawings may be submitted in lieu of Contractor prepared shop drawings if manufacturer's standard drawings show required details.
- C. Samples: For each door face material, at least 3 by 5 inches in size, in specified finish.
- D. Schedule: Provide complete door and frame schedule, including types, general locations, sizes, construction details, latching or locking provisions, and other data pertinent to installation.
- E. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items with concealed framing, suspension systems, piping, ductwork, and other construction. Show the following:
 - 1. Method of attaching door frames to surrounding construction.
 - 2. Ceiling-mounted items including access doors and frames, lighting fixtures, diffusers, grilles, speakers, sprinklers, and special trim.

- F. Certification:
1. Certification from manufacturer of steel gratings verifying that gratings are capable of supporting loading as shown.
 2. Certified test reports of successful factory testing performed on passenger emergency-egress hatches. Certification of previous successful testing of hatches of same design furnished under similar Authority contracts acceptable in lieu of specified testing.
 3. Certification that welding personnel are currently qualified in accordance with AWS D1.1.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. AASHTO: Standard Specifications for Highway Bridges: HS-20-44 Loading.
 3. AGA: The Design and Fabrication of Galvanized Products.
 4. AISC: Specification for Structural Steel for Buildings-Allowable Stress Design
 5. ASTM: A36, A53, A90, A123, A143, A153, A167, A193, A276, A307, A384, A413, A501, A588, A593, A633, A666, A780, A786, B221, B633, D1187, F594.
 6. AWS: D1.1, D1.2, D1.3, D1.4.
 7. FS; FF-B-588, FF-P-395, FF-S-325, RR-G-661, TT-P-664.
 8. MS: MIL-P-21305.
 9. NAAMM: Metal Finishes Manual for Architectural Metal Products
 10. NFPA: 101 (Fire Exit Hardware), 252 (Standard Method of Fire Tests for Door Assemblies)
 11. SSPC: SP 11, Paint 12.
 12. UL: 10B (Fire Tests of Door Assemblies)
- B. Source Limitations: Obtain doors and frames through one source from a single manufacturer.
- C. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are labeled and listed by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction:
1. NFPA 252 or UL 10B for vertical access doors.
- D. Size Variations: Obtain the Engineer's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.
- E. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code-Steel."
 2. AWS D1.2, "Structural Welding Code-Aluminum."
 3. AWS D1.3, "Structural Welding Code-Sheet Steel."
 4. AWS D1.4, "Structural Welding Code-Reinforcing Steel."
 5. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification. Such certification is to remain in force for the duration of the welding operations under this Contract.
- F. Passenger Emergency-Egress Hatches Meeting AASHTO HS-20-44 Loading:
1. Performance Requirements:
 - a. Design exit hardware so that:
 - 1) Force of not more than 15 pounds on pull ring will actuate release



- bar and latches and outward force of not exceeding 30 pounds will open hatch.
 - 2) Force of not more than 50 pounds on pull ring will actuate release bar and latches when latched leaf is subjected to outward force of 250 pounds applied against latching edge adjacent to latch or to flush grip handle in direction in which latch opens.
 - b. Provide one-inch minimum distance between bar and other door parts, when bar has traveled to fully open position.
 - c. Provide sufficient supports on latch bars to prevent damage and misalignment.
 - d. Design and provide sufficient latch bar springs for proper operation.
 - e. Coordinate design with design-specialty applications which interface with hatch design
 - f. Make recommendations for specialty-design actions to be performed by other specialties.
2. Factory testing:
- a. Perform endurance testing in which hatch leaf is attached to frame assembly and, complete with exit hardware, is subjected to 1,000 opening-and-closing cycles. Hatch, including release mechanism, exit hardware and latches, to operate without failure and show no signs of excessive wear.
 - b. Perform opening tests in which hatch leaf is subjected to the 15-pound test before and after endurance test and in which hatch leaf is subjected to 250-pound-outward-force test after endurance test. With spring scales, or by other approved means, test and record force required to open hatch. Opening force not to exceed 30 pounds for normal test and 50 pounds for 250-pound-outward-force test.
 - c. Test data to be recorded and certified by the manufacturer.
 - d. Notify the Authority at least 14 calendar days prior to each test.
3. Covers: Shall be reinforced to support a minimum live load of 300 psf (1464 kg/m²) with a maximum deflection of 1/150th of the span. Operation shall be smooth and easy with controlled operation throughout the entire arc of opening and closing. Operation shall not be affected by temperature.
4. AASHTO-HS-20-44 load or higher load if required by the jurisdictional authority where the hatch is installed: Structural steel plate with load-carrier beams.

1.04 PROJECT CONDITIONS:

- A. Field Measurements: Where doors and hatches are indicated to fit in walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products undamaged
- B. Store products so as to prevent rust

- C. Handle products so as to prevent damage.
- D. After completion of factory testing, package and ship hatches as directed.

1.06 COORDINATION:

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on a schedule.
- B. Concrete Work: Coordinate with concrete work so that frames are available for placing integrally with floor slabs or concrete walls unless frames are to be installed during related interior floor work.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General Requirements:
 - 1. Insofar as practicable, furnish similar products of a single manufacturer.
 - 2. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 FERROUS METALS:

- A. Structural Steel: Plates, shapes, bars and angles: ASTM A36.
- B. Rolled-Steel Floor Plate: ASTM A786/A786M, raised pattern floor plates from rolled-steel floor plate, galvanized after fabrication, of thickness and in pattern indicated below:
 - 1. Thickness: Minimum 1/4 inch, unless otherwise shown or calculated.
 - 2. Pattern: No. 2, or as selected from manufacturer's standard patterns; flat back.
- C. Load-carrier beams: ASTM A588.
- D. Structural Tubing: ASTM A501.
- E. Steel Pipe: ASTM A53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads. Galvanized unless otherwise shown or specified.
- F. Pipe Sleeves and Pipe Fittings: ASTM A53. Galvanized unless otherwise shown or specified.
- G. Stainless Steel Sheets, Strips, Plates, Shapes, and Flat Bars: ASTM A666, Type 304. Type 316L for corrosive environments.
- H. Stainless Steel Bars and Shapes: ASTM A276, Type 304. Type 316L for corrosive environment.
- I. Guard Chain: ASTM A413, Class Grade 28, galvanized steel, 9/32-inch thick, complete with stainless steel eyes, spring-loaded catches and mounting components.

- J. Grating: Steel, bar and crossbar type shown, hot-dipped galvanized after fabrication and sizing, FS RR-G-661, Type 1, Class 1 or 2.

2.03 ALUMINUM:

- A. Aluminum Extrusions: ASTM B221, Alloy 6063.
- B. Aluminum-Alloy Rolled Tread Plate: ASTM B 632, alloy 6061.

2.04 FASTENERS:

- A. General: Provide Type 302 or 316 stainless steel fasteners for exterior use and zinc-plated fasteners complying with ASTM B633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Screws: Material, type and size to suit purpose; steel, except stainless., cadmium-plated.
1. Stainless steel, ASTM A193, Alloy S30400.
- C. Machine Bolts: Material, type and size best suited to the purpose. Minimum tensile strength 60,000 psi.
1. Carbon steel: ASTM A307, Grade B, galvanized.
 2. Stainless steel: ASTM A193, Class 1A.
- D. Toggle bolt: FS FF-B-588.
- E. Drive stud: FS FF-S-325, Group 6.
- F. Expansion shield: FS FF-S-325 Group I, Type 2, Class 2, Style 1; Group II, Type 3, Class 1; Group IV, Type 1; best suited to the purpose.
- G. Screw anchors: Lead or plastic for wood or metal screws.
- H. Anchor bolt sleeve: Corrugated high-density polyethylene plastic.
- I. Powder actuated: FS FF-P-395.
- J. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E488, conducted by a qualified independent testing agency.
1. Material: Alloy Group 1 or 2 stainless steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

2.05 CONCRETE AND GROUT:

- A. Nonshrink Grout: Section 04050.
- B. Surface hardener: Water-soluble, inorganic fluosilicate compound for curing, hardening and dustproofing fresh concrete.

2.06 COATINGS:

- A. Shop Primer for Ferrous Metals: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- B. Galvanizing (zinc-coating by hot-dipped process): ASTM A90, ASTM A123, or ASTM A143, ASTM A153 or ASTM A384, as applicable.
- C. Zinc-rich paint: MS MIL-P-21305.
- D. Electro deposited zinc coating: ASTM B633.
- E. Galvanizing Repair Compound: Stick form, melting point 600-degree F to 650-degree F, GALVABAR or equal.
- F. Bituminous Coating: Cold-applied asphalt mastic complying with SSPC Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187.

2.07 FABRICATION, GENERAL:

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Provide access door assemblies manufactured as integral units ready for installation.
- C. Fabricate and prepare products required to be galvanized in accordance with recommendations of AGA.
- D. Provide material that is free from mill scale, flake rust and mill pitting.
- E. Cut, reinforce, drill and tap metal fabrications as indicated to receive finish hardware, screws, and similar items. Provide plates welded on for mounting hardware.
- F. Shear and punch metals cleanly and accurately. Remove burrs.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners whenever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- H. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where miscellaneous access openings, with exception of gratings, occur in finished floor areas, include stainless steel edge rims of depth to accommodate floor finishing materials.

- K. Welding corners and seams continuously to comply with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- L. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- M. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- N. Remove sharp or rough areas on exposed traffic surfaces.
- O. Painting: Shop paint (prime) before shipment. Phosphatize galvanized surfaces before priming.

2.08 WALL AND CEILING ACCESS DOORS AND FRAMES:

- A. Access Doors: Steel, baked-enamel prime coat; 12-inches square, minimum size.
1. Wall-mounted, sheet steel type: Sizes under four square feet.
 - a. Door:
 - 1) Fixed: 1/4-inch steel plate screwed to frame 18 inches on centers maximum, with flathead, countersunk, tap screws.
 - 2) Operable: Equipped with spring hinges and lockset conforming to requirements of Section 08710; locks keyed into group with mechanical rooms.
 - b. Frame: Structural steel shapes and corners mitered and welded. Strap anchors places not more than 18 inches on centers and extending 18 inches minimum into masonry or concrete.
 2. Wall-mounted, hollow metal type: Size over four square feet.
 - a. Door and frame: Conform to the requirements of Section 08110; galvanized in exterior walls.
 - b. Hardware: Equipped with spring hinges and lockset conforming to requirements of Section 08710; locks keyed into group with mechanical rooms.
 - c. Fire rated: UL 1-1/2 hour B-Label, with labeled hardware.
 3. Ceiling mounted: Galvanized steel, door and frame 16-gauge minimum; continuous piano hinge; with sleeve and plastic grommet for screwdriver from the room side; for gypsum board ceiling.
 - a. Door and frame: Flush with ceiling surface; flush metal door fitting neatly into the frame.
 - b. Size and locations: As required to access equipment indicated or as shown.
 - c. Insulation: Provide upper side of doors with one-inch thick mineral fiberboard permanently cemented in place.
 - d. Manufactured by the C. M. Walsh Company of Boston, Massachusetts, or equal.
 4. Wall or ceiling mounted in plaster walls or ceilings: Size 16 inches square.
 - a. Flush door panel mounted to frame on concealed spring hinges opening to 175 degrees.

- b. Fire rated: UL 1-1/2 hour B-Label, with key operated flush lock.
- c. Manufactured by MILCOR, K-access door or equal.

2.09 ACCESS HATCH, TYPE A:

- A. Fabricated by a manufacturer regularly engaged in the production of access hatches; and designed to meet the requirements of AASHTO-HS-20-44 load or higher load if required by the jurisdictional authority where the hatch is installed.
- B. Door:
 - 1. Grating: Steel, ASTM A36.
 - 2. Side Plate: Floor plate, diamond pattern, flat back.
 - 3. Bearing bars: 2-1/2 inches by 1/4 inch at 13/16-inch on centers and cross bars at four inches on centers.
- C. Frame: Structural steel angle framed on three sides, formed steel plate on the hinge side.
- D. Ferrous-metal components: Galvanized after fabrication.
- E. Hardware:
 - 1. Hinges: Forged brass with stainless steel pins.
 - 2. Lifting mechanism: Stainless steel compression-spring mechanism balancing door leaves through entire arc acting as check to downward motion. Force necessary to open the hatch not to exceed 50 pounds.
 - 3. Hold-open devices: Automatic, 90-degree hold-open arms with vinyl-covered release handles.
 - 4. Locking devices: Snap locks with handles on the underside and removable key handles on top side. Include removable plugs for concealing key holes.

2.10 PASSENGER EMERGENCY-EGRESS HATCH:

- A. Fabricated by a manufacturer regularly engaged in the production of access hatches; and designed to meet the following requirements:
- B. Door leaves: Fabricated in accordance with approved shop drawings.
 - 1. 250 pounds per-square-foot loading: Rolled Steel Floor plate, diamond pattern, flat back. Galvanized after fabrication.
- C. Frame: 1/4-inch structural steel with formed gutters with drainage couplings. Frames welded to eight-inch supporting channels on four sides with full flange around perimeter. Galvanized after fabrication.
- D. Drain Coupling: Provide a 1-1/2" drain coupling located in the right front corner of the channel frame (note: can be placed at a different location if directed by the Engineer).
- E. Hardware:
 - 1. Hinges: Forged brass or Type 316 stainless steel. Hinge pins of stainless steel. Each hinge equipped with two pressure-lubrication fittings, Lincoln No. 5012, or equal.
 - 2. Lifting Mechanism: Stainless steel compression-spring mechanism balancing door leaves through entire arc acting as check to downward motion. Force necessary to open the hatch when applied to inner edge of exit release bar not to exceed 30

- pounds. Manufacturer shall provide the required number and size of compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe fastened to a formed 1/4" gusset support plate.
3. Hold-open devices: Covers shall be equipped with a hold open arm which automatically locks the covers in the open position.
 4. Locking devices:
 - a. Interior: Stainless steel panic bar fabricated and installed to meet NFPA 101 requirements.
 - b. Exterior: A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the leaf and the latch release shall be protected by a flush, gasketed, removable screw plug.
 - c. Miscellaneous: Flush grip handles, pull rings with removable caps, handrails on leaves and guard chains of type standard with manufacturer.

2.11 TILE-COVERED FLOOR HATCH:

- A. General: Commercially manufactured to support a uniformly distributed live load of 150 psf and a maximum deflection of 1/150 of the span. Custom sized heavy duty aluminum frame and cover with aluminum or brass exposed edges, and complete with reinforcing, support beams (where necessary), and related accessories.
- B. Aluminum Frames and Covers: Extruded aluminum, ASTM B 221, alloy 6063-T6, with mitered and keyed corners and factory coated with zinc chromate primer or manufacturer's standard protective paint where surfaces will be in contact with concrete.
 1. Exposed Edge Finishes: Mill finish, No. 385 alloy bronze.
 2. Cover Reinforcing: ASTM A 185 (mesh) or ASTM A 615 (bars), factory engineered to meet design load requirements for medium and heavy duty applications.
- C. Steel Support Beams: ASTM A 36, factory engineered to meet design load requirements where maximum spans for single cover are exceeded and elsewhere when required. 1. Furnish steel beam pocket and bearing plate for support beams
- D. Hardware:
 1. Lifting/Locking Device: Lifting blocks (one each corner typically) secured to hatch cover and fitted with threaded bolt
 - a. Furnish threaded handle for lifting, with integral hex head drive for removing securing bolt (for covers equipped with double seals) or blanking bolt (for non-sealed covers).
 2. Seals: Continuous EPDM perimeter seal.
 3. Concrete Fill: Section 0330
- E. Fabrication:
 1. Shop fabricate floor access hatches and covers in sizes and configurations shown for single unit pit access, or multiple unit trench access.

2. Sizes (Single Unit Maximum): 48 inches square (clear opening).
 - a. Where size requirements exceed those shown, multiple covers can be joined together to obtain the desired sizes.
 - b. Where very large covers are required, a small inspection cover may be integrated into the large cover for convenience.
3. Sizes (Multiple Units Maximum): 36 inches square (clear opening).
4. Furnish reinforcement assembly loose for field positioning.
5. All aluminum surfaces in contact with concrete shall receive a factory applied primer or protective paint.
6. Dissimilar metals shall be protected against electrolytic action.

2.12 FINISHES:

A. General:

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish metal fabrications after assembly.
3. Galvanize ferrous metal unless other finish is shown or specified.

B. Galvanizing:

1. Clean ferrous metal thoroughly before applying zinc coating.
2. Apply zinc coating to products after fabrication, by hot-dip method, using coating weighing not less than two ounces per-square-foot.

C. Shop Paint:

1. Ferrous metal thoroughly cleaned as recommended by primer manufacturer and in accordance with SSPC SP11 and, except for items to be encased in concrete, given prime coat of paint.
2. Zinc yellow iron-oxide primer or red-lead based primer applied so as to thoroughly cover surfaces without leaving runs or sags

D. Stainless Steel: Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

E. Aluminum: AA-M10 (Mechanical Finish: as fabricated, unspecified).

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Advise installers of other work about specific requirements relating to access door and floor door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.

- B. Examine the substrates and conditions under which the work is to be performed, and notify the General Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the installation until unsatisfactory conditions have been corrected.
- C. Remove foreign substances from surfaces to receive metal items.
- D. Protect surrounding surfaces from damage while performing the work of this section.

3.02 INSTALLATION, GENERAL:

- A. Coordinate placement of doors with the work of other trades
- B. Comply with manufacturer's written instructions for installing all access doors and hatches.
- C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- D. Cutting, Fitting and Placement: Perform cutting, drilling, and fitting required for installing doors and hatches. Set frames, doors and hatches accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry or similar construction.
- F. Provide anchors and inserts in sufficient numbers for proper fastening of doors and hatches.
- G. Provide bar anchors with turned ends extending six inches minimum into concrete and 12 inches minimum into masonry. Lay anchors flat in masonry joints.
- H. Embed anchors accurately in concrete to permit aligning door in proper position.
- I. For fabricated items, use fastenings and anchors of size and type shown on approved shop drawings or manufacturer's standard drawings.

3.03 INSTALLING PASSENGER EMERGENCY-EGRESS HATCH:

- A. Lift hatches by means of slings attached at four corners of each hatch frame.

- B. Set hatch in framed opening; shim as necessary to ensure even support of hatch and alignment with adjoining work and in accordance with manufacturer's recommendations. Shim pattern, as shown
- C. After shimming, ensure hatch is not racked and weld in place as shown.
- D. After welding is completed, repair damaged zinc-coating and abraded shop coatings.
- E. Field-weld steel inserts to hatch frame and opening frame at hatch hinge points and coat completely with galvanizing repair compound at rate of two ounces per-square-foot.
- F. Fill space between hatch and frame and framed opening with nonshrink grout.
- G. Install 1-1/2 inch steel, Schedule 40, piping from hatch frame drain to floor drain, or if no drain, to floor. Piping not to encroach on egress pathway or headroom clearance (six-feet, eight-inches, minimum). Drain not to discharge into egress pathway.

3.04 TILE-COVERED ACCESS HATCHES:

- A. Set aluminum frames in recess, level and in proper relationship to adjacent finished flooring. For multiple covers and where maximum span for single covers is exceeded, install beam pockets and set support beams on base plates grouted to required heights. Grout frames solid with Portland cement concrete.
- B. Place cover in frame properly aligned. Clip reinforcement assembly into proper position and fill cover with Portland cement concrete to height necessary to receive scheduled finish flooring material. Hand trowel to smooth dense surface.

3.05 PAINTING AND REPAIRING COATED SURFACES:

- A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finish work, except items encased in concrete.
- B. Where shop coat is abraded or burned by welding, clean and touch-up.
- C. Touch-up primed surfaces with same material as coating.
- D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.
- E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780

and as follows:

1. Wire brush areas to be coated to bright metal.
2. Apply galvanizing repair compound at rate of two ounces per-square-foot.

3.06 FIELD QUALITY CONTROL OF PASSENGER EMERGENCY-EGRESS HATCH:

- A. Field Testing of Passenger Emergency-Egress Hatch:
 1. Upon completion of installation of passenger emergency-egress hatch, verify with spring scales that each leaf of each access hatch will open when force of 30 pounds or less is applied at inner end of exit release bar.
 2. Operate leaf no less than three times. Record opening force required each time. If adjustments are necessary to achieve specified results, repeat the test.
 3. Perform field tests in the presence of the Engineer.
 4. At the time of final inspection for substantial completion, repeat field tests as specified.
 5. If hatch fails field tests, make necessary adjustments until it operates as specified.
 6. During the life of the Contract, check operation of hatch leaves at periods not exceeding 90 days. Lubricate moving parts and check for proper operation.

3.07 ADJUSTING AND CLEANING:

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.
- C. Tile-Covered Access Hatches: If necessary for alignment after finish flooring is installed, exposed edges of frame and cover may be ground to remove up to 1/8 inch and provide flush surface.

END OF SECTION

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SECTION 08361

SECTIONAL OVERHEAD DOORS

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This Section includes electrically operated sectional overhead doors.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. List below only products, construction, and equipment that the reader might expect to find in this Section but are specified elsewhere.
- B. Division 5 Section "Metal Fabrications" for miscellaneous steel supports.
- C. Division 8 Section "Door Hardware" for lock cylinders and keying.
- D. Division 9 Section "Painting" for field-applied paint finish.
- E. Division 16 Sections for electrical service and connections for powered operators and accessories.

1.03 DEFINITIONS

- A. Operation Cycle: One cycle of a door is complete when it is moved from the closed position to the fully open position and returned to the closed position.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide sectional overhead doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
 - 1. Wind Loads: Determine loads based on the following minimum design wind pressures:
 - a. Uniform pressure (velocity pressure) of **20 lbf/sq. ft. (960 Pa)**, acting inward and outward.
 - 2. Air Infiltration: Maximum rate not more than indicated when tested according to ASTM E 283.
 - a. Maximum Rate: 0.08 cfm (0.038 L/s) at 15 mph (24 km/h).
 - 3. Impact Test for Flying Debris: Comply with ASTM E 1996, tested according to ASTM E 1886.
 - a. Level of Protection: Enhanced Protection.
 - b. Wind Zone per local codes: **110 mph (176 km/h)**, pressure test to 3/4 and 1-1/2 x design pressure (positive and negative).
- B. Operation-Cycle Requirements: Provide sectional overhead door components and operators capable of operating for not less than 10,000 cycles.

1.05 SUBMITTALS

- A. Product Data: For each type and size of sectional overhead door and accessory. Include the following:

1. Summary of forces and loads on walls and jambs.
 2. Motors: Show nameplate data and ratings, characteristics, and mounting arrangements.
- B. Shop Drawings: For special components and installations not dimensioned or detailed in manufacturer's product data.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
1. Frame: 6 inches (150 mm) long.
 2. Panel: 6 inches (150 mm) square.
- E. Qualification Data: For Installer.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project
- B. Source Limitations: Obtain sectional overhead doors through one source from a single manufacturer.
1. Obtain operators and controls from sectional overhead door manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of sectional overhead doors and accessories and are based on the specific system indicated. Other manufacturers' systems with equal performance and dimensional characteristics may be considered. Refer to Division 1 Section "Product Requirements."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Steel Doors with Insulated Steel Panels:
 - a. Amarr Garage Doors.
 - b. Arm-R-Lite.
 - c. Clopay Building Products Company; a Griffon Company.
 - d. Fimbel Door Corporation.
 - e. General American Door Company.
 - f. Haas Door; a Nofziger Company.
 - g. Martin Door Manufacturing.
 - h. Overhead Door Corp.
 - i. Raynor.
 - j. Wayne-Dalton Corp.
 - k. Windsor Door; a MAGNATRAX Corporation.

2.02 STEEL DOOR SECTIONS

- A. Construct door sections including face sheets and frames from zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet, complying with ASTM A 653/A 653M, G90 (Z275) coating designation.
 - 1. Minimum Base-Metal (Uncoated) Thickness for Section Faces: 0.033 inch (0.85 mm).
 - 2. Exterior-Section Face: Flat.
 - 3. Exterior-Section Face: Manufacturer's standard grooved, ribbed, or fluted.
- B. Fabricate door panels from a single sheet to provide sections not more than 24 inches (600 mm) high and nominally 2 inches (51 mm) deep. Roll horizontal meeting edges to a continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weathertight seal, with a reinforcing flange return.
 - 1. For insulated doors, provide door sections with continuous thermal-break construction, separating faces of door.
- C. Enclose open sections with channel end stiles formed from not less than 0.064-inch- (1.6-mm-) thick galvanized steel sheet and weld end stiles to door section in place. Provide intermediate stiles formed from not less than 0.064-inch- (1.6-mm-) thick galvanized steel sheet, cut to door section profile, and welded in place.
 - 1. Stile Spacing: Not more than 48 inches (1200 mm) apart.
- D. Reinforce bottom section with a continuous channel or angle complying with bottom-section profile and allowing installation of astragal.
- E. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Provide galvanized steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place.
- F. Provide reinforcement for hardware attachment.
- G. Thermal Insulation: Insulate inner core of steel sections with door manufacturer's standard polyurethane insulation, foamed in place to completely fill inner core of section and pressure bonded to face sheets to prevent delamination under wind load, and with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within steel sections that incorporate the following inside facing material, with no exposed insulation material evident:
 - 1. Inside Facing Material: Zinc-coated (galvanized) steel sheet with a minimum base (uncoated) metal thickness of 0.028 inch (0.70 mm).
- H. Fabricate sections so finished door assembly is rigid and aligned, with tight hairline joints and free of warp, twist, and deformation.
- I. Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean galvanized surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants.
 - a. Pretreat zinc-coated steel, after cleaning, with a conversion coating of type suited to organic coating applied over it.
 - 2. Apply manufacturer's standard primer to both door faces after forming, according to coating

- manufacturer's written instructions for application and minimum dry film thickness.
3. Apply manufacturer's standard primer and finish coats to interior- and exterior-door faces after forming, according to coating manufacturer's written instructions for application, thermosetting, and minimum dry film thickness.
 4. Apply manufacturer's standard primer and powder-coat finish to interior- and exterior-door faces after forming, according to coating manufacturer's written instructions for application, thermosetting, and minimum dry film thickness.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.03 TRACKS, SUPPORTS, AND ACCESSORIES

- A. Tracks: Manufacturer's standard, galvanized steel track system, sized for door size and weight, designed for lift type indicated and clearances shown, and complying with ASTM A 653/A 653M for minimum G60 (Z180) zinc coating. Provide complete track assembly including brackets, bracing, and reinforcement for rigid support of ball-bearing roller guides for required door type and size. Slot vertical sections of track spaced at 2 inches (51 mm) apart for door-drop safety device. Slope tracks at proper angle from vertical or design to ensure tight closure at jambs when door unit is closed. Weld or bolt to track supports.
 1. Provide tracks configured for the following lift types:
 - a. Standard.
 - b. Low headroom.
 - c. High.
- B. Track Reinforcement and Supports: Galvanized steel track reinforcement and support members, complying with ASTM A 36/A 36M and ASTM A 123/A 123M. Secure, reinforce, and support tracks as required for door size and weight to provide strength and rigidity without sag, sway, and vibration during opening and closing of doors.
 1. Support and attach tracks to opening jambs with continuous angle welded to tracks and attached to wall. Support horizontal (ceiling) tracks with continuous angle welded to track and supported by laterally braced attachments to overhead structural members at curve and end of tracks.
 - a. Repair galvanized coating on tracks according to ASTM A 780.
- C. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of overhead door.
 1. Provide motor-operated doors with combination bottom weatherseal and sensor edge.
 2. Provide continuous flexible seals at door jambs for a weathertight installation.
- D. Full-Vision Panels: Manufacturer's standard, tubular, aluminum-framed section fully glazed with 6-mm-thick, clear polycarbonate glazing set in vinyl, rubber, or neoprene glazing channel and with removable extruded-vinyl or aluminum stops. Finish to match steel sections.

2.04 HARDWARE

- A. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.
- B. Hinges: Heavy-duty galvanized steel hinges of not less than 0.0747-inch- (1.9-mm-) thick, uncoated steel at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is not possible. Provide double-end hinges where required, for doors exceeding

16 feet (4.87 m) in width, unless otherwise recommended by door manufacturer.

- C. Rollers: Heavy-duty rollers with steel ball bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch- (75-mm-) diameter roller tires for 3-inch- (75-mm-) wide track and 2-inch- (51-mm-) diameter roller tires for 2-inch- (51-mm-) wide track.
 - 1. Tire Material: Case-hardened steel.
- D. Push/Pull Handles: For push-up-operated or emergency-operated doors, provide galvanized steel lifting handles on each side of door.
- E. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
- F. Fabricate locking device assembly with lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bar to engage through slots in tracks.
 - 1. Locking Bars: Single-jamb side or Full-disc cremone type, both jamb sides operable from inside and outside.
 - 2. Lock cylinder is specified in Division 8 Section "Door Hardware."
- G. Chain Lock Keeper: Suitable for padlock.
- H. If door unit is power operated, provide safety interlock switch to disengage power supply when door is locked.

2.05 COUNTERBALANCE MECHANISM

- A. Extension Spring: Counterbalance mechanism with aircraft-type steel cable over ball-bearing sheaves. Provide oil-tempered wired springs with internal safety rods. Combine operation with a spring bumper in each horizontal track to cushion door at end of opening operation.
- B. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from oil-tempered-steel wire complying with ASTM A 229/A 229M, Class II, mounted on a cross-header tube or steel shaft. Connect to door with galvanized aircraft-type lift cables with cable safety factor of at least 5 to 1. Provide springs calibrated for a minimum of 50,000 cycles.
- C. Cable Drums: Cast-aluminum or gray-iron casting cable drums grooved to receive cable. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of shaft. Provide one additional midpoint bracket for shafts up to 16 feet (4.87 m) long and two additional brackets at one-third points to support shafts more than 16 feet (4.87 m) long unless closer spacing is recommended by door manufacturer.
- D. Cable Safety Device: Include a spring-loaded, steel or bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either cable breaks.
- E. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level shaft and prevent sag.
- F. Provide a spring bumper at each horizontal track to cushion door at end of opening operation.

2.06 ELECTRIC DOOR OPERATORS

- A. General: Provide electric door operator assembly of size and capacity recommended and provided by door manufacturer for door specified, with electric motor and factory-prewired motor

controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

- B. Comply with NFPA 70.
- C. Disconnect Device: Hand-operated disconnect device or mechanism for automatically engaging chain-and-sprocket operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount disconnect device and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- D. Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency auxiliary operator.
- E. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70, Class 2 control circuit, maximum 24-V, ac or dc.
- F. Door-Operator Type: Unit consisting of electric motor and the following:
 - 1. Jackshaft gear-head hoist type, with enclosed worm-gear, running-in-oil, primary drive; chain-and-sprocket secondary drive; auxiliary chain hoist; and floor-level quick release for manual operation.
- G. Electric Motors: High-starting torque, reversible, continuous-duty, Class A insulated, electric motors complying with NEMA MG 1, with overload protection, sized to start, accelerate, and operate door in either direction from any position, at not less than 2/3 fps (0.2 m/s) and not more than 1 fps (0.3 m/s), without exceeding nameplate ratings or service factor.
 - 1. Type: Polyphase, medium-induction type.
 - 2. Service Factor: Comply with NEMA MG 1, unless otherwise indicated.
 - 3. Coordinate wiring requirements and electrical characteristics of motors with building electrical system.
 - 4. Provide open dripproof-type motor, and controller with NEMA ICS 6, Type 1 enclosure.
 - 5. Provide totally enclosed, nonventilated or fan-cooled motor, fitted with plugged drain, and controller with NEMA ICS 6, Type 4 enclosure where indicated.
- H. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."
 - 1. Provide full-guarded, surface-mounted, heavy-duty-type interior unit with general-purpose, NEMA ICS 6, Type 1 enclosure.
- I. Obstruction Detection Device: Provide each motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. Activation of sensor immediately stops and reverses downward door travel.
 - 1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
 - a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.
 - 2. Pressure-Sensor Edge: Provide each motorized door with an automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor immediately stops and reverses downward door travel. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.
 - a. Provide electrically actuated automatic bottom bar.
 - 1) Self-Monitoring Type: Four-wire configured device.



- J. Limit Switches: Adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install door, track, and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers, and equipment supports according to Shop Drawings, manufacturer's written instructions, and as specified.
- B. Fasten vertical track assembly to framing, spaced not less than 24 inches (600 mm) apart. Hang horizontal track from structural overhead framing with angle or channel hangers fastened to framing by welding or bolting or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.

3.02 STARTUP SERVICES

- A. Engage a factory-authorized service representative to perform startup services.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.03 ADJUSTING

- A. Lubricate bearings and sliding parts; adjust doors to operate easily, free from warp, twist, or distortion and with weathertight fit around entire perimeter.
- B. Adjust belt-driven motors as follows:
 - 1. Use adjustable motor-mounting bases for belt-driven motors.
 - 2. Align pulleys and install belts.
 - 3. Tension belt according to manufacturer's written instructions.
- C. Touch-up Painting: Immediately after welding galvanized track to track supports, clean field welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional overhead doors. Refer to Division 1.

END OF SECTION

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SECTION 08410

ALUMINUM ENTRANCES AND STOREFRONTS

PART 1 -GENERAL

1.01 SUMMARY OF WORK:

- A. This Section specifies provision of exterior aluminum entrances and storefronts including doors, hardware, weatherstripping, and framing members.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 08800: Glass and Glazing.
- B. Section 08710: Finish Hardware.

1.03 QUALITY ASSURANCE:

- A. Installer Qualifications: Engage an experienced installer to assume engineering responsibility and perform work of this Section who has specialized in installing entrances similar to those required for this Project and who is acceptable to manufacturer.

1.04 DESCRIPTION:

- A. General: Provide aluminum entrances and storefronts capable of withstanding loads and thermal and structural movement requirements indicated without failure. Failure includes the following:
 - 1. Air infiltration and water penetration exceeding specified limits.
 - 2. Framing members transferring stresses, including those caused by thermal and structural movement, to glazing units.
- B. Glazing: Physically and thermally isolate glazing from framing members.
- C. Thermally Broken Construction: Provide aluminum entrances and storefronts that isolate aluminum exposed to exterior from aluminum exposed to interior with a material of low thermal conductance.
- D. Wind Loads: Provide aluminum entrances and storefronts, including anchorage, capable of withstanding wind-load design pressures calculated according to requirements of authorities having jurisdiction or the American Society of Civil Engineers' ASCE 7, "Minimum Design Loads for Buildings and Other Structures," 6.4.2, "Analytical Procedure," whichever are more stringent.
 - 1. Deflection of framing members in a direction normal to wall plane is limited to 1/175 of clear span or 3/4 inch whichever is smaller, unless otherwise indicated.
 - 2. Static-Pressure Test Performance: Provide aluminum entrances and storefronts that do not evidence material failures, structural distress, failure of operating components to function normally, or permanent deformation of main framing members exceeding 0.2 percent of clear span when tested according to ASTM E 330.
 - a. Pressure: 150 percent of inward and outward wind-load design pressures.
 - b. Duration: As required by design wind velocity; fastest 1 mile of wind for relevant exposure category.

- E. Dead Loads: Provide entrance-members that do not deflect an amount which will reduce glazing bite below 75 percent of design dimension when carrying full dead load.
 - 1. Provide a minimum 1/8-inch clearance between members and top of glazing or other fixed part immediately below.

- F. Air Infiltration: Provide aluminum entrances and storefronts with permanent resistance to air leakage through fixed glazing and frame areas of not more than 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a static-air-pressure difference of 1.57 lbf/sq. ft.

- G. Water Penetration: Provide aluminum entrances and storefronts that do not evidence water leakage through fixed glazing and frame areas when tested according to ASTM E331 at minimum differential pressure of 20 percent of inward-acting wind-load design pressure as defined by ASCE 7, "Minimum Design Loads for Buildings and Other Structures," but not less than 6.24 lbf/sq. ft. Water leakage is defined as follows:
 - 1. Uncontrolled water infiltrating aluminum entrances and storefronts or appearing on normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not water leakage.

- H. Thermal Movements: Provide aluminum entrances and storefronts, including anchorage, that accommodate thermal movements of aluminum entrances and storefronts and supporting elements resulting from the following maximum change (range) in ambient and surface temperatures without buckling, damaging stresses on glazing, failure of joint sealants, damaging loads on fasteners, failure of doors or other operating units to function properly, and other detrimental effects.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

- I. Structural-Support Movement: Provide aluminum entrances and storefronts that accommodate structural movements including, but not limited to, sway and deflection.

- J. Condensation Resistance: Provide aluminum entrances and storefronts with condensation resistance factor (CRF) of not less than 45 when tested according to AAMA 1503.1.

- K. Dimensional Tolerances: Provide aluminum entrances and storefronts that accommodate dimensional tolerances of building frame and other adjacent construction.

1.05 SUBMITTALS:

Submit the following in accordance with requirements elsewhere in this Contract and with the additional requirements as specified for each:

- A. Product Data: For each product specified. Include details of construction relative to materials, dimensions of individual components, profiles, and finishes.

- B. Shop Drawings: For aluminum entrances and storefronts show details of fabrication and installation, including plans, elevations, sections, details of components, glazing provisions for expansion and contraction, and attachments to other work.
 - 1. For aluminum entrances and storefronts, include hardware schedule and indicate operating hardware types, quantities, and location



- C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for factory-applied color finishes.
- D. Samples for Verification: Of each type of exposed finish required. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.
- E. Cutaway Sample: Of vertical-to-horizontal framing intersection, made from minimum 6-inch lengths of full-size components and showing details of the following:
 - 1. Joinery.
 - 2. Anchorage.
 - 3. Expansion provisions.
 - 4. Glazing.
 - 5. Flashing and drainage.

1.06 WARRANTY:

- A. Warranty Period: 1 year in addition to the warranty requirements specified elsewhere in this Contract, for a total of 2 years from date of Substantial Completion.
 - 1. Failures include, but are not limited to, the following:
 - 2. Failure of aluminum entrances and storefronts to meet performance requirements.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Failure of operating components to function normally.
 - 5. Water leakage through fixed glazing and frame areas.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated, complying with the requirements of standards indicated below.
 - 1. Sheet and Plate: ASTM B 209.
 - 2. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221.
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 - 4. Bars, Rods, and Wire: ASTM B 211.
 - 5. Aluminum Finish: Dark bronze integral color anodized Class 1 finish, NAAMM AA-M12C22A44.
 - a. Provide all material, free of scratches and surfaces blemishes.
 - b. Match existing adjacent installations.
- B. Glazing as specified in Section 08800.
- C. Glazing Gaskets: Manufacturer's standard pressure-glazing system of black, resilient glazing gaskets, setting blocks, and shims or spacers, fabricated from an elastomer of type and in hardness recommended by system and gasket manufacturer to comply with system performance requirements. Provide gasket assemblies that have corners sealed with sealant recommended by gasket manufacturer. Insert specific gasket-material requirements, if any.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements, except containing no asbestos, formulated for 30-mil thickness per coat.

- E. Sill Mastic: Butyl: Polymerized butyl rubber and inert fillers (pigments), solvent-based with minimum 75-percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, and complying with FS TT-S-001657.

2.02 COMPONENTS:

- A. Doors: Provide manufacturer's standard 1-3/4-inch thick glazed doors with minimum 0.125-inch-thick, extruded tubular rail and stile members as approved. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie-rods.
1. Glazing Stops and Gaskets: Provide manufacturer's standard snap-on extruded-aluminum glazing stops and preformed gaskets, as approved.
 2. Stile Design: Match existing.
- B. Brackets and Reinforcements: Provide manufacturer's standard brackets and reinforcements that are compatible with adjacent materials, as approved. Provide nonstaining, nonferrous shims for aligning components as approved.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials, as approved.
1. Reinforce members as required to retain fastener threads.
 2. Do not use exposed fasteners, except for hardware application. For hardware application, use countersunk Phillips flat-head machine screws finished to match framing members or hardware being fastened, unless otherwise indicated.
- D. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing, compatible with adjacent materials, and of type approved.
- E. Weather Stripping: ANSI/BHMA A156.22, Finish 628 (satin aluminum clear anodized) with stainless steel sheet-metal screws and as follows:
1. Head and jamb: Head and jamb type, stop-applied; National Guard A626 or equal. Provide nylon brush gasketing or equal.
 2. Sill: Drip strip at sill; National Guard 15 or equal.
 3. Sweep: Door sweep type, surface mounted at bottom of door; National Guard D608 nylon brush gasketing or equal. Provide sweep on side opposite to drip strip where scheduled.

2.03 FINISH HARDWARE:

- A. General: Provide heavy-duty hardware units indicated in sizes, number, and type recommended by manufacturer for entrances indicated as specified in Section 08710, and as approved. Finish exposed parts to match door finish, unless otherwise indicated.
- B. Offset Pivots where approved: ANSI/BHMA A156.4, Grade 1 with exposed parts of cast-aluminum alloy. Provide top, bottom, and intermediate pivots at each door leaf.
- C. Ball-Bearing Butts: ANSI/BHMA A156.1, Grade 1, 5-knuckle, ball-bearing butts. Provide nonremovable pins at hinges exposed to door outside and provide full-mortise Type 1 slip-in nonferrous hinges for applications exposed to weather. Provide 3 hinges at each leaf for doors up to 36 inches wide and 80 inches tall; provide 4 hinges at each leaf for taller doors.



- D. Closers, General: Comply with manufacturer's recommendations for closer size, depending on door size, exposure to weather, and anticipated frequency of use.
1. Closing Cycle: Comply with requirements of authorities having jurisdiction or the Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," whichever are more stringent.
 2. Opening Force: Comply with the following maximum opening-force requirements for locations indicated:
 - a. Exterior Doors: 15 lbf.
 3. Surface Mounted Overhead Closers: ANSI/BHMA 156.4, Grade 1, provide cover and the following:
 - a. Mounting: parallel arm, interior locations (room side of door unless otherwise specified).
 - b. Cushion stop: Adjustable at angle directed by the Engineer from manufacturer's standard options.
 4. Door Stops: ANSI/BHMA A156.16, Grade 1, floor- or wall-mounted door stop, as appropriate for door location indicated, with integral rubber bumper. Retain appropriate cylinder requirements below.
- E. Cylinders and Keying for Yard Buildings: Match the Authority's existing keying and interchangeable core system as follows and at no additional cost to the Authority.
1. Cylinders: Finish 630.
 - a. For locksets: ANSI/BHMA A156.5, interchangeable-core type, designed to accept the Authority's existing Russwin Recore System. One core furnished for each lock, stamped with visual key control.
 - b. High security: Interlocking-pin type, Emhart High-Security Locking System or equal
 2. Construction cores: Provide construction cylinders until final cylinders and keying is approved and installed.
 3. Keys and keying:
 - a. Keys: Stamped with the inscription TRANSIT AUTHORITY - DO NOT DUPLICATE and with visual key-control data.
 - b. Quantity: Three keys for each core plus blanks equal to 10-percent of total keys furnished.
 4. Key tags and holders: ANSI/BHMA A156.5, inscribed with key-change number and key-control symbol.
 5. Cylinder Guard: Manufacturer's standard hardened-steel security ring with retainer plate for inside stile wall that protects lock cylinder from removal by wrenches, prying, or sawing.
- F. Deadlatch Locks: Manufacturer's standard mortise deadlatch with minimum 1/2-inch-12.7-mm- long latch bolt and auxiliary bolt located below latch bolt and complying with ANSI/BHMA A156.5, Grade 1 requirements.
1. Lever Handles: Manufacturer's standard cast-aluminum-alloy, inside-lever, deadlatch operating unit.
 2. Latch Paddle Devices: Manufacturer's standard extruded-aluminum deadlatch operating paddle.
 - a. Provide units for push applications.
 - b. Provide units for push and pull applications. Hook-bolt locks are recommended for pairs of doors, since they provide additional resistance to prying.
 3. Lockset Faceplates: Manufacturer's standard extruded-aluminum faceplate for lock type indicated that lays flush with door stile.

- a. Provide radiused faceplate with weather sweep extending full length of lock at meeting stiles of pairs of doors.
- 4. Flat Face Strikes: Manufacturer's standard stainless-steel, flat face strike with steel mounting plate and black-plastic dustbox.
- 5. Retain one flush-bolt requirement below if required for inactive leaf of pairs of doors. Model codes prohibit manual flush bolts on means of egress doorways. If exit devices are not required, consider specifying 2- or 3-point locking systems listed above or inserting requirements for automatic flush bolts that comply with requirements of authorities having jurisdiction.
- 6. Manual Flush Bolts: ANSI/BHMA A156.16, edge-mortised, lever-extension-type flush bolts.
 - a. Locate flush bolts at bottom of inactive leaf of pairs of doors.
 - b. Locate flush bolts at top and bottom of inactive leaf of pairs of doors.
- G. Pull Handles: Aluminum pull handles as indicated on Drawings.
- H. Push Bars: Aluminum push bars as indicated on Drawings.
- I. Thresholds: At exterior doors, provide manufacturer's standard threshold with cutouts coordinated for operating hardware, with anchors and jamb clips, and not more than 5/16-inch, with beveled edges providing a floor level change with a slope of not more than 1:2, and in the following material:
 - 1. Material: Aluminum, mill finish.
- J. Weatherstripping: ANSI/BHMA A156.22, Finish 628 (satin aluminum clear anodized) with stainless steel sheet-metal screws and as follows:
 - 1. Head and jamb: Head and jamb type, stop-applied; National Guard A626 or equal or compression type gasketing as approved.
 - 2. Sill: Drip strip at sill; National Guard 15 or equal.
 - 3. Sweep: Door sweep type, surface mounted at bottom of door; National Guard D608 nylon brush gasketing or equal. Provide sweep on side opposite to drip strip where scheduled.
- K. Special Security Alarmed Exit Device for Parking Structures: To sound alarm at unauthorized entry or exit at locations indicated and as required and approved.

2.04 FABRICATION:

- A. General: Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- B. Forming: Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
- C. Prepare components to receive concealed fasteners and anchor and connection devices.
- D. Fabricate components to drain water passing joints and condensation and moisture occurring or migrating within the aluminum entrances and storefronts to the exterior.
- E. Welding: Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Weld in concealed locations to greatest extent

possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

- F. Glazing Channels: Provide minimum clearances for thickness and type of glass indicated according to FGMA's "Glazing Manual."
- G. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- H. Entrances: Fabricate door framing in profiles indicated. Reinforce as required to support imposed loads. Factory assemble door and frame units and factory install hardware to greatest extent possible. Reinforce door and frame units as required for installing hardware indicated. Cut, drill, and tap for factory-installed hardware before finishing components.
 - 1. Exterior Doors: Provide nylon brush gasketing or compression weather stripping where indicated as approved.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of aluminum entrances and storefronts. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

- A. General: Protect and handle aluminum entrances and storefronts components to prevent damage; do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
- B. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- C. Install components to drain water passing joints and condensation and moisture occurring or migrating within the aluminum entrances and storefronts to the exterior.
- D. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction, unless otherwise indicated. Comply with requirements as specified in Section 07900.
- E. Install framing components plumb and true in alignment with established lines and grades without warp or rack of framing members.
- F. Install entrances plumb and true in alignment with established lines and grades without warp or rack. Lubricate operating hardware and other moving parts according to hardware manufacturers' written instructions.
 - 1. Install surface-mounted hardware in accordance with Section 08710 and according to manufacturer's written instructions using concealed fasteners to greatest extent possible.

- G. Install glazing to comply with requirements of Section 08800, unless otherwise indicated. Delete subparagraphs below if no structural-sealant-glazed systems.
- H. Install perimeter sealant to comply with manufacturer's requirements and Section 08800, unless otherwise indicated.
- I. Erection Tolerances: Install entrance and storefront aluminum entrances and storefronts to comply with the following maximum tolerances:
 - 1. Variation from Plane: Limit variation from plane or location shown to 1/8 inch in 12 feet 1/4 inch over total length.
 - 2. Alignment: Where surfaces abut in line, limit offset from true alignment to 1/16 inch. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch.
 - 3. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch.

3.03 FIELD QUALITY CONTROL:

- A. Water Spray Test: After completing the installation of test areas indicated, test aluminum entrances and storefronts for water penetration according to AAMA 501.2 requirements.
- B. Repair or remove and replace Work as directed by the Engineer that does not meet requirements or that is damaged by testing; replace to conform to specified requirements.

3.04 ADJUSTING:

- A. Adjust doors and hardware to provide tight fit at contact points and weather stripping, smooth operation, and weathertight closure.

3.05 PROTECTION:

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure aluminum entrances and storefronts are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

SECTION 08630

METAL-FRAMED SKYLIGHTS

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This Section includes aluminum-framed skylights with the following characteristics:
 - 1. Glazing is glass.
 - 2. Glazing is retained by field-installed pressure caps on four sides.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Division 5 Section "Structural Steel" for steel framing that supports skin-system assemblies.
- B. Division 7 Section "Building Insulation" for insulation materials field installed with metal-framed skylights.
- C. Division 7 Section "Sheet Metal Flashing and Trim" for metal flashings installed at perimeters of assemblies.
- D. Division 7 Section "Joint Sealants" for sealants installed at perimeters of metal-framed skylights.

1.03 PERFORMANCE REQUIREMENTS

- A. Provide metal-framed skylights, including anchorage, capable of withstanding, without failure, the effects of the following:
 - 1. Structural loads.
 - 2. Thermal movements.
 - 3. Movements of supporting structure.
 - 4. Dimensional tolerances of building frame and other adjacent construction.
- B. Failure includes the following:
 - 1. Deflection exceeding specified limits.
 - 2. Water leakage.
 - 3. Thermal stresses transferred to building structure.
 - 4. Noise or vibration created by wind and thermal and structural movements.
 - 5. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
 - 6. Loosening or weakening of fasteners, attachments, and other components.
 - 7. Sealant failure.
- C. Structural Loads:
 - 1. Wind Loads: Per local codes.
 - 2. Snow Loads: Per local codes.
 - 3. Concentrated Live Loads: 250 lbf (1112 N) applied to framing members at locations that will produce greatest stress or deflection.
 - 4. Seismic Loads: Per local codes.
 - 5. Load Combinations: Calculate according to requirements of applicable codes.
- D. Deflection of Framing Members:
 - 1. Deflection Normal to Glazing Plane:
 - a. Spans Up to 20 Feet (6 m): Limited to 1/175 or 1/180 of clear span or 1 inch (25.4 mm), whichever is smaller.

- b. Spans Exceeding 20 Feet (6 m): Limited to 1/240 of clear span.
 - c. Glass Edge Deflection: Limit edge deflection of individual glass lites to 3/4 inch (19 mm).
- 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.

- E. Lateral Bracing of Framing Members: Compression flanges of flexural members are laterally braced by cross members with minimum depth equal to 50 percent of flexural member that is braced. Glazing does not provide lateral support.

- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

- G. Structural-Sealant Glazing:
 - 1. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by metal-framed skylight assemblies without failing adhesively or cohesively. Sealant fails cohesively before sealant releases from substrate when tested for adhesive compatibility with each substrate and joint condition required.
 - a. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
 - b. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
 - 2. Structural-Sealant Joints: Designed to produce tensile or shear stress in structural-sealant joints of less than 20 psi (138 kPa).
 - a. Structural-sealant joints do not carry gravity loads of glazing.

1.04 PERFORMANCE TESTING


- A. Provide metal-framed skylights that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard assemblies by a qualified independent testing agency.

- B. Structural-Performance Test: ASTM E 330.
 - 1. Performance at Design Load: When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - 2. Performance at Maximum Test Load: When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main supporting members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity but not less than 10 seconds.

- C. Air-Infiltration Test: ASTM E 283.
 - 1. Minimum Static-Air-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
 - 2. Maximum Air Leakage: 0.06 cfm/sq. ft. (0.30 L/s per sq. m)

- D. Test for Water Penetration under Static Pressure: ASTM E 331.
 - 1. Minimum Static-Air-Pressure Difference: 20 percent of positive wind-load design pressure, but not less than 12 lbf/sq. ft. (574 Pa).
 - 2. Water Leakage: None.

- E. Test for Water Penetration under Dynamic Pressure: AAMA 501.1.

- 
1. Dynamic Pressure: 20 percent of positive wind-load design pressure, but not less than 12 lbf/sq. ft. (574 Pa).
 2. Water Leakage: No uncontrolled water penetrating systems or appearing on systems' normally exposed interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained to exterior and cannot damage adjacent materials or finishes is not considered water leakage.

1.5 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for metal-framed skylights.
- B. Shop Drawings: For metal-framed skylights. Include plans, elevations, sections, details, and attachments to other work.
 1. Include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Of each framing intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:
 1. Joinery.
 2. Anchorage.
 3. Expansion provisions.
 4. Glazing.
 5. Flashing and drainage.
- F. Field quality-control test and inspection reports.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for metal-framed skylights.
- H. Maintenance Data: For metal-framed skylights to include in maintenance manuals.
- I. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Entity capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
- B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 699 for testing indicated.
- C. Welding: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."
- D. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 1. Build mockup of typical skylight area as shown on Drawings.
 2. Approved mockups may become part of the completed Work if undisturbed at time of

Substantial Completion.

- E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.

1.8 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-framed skylights that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Adhesive or cohesive sealant failures.
 - e. Water leakage.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.
 - 1. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for metal-framed skylights is based on Naturalite BSM-3000 glass insulated panel skylight.. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
 - 1. Acralight.
 - 2. Architectural Skylight Co., Inc.
 - 3. Bristolite Skylights.
 - 4. CPI International.
 - 5. Exarc Skylights, Inc.
 - 6. Fisher Skylights.
 - 7. Gammans Architectural Products Inc.
 - 8. Lane-Aire Manufacturing Corp.
 - 9. LinEI Signature.
 - 10. Kawneer.
 - 11. Major Industries, Inc.; Auburn Skylights Division.
 - 12. Naturalite Skylight Systems; Vistawall Group (The). Basis of Design.
 - 13. O'Keeffe's Inc.
 - 14. Regal Manufacturing Co.
 - 15. Skyline Products, Inc.
 - 16. Super Sky Products Inc.
 - 17. TRACO.
 - 18. View Thru Glass & Metal Products.
 - 19. Wasco Products, Inc.

2.2 FRAMING SYSTEMS

- A. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.
 - 1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
 - 3. Extruded Structural Pipe and Tubes: ASTM B 429.
- B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
 - 1. Include snap-on aluminum trim that conceals fasteners.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.
- D. Anchors, Fasteners, and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding; compatible with adjacent materials.
 - 1. At pressure caps, use ASTM A 193/A 193M, 300 series stainless-steel screws.
 - 2. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 - 3. Exposed Fasteners:
 - a. Use exposed fasteners with countersunk Phillips screw heads.
 - b. Finish exposed portions to match framing system.
 - 4. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.
- E. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- F. Anchor Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- G. Concealed Flashing: [Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- H. Exposed Flashing and Closures: Manufacturer's standard aluminum components not less than 0.040 inch (1.016 mm) thick.
- I. Framing Gaskets: Manufacturer's standard.
- J. Framing Sealants: As recommended in writing by manufacturer.

2.3 GLAZING SYSTEMS

- A. Glazing: 1 inch insulating glass unit, maximum U-value 0.50, maximum shading coefficient 0.55. Minimum visible light transmittance 55%..
 - 1. Exterior lite: 1/4 inch clear heat strengthened glass.
 - 2. Air space: 1/2 inch
 - 3. Interior lite: Laminated glass, 2 1/8 glass plies; 0.060 inch polyvinyl butyl interlayer.
- B. Spacers, Setting Blocks, and Gaskets: Manufacturer's standard elastomeric types.
- C. Bond-Breaker Tape: Manufacturer's standard tetrafluoroethylene-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
- D. Glazing Sealants: As recommended in writing by manufacturer.

1. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; neutral-curing silicone formulation compatible with structural sealant and other components with which it comes in contact; and recommended in writing by structural- and weatherseal-sealant and metal-framed skylight manufacturers for this use.
 - a. Color: Matching structural sealant.

2.4 ACCESSORY MATERIALS


- A. Insulating Materials: Specified in Division 7 Section "Building Insulation."
- B. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.5 FABRICATION

- A. Fabricate aluminum components before finishing.
- B. Fabricate aluminum components that, when assembled, have the following characteristics:
 1. Profiles that are sharp, straight, and free of defects or deformations.
 2. Accurately fitted joints with ends coped or mitered.
 3. Internal guttering systems or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
 4. Physical and thermal isolation of glazing from framing members.
 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
- C. Fabricate aluminum sill closures with weep holes and for installation as continuous component.
- D. Reinforce aluminum components as required to receive fastener threads.
- E. Weld aluminum components in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- F. Factory-Glazed Units:
 1. Factory install glazing to comply with requirements in Division 8 Section "Glass and Glazing".
 2. Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
- G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.6 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coating; Organic Coating:



manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

1. Color and Gloss: [As selected by Architect from manufacturer's full range.

2.7 SOURCE QUALITY CONTROL

- A. Structural-Sealant Glazing: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, material qualification procedures, sealant testing, and fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 1. Comply with manufacturer's written instructions.
 2. Do not install damaged components.
 3. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
 4. Rigidly secure nonmovement joints.
 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
 7. Seal joints watertight, unless otherwise indicated.
- B. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with bituminous paint or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
- C. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
- D. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within skylight to exterior.
- E. Install components plumb and true in alignment with established lines and elevations.
- F. Install glazing as specified in Division 8 Section "Glass and Glazing."
 1. Structural-Sealant Glazing:
 - a. Prepare surfaces that will contact structural sealant according to structural-sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
 - b. Install weatherseal sealant according to Division 7 Section "Joint Sealants" and according to weatherseal-sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind weatherseal sealant as recommended in writing by weatherseal-sealant manufacturer.

- G. Install insulation materials as specified in Division 7 Section "Building Insulation."
- H. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:
 - 1. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).
 - 2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m) but no greater than 1/2 inch (13 mm) over total length.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test and inspection reports.
- B. Testing Services: Testing and inspecting of representative areas to determine compliance of installed skylights with specified requirements shall take place as follows. Do not proceed with installation of the next area until test results for previously completed areas show compliance with requirements.
 - 1. Water-Spray Test: Before installation of interior finishes has begun, skylights shall be tested according to AAMA 501.2 and shall not evidence water penetration.
- C. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION

SECTION 08710

FINISH HARDWARE

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing finish hardware.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Access Doors and Frames including locks and cylinders: Section 08305.
- B. NOT USED
- C. Hollow Metal Doors and Frames: Section 08110.
- D. Aluminum Entrances and Storefronts: Section 08410.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulation of the jurisdictional authorities.
 - 2. ANSI/BHMA: A156-Series Standards for Builders Hardware.
 - 3. ASTM: A413
 - 4. FS: TT-S-001657.
 - 5. ADA: ADAAG.
 - 6. NFPA: 80, 101, 130.
 - 7. DHI: Recommended Locations for Builders Hardware for Standard Steel Doors and Frames, Recommended Locations for Builders Hardware for Custom Steel Doors and Frames.
- B. Hardware Supplier Qualifications: A recognized architectural finish hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying finish hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to the Engineer and Contractor, at reasonable times during the course of the Work for consultation.
 - 1. Require supplier to have his AHC develop the hardware schedule.
 - 2. Require supplier's AHC to meet with the Engineer to discuss and finalize lock-functions and keying requirements.
- C. Fire-Rated Openings: Provide hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels.
 - 1. Equip labeled doors with hinges of steel or stainless steel base metal, closers, and automatic latching devices in addition to the hardware requirements in the specified hardware sets.
 - 2. If a conflict appears between this paragraph and the hardware sets scheduled, the requirements of this paragraph govern.
- D. Americans With Disabilities Act (ADA): Comply with the ADA Accessibility Guidelines (ADAAG).

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
1. Product Data: Manufacturers' technical literature and catalog cuts, edited as necessary to indicate each item of hardware, model, selected options, finish, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements. Make coordinated submittals packages complete with all supporting data.
 2. Hardware Schedule: Hardware schedule coordinated with doors, frames, gates and related work to ensure proper size, thickness, hand, function, design and finish of hardware. Base Hardware Schedule on hardware sets indicated in PART 3 of this section. Indicate complete designations of each item required for each door or opening, including the following information:
 - a. Explanation of each abbreviation, symbol, and code contained in hardware schedule. Schedules with unidentified notations will be rejected without review.
 - b. Door and frame number, size, and materials.
 - c. Type, style, function, size, and finish of each hardware item. Include lockset functions, angle of closer operation, lever and handle designs, lengths of flush bolts, types of stops, sizes of armor and kick plates, and other such data.
 - d. Name and manufacturer of each item.
 - e. Fastenings and other pertinent information.
 - f. Location of each hardware set cross-referenced to indications on Drawings, both on floor plans and in door schedule.
 - g. Mounting locations for hardware.
 - h. Keying information.
 3. Submittal sequence: Submit hardware schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with hardware schedule the product data, samples, shop drawings of work affected by finish hardware, and other information essential to a coordinated review of hardware schedule.
 4. Templates: Transmit hardware templates directly to trades fabricating related work specified to be prepared for the installation of finish hardware under this section. Submit record copy of these transmittals to the Engineer.
 5. Coordinating hardware preparation by other trades: Check shop drawings of other trades to ensure that correct provisions from transmitted templates are made for locating and installing finish hardware to comply with indicated requirements.
- B. Samples:
1. Finishes: Two, minimum four-inch squares of each finish to be furnished. Submit with shop drawings.
 2. Hardware units: Each type of exposed hardware unit in approved finish and tagged with full description for coordination with hardware schedule. Submit unit samples prior to submission of final hardware schedule.
 - a. When requested, samples will be returned to the supplier. Accepted units that remain undamaged through the submittal, review, and field-comparison process may, after final check of operation, be used in the Work, within limitations of keying coordination requirements.
 - b. Submit the following:
 - 1) One sample of a lockset including, trim, escutcheon, strike box, lever, cylinder, and key.

- 2) One sample of hinge.
 - 3) One sample of each miscellaneous item of finish hardware.
 - 4) Provide finishes so that color and surface finish or polish of various items of the same designated finish match throughout the work. Hardware with non-matching finishes will be rejected.
- c. The Authority reserves the right to require samples of each specific item to be furnished

C. Certification.

D. Documentation:

1. Construction keying schedule.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to jobsite in original unopened packages, clearly labeled with manufacturer's name, brand, specification identification data and identification as shown on approved hardware schedule.
- B. Store products in an approved dry area, protect from contact with soil and from exposure to the elements. Keep products dry.
- C. Handle products so as to prevent breakage of containers and damage to products.

1.06 MAINTENANCE TOOLS AND INSTRUCTIONS:

- A. Furnish a complete set of specialized tools and maintenance instructions as needed for the Authority's continued adjustment, maintenance, removal and replacement of hardware.

PART 2 - PRODUCTS

2.01 HARDWARE TYPES:

- A. General:
 1. Hardware grade: Provide only Grade 1 hardware in accordance with ANSI/BHMA A156-Series Standards and with the additional requirements specified in this section, except where otherwise specified or approved in writing by the Engineer for each specific door number.
 2. Fire-rated hardware: Where applied to fire-rated labeled doors and frames, provide fire-rated listed hardware, tested by a fire-rating testing agency acceptable to authorities having jurisdiction.
 3. Finishes: Finish designations are ANSI/BHMA A156.18 standards and are subject to approval for color, texture and appearance.
 - a. Finish 630 (Formerly US 32D): Except where otherwise indicated, provide finish 630, satin-polish stainless steel on stainless steel base metal, matching sample on file with the Engineer.
 - b. Finish 630 may be substituted for Finish 626 or Finish 652 at no additional cost to the Authority.
 4. Single Source: Obtain each type of hardware from a single manufacturer.
- B. Hinges: ANSI/BHMA A156.1, full mortise butt hinges, anti-friction bearings, button tips (not flush), unless otherwise specified for each specific door number. Extruded butts may be used in lieu of wrought butts.

1. Quantity required per door leaf:
 - a. Doors 61 inches to 90 inches in height: 1-1/2 pairs.
 - b. Doors 91 inches to 120 inches in height: Two pairs.
2. Types:
 - a. Exterior doors, doors from public passageways, and doors to wet areas such as showers: Stainless steel butts, Type A5111, finish 630.
 - b. Interior, non-public doors: Steel butts, Type A8111 (Grade 1), Finish 652.
 - c. Doors with reverse-bevel swing (out-swinging) having locks: Fit butts with non-removable pins effective when door is in closed position.

C. Locksets:

D. Hollow metal doors: ANSI/BHMA A156.13, full mortise, adjustable armored front, 3/4-inch-throw anti-friction latchbolt, one-inch-throw stainless steel deadbolt, Finish 630, Function as scheduled.

1. Trim design:
 - a. Cast lever handles, recurving to within 1/2-inch of door face, equal in appearance and dimensions to one of the following unless otherwise scheduled:

Series	Design	Producer
ML2200 Series	Newport NSA	Corbin/Ruswin
8200 Series	KD rose, L lever	Sargent
8700 Series	PB lever, YK rose	Yale

- b. Finish: 630 unless otherwise scheduled.
 - c. Roses: Concealed screw or screwless, 2-1/4 inch diameter.
 - d. Cylinder trim: Equip with flush or security-beveled solid cylinder collar as appropriate for flush or projecting cylinder.
2. Aluminum doors in Yard Buildings:
 - a. Finish: 630 unless otherwise scheduled.

E. Cylinders and Keying for all doors except aluminum doors in Parking Structures: Match the Authority's existing keying and interchangeable core system as follows and at no additional cost to the Authority.

1. Cylinders: Finish 630.
 - a. For locksets: ANSI/BHMA A156.5, interchangeable-core type, designed to accept the Authority's existing Ruswin Recore System. One core furnished for each lock, stamped with visual key control.
 - b. High security: Interlocking-pin type, Emhart High-Security Locking System or equal.
 - c. Construction cores: Provide construction cylinders until final cylinders and keying is approved and installed.
2. Keys and keying:
 - a. Keys: Stamped with the inscription TRANSIT AUTHORITY - DO NOT DUPLICATE and with visual key-control data.
 - b. Quantity: Three keys for each core plus blanks equal to 10-percent of total keys furnished.
3. Key tags and holders: ANSI/BHMA A156.5, inscribed with key-change number and key-control symbol.

- F. Push Plates and Door Pulls: ANSI/BHMA A156.6, Finish 630, with the following additional requirements:
1. Push plate: 3/16 inch by 10 inches by 20 inches unless otherwise shown, with edges beveled.
 2. Door pull: 3/4-inch round bar, eight inches center-to-center, concealed fasteners; escutcheon plate same as push plate.
- G. Door Closers: ANSI/BHMA A156.4, Type C02xx1 (xx - indicates top-of-door-mounted, on interior side), Finish 630.
1. Surface-mounted.
 2. Sweep period: Adjusted so that from an open position of 70 degrees, the door will take at least three seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.
 3. Cover plate: Full metal cover, Finish 630.
 4. Parallel arms and drop brackets: Provide as necessary for mounting on interior side unless otherwise noted. Where hold-open feature is specified for closers, use type that permits doors to open 140 degrees, other conditions permitting.
 5. Maximum force for pushing or pulling open a door with closer (measured with a push-pull scale applied perpendicular to the door at the door opener or 30 inches from the hinged side, whichever is farther from the hinge):
 - a. Fire doors: Minimum opening force allowable by the jurisdictional authorities.
 - b. Interior hinged doors: 5 lbf.
- H. Stops:
1. Overhead-type: ANSI/BHMA A156.8, Type C54511 holder/stop; holder deactivated on labeled doors, Finish 630.
 2. Wall-type: ANSI/BHMA A156.16, Type L02101, with vandal-resistant concealed fasteners, Finish 630. Use floor-type where wall-type is not practicable.
 3. Floor-type: ANSI/BHMA A156.16, Type L02141 or L02161 as necessary, with matching extender if necessary to properly engage door bottom, Finish 630.
- I. Flush Extension Bolts: ANSI/BHMA A156.8, Type L04081, Finish 630.
1. Dustproof strikes, Type L04021, provided for bolts located at bottom of door leaf, except where metal thresholds are specified. Cut opening to suit bolt.
 2. Operating mechanism located approximately six feet from floor for top bolts and approximately 12 inches from floor for bottom bolts.
 3. Bolts located in edge of inactive leaf of pair of doors.
 4. Automatic Flush Bolts: Listed for 1-1/2 hour, B-labeled, Finish 630; Ives No. 559 or equal with strikes; with coordinator where recommended by manufacturer.
- J. Silencers: ANSI/BHMA A156.16, Type L03011. Provide silencers for each door:
1. Three for each single door.
 2. Two for each pair of doors.
- K. Exit Devices: ANSI/BHMA A156.3; complying with NFPA 80, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction; lever trim as required for locksets; Finish 630.
1. Single door: Function F03 (mortise); latch bolt by push on crossbar inside and by key from outside; operation from outside is by lever.
 2. Double door: Active leaf Function F03 as above, inactive leaf (manual flush bolts) without outside trim.
 3. Maximum pushing force to operate exit device:
 - a. Fire doors: Minimum opening force allowable by the jurisdictional authorities.
 - b. Interior hinged doors: 5 lbf.

4. Coordinators: ANSI/BHMA A156.3.
- L. Metal Thresholds: ANSI/BHMA A156.21; profiles as shown for each location; ADA compliant; metal thickness 0.125 inch; maximum height 5/16"; with countersunk matching screws.
1. Public passageways and mezzanines: Finish 630, stainless steel with abrasive finish or Finish 613, satin-finish statuary bronze.
 2. Other locations: Finish 719, mill finish aluminum with grooves.
- M. Weather Stripping /Smoke Seals: ANSI/BHMA A156.22, Finish 628 (satin aluminum clear anodized) with stainless steel sheet-metal screws and as follows:
1. Head and jamb: Head and jamb type, stop-applied; National Guard A626 or equal. Provide nylon brush gasketing or equal.
 2. Sill: Drip strip at sill; National Guard 15 or equal.
 3. Sweep: Door sweep type, surface mounted at bottom of door; National Guard D608 nylon brush gasketing or equal. Provide sweep in addition to drip strip where scheduled.
 4. Astragals: Provide nylon brush overlapping type: National Guard 600 or equal.
- N. Chain: ASTM A413, Class PT, case-hardened, carbon-steel security chain, 3/8-inch diameter.
- O. Padlock: Interchangeable-core type padlock, designed to accept the Authority's existing Russwin Recore System.
1. One core furnished for each lock, stamped with visual key control; with two keys, keyed and master-keyed as directed.
 2. Body: Solid extruded brass.
 3. Five-pin tumblers.
 4. Shackle: Hardened steel, zinc-plated, 1-3/4 inch opening height, self-locking spring-type.
- P. Deadlock: ANSI/BHMA A156.5 mortise dead lock, Grade 2 (1/2-inch minimum throw) with interchangeable-core cylinder; operation as scheduled.
- Q. Authority-Furnished Property:
1. Cross-bar lock: High-security locking bar with surface-mounted keepers, inside knob and high-security cylinder.

2.02 FASTENINGS:

- A. Provide hardware complete with screws, through-bolts and other fasteners of suitable type for secure anchorage to construction materials.
- B. Screws, through-bolts and other fasteners having spanner-type heads: As approved.
- C. Provide fasteners that harmonize in material, color and texture with finished appearance of hardware items.
- D. Provide concealed fastenings with door pull, flush pulls, wall door stops and other such items.
- E. Provide phillips-head or Torx head through-bolts and hex bolts as applicable for surface-mounted hardware.
- F. Sheet-metal screws and self-tapping screws are prohibited except where specified.

2.03 TEMPLATES:

- A. Furnish templates of hardware to other trades, so that doors, frames and gates can be cut, reinforced and otherwise prepared in the shop for installation of finish hardware.

2.04 THRESHOLD SEALANT:

- A. Butyl: Polymerized butyl rubber and inert fillers (pigments), solvent-based with minimum 75 percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, and complying with FS TT-S-001657.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. General:
 1. Coordinate work of this section with work of other trades.
 2. Install each hardware item in compliance with the manufacturer's instructions and recommendations.
 3. Apply finish hardware in a neat and workmanlike manner. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
 4. Cut mortises neat, clean and of proper net size. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
 5. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in other sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
 6. Provide keying in accordance with keying schedule prepared by and for the Contractor in accordance with the Authority's keying system. Deliver keying schedule and keys to the Engineer prior to final acceptance.
- B. Mounting Heights: Mount hardware units at heights indicated in the following publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by the Engineer:
 1. Recommended Locations for Builders Hardware for Standard Steel Doors and Frames by DHI.
 2. Recommended Locations for Builders Hardware for Custom Steel Doors and Frames by DHI.
 3. ADA Accessibility Guidelines (ADAAG).
- C. Exterior Thresholds: Set thresholds for exterior doors in full bed of specified butyl sealant.
- D. Weatherstripping /Smoke Seals: Install weatherstripping around entire perimeter of door frame to form a complete seal and in accordance with manufacturers instructions.
 1. Position and install head and jamb weatherstripping so that door closes snugly against seal but does not inhibit latching of lockset.
 2. Position and install sill weatherstripping to seal snugly against threshold without inhibiting latching of lockset.
 3. Note that at fire-rated doors, lockset is to latch by closer operation only, without manual assistance.
- E. Adjustment: Adjust hardware to operate as designed and replace hardware that is missing, scratched, marred or otherwise damaged.

1. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
2. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
3. Clean adjacent surfaces soiled by hardware installation.

F. Instruction: At a time prescribed by the Engineer, have the hardware installer or knowledgeable operating-hardware-manufacturers' representatives instruct the Authority's personnel in the proper adjustment and maintenance of hardware and hardware finishes.

3.02 CLEAN-UP:

- A. Remove from the site rubbish and debris caused by this work.
- B. Leave areas surrounding doors in broom-clean condition.

3.03 HARDWARE SETS:

- A. Hardware Sets:
 1. Provide hardware sets in accordance with door schedule and the following set schedule.
 2. Provide the number of pairs of butt hinges in accordance with previously specified requirements.
 3. Designations used to describe hardware items by using a manufacturer's product name and number are for the purpose of describing a general level of quality and function. Products that are equal, complying with the requirements specified in this section may be used.

SET NO. 1	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Lockset, Function F09
1 Each	Door Closer
1 Each	Wall-Type Stop
1 Each	Metal Threshold

SET NO. 2

Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Lockset, Function F07
1 Each	Door Closer
1 Each	Wall-Type Stop

SET NO. 3	
Quantity	Hardware
As Necessary	Lock Cylinders (Provide proper cam to engage lock mechanism by other trade.)

SET NO. 4 (NOT USED)	
Quantity	Hardware
1 Each	Deadlock, E06082

SET NO. 5	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Latchset, Function F01
1 Each	Door Closer
1 Each	Wall-Type Stop

SET NO. 6 (NOT USED)	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Exit Device, Function F03
1 Each	Door Closer
1 Each	Wall-Type Stop

SET NO.7 (NOT USED)	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Lockset, Function F13
1 Each	Door Closer with Hold-Open
1 Each	Wall-Type Stop
1 Each	Cross-Bar Lock

SET NO. 8	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Lockset, Function F07
2 Each	Door Closer
2 Each	Wall-Type or Floor-Type Stop
2 Each	Automatic Flush Bolt
1 Each	Coordinator

SET NO. 9 (NOT USED)	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Lockset, Function F07
2 Each	Door Closer
2 Each	Overhead-Type Stop
1 Each	Metal Threshold
2 Each	Automatic Flush Bolt
1 Each	Coordinator
1 Set	Weatherstripping

SET NO. 10	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
2 Each	Door Pulls
2 Each	Door Closer with Hold-Open
2 Each	Wall-Type or Floor-Type Stop, As Necessary

SET NO. 11(NOT USED)	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Lockset, Function F09
2 Each	Door Closer
1 Each	Wall-Type Stop
1 Each	Metal Threshold
2 Each	Automatic Flush Bolt
1 Each	Coordinator

SET NO. 12	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Lockset, Function F07
1 Each	Door Closer
1 Each	Overhead-Type Stop
1 Each	Metal Threshold
1 Set	Weatherstripping

SET NO. 13	
Quantity	Hardware
Previously Specified	Butt Hinges, 4-1/2 by 4-1/2
1 Each	Lockset, Function F14
1 Each	Door Closer
1 Each	Overhead-Type Stop
1 Each	Metal Threshold
1 Set	Weatherstripping

END OF SECTION

SECTION 08800

GLASS AND GLAZING

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing glass and glazing (sealing) of glass areas.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. ANSI: Z97.1.
 3. ASTM: C509, C542, C864, C920, C1036, C1048, C1172, C1281, D635, D1044, D1925, E774, E1300.
 4. CPSC: 16 CFR 1201, Category II.
 5. UL: 9, 10B.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Samples:
1. Three each of the following:
 - a. Glass and safety plastic: 12 inches square, each material and type.
 - b. Glazing compound: Pint containers.
 - c. Setting blocks and edge blocks.
 - d. Sealant: Cured color samples.
 - 1) Sealant for sealing platform granite edge glass lenses: Clear silicone sealant,, one six-inch long bead.
 - e. Gasket material: 12 inches long.
- B. Certification:
1. When glass is not cut to size by manufacturer and is furnished unlabeled from local stock, submit certification stating location to be installed, quality, thickness, type and manufacturer of each unit of glass furnished.
 2. All tempered safety and laminated tempered safety glass to be permanently marked with the name or trademark of the manufacturer and designation of the applicable safety glazing standard.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to the jobsite in original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type, class and rating as applicable. Deliver glass with each light bearing manufacturer's label showing strength, grade, thickness, type, quality and safety marking. Do not remove labels from glass

until it has been set and inspected.

- B. Store products in approved dry area; protect from contact with soil and from exposure to the elements.
- C. Handle products to prevent breakage of containers and damage to products.

1.05 JOB CONDITIONS:

- A. Environmental Requirements:
 - 1. Do not install glass when the ambient temperature is below 40F or expected to fall below 40F, unless otherwise approved.
 - 2. Do not apply glazing materials to unprotected surfaces in wet weather or to surfaces on which ice, frost, water or dampness is visible.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Glass:
 - 1. Plate glass: ASTM C1036, Type I (transparent glass, flat), Class 1 (clear), Quality q3.
 - 2. Safety glass: CPSC 16 CFR 1201, Category II and ANSI Z97.1 and as follows:
 - a. Tempered: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated surfaces), Type I (transparent glass, flat), Class 1 (clear), Quality q3; 1/4-inch thick unless otherwise shown.
 - b. Laminated: ASTM C1172, Kind LT (fully tempered), 0.060-inch thick polyvinyl-butylal (PVB) interlayer factory-laminated between two pieces of tempered safety glass with protective edgecoat on the assembly to prevent contact of interlayer with water or joint materials; edgecoat such as Edgeseal by PPG, special polyurethane seal on Solaflex glazing by Monsanto, Sommer Macca Urethane E#2 by SX Chemical Company, or equal.
 - 3. Wired: ASTM C1036, Type II (wired), Class 1 (translucent), Form 1 (wired, polished both sides), Quality q8; Mesh m1 (diamond), unless otherwise shown.
 - 4. Spandrel glass: Laminate opacifier film to second surface of insulated unit. Appearance to match insulating vision glazing.
- B. Insulating Glass: ASTM E774, Class CBA; factory preassembled, sealed insulating glass units with 1/2-inch air space; aluminum spacer tube with desiccant held captive within, and dual seal construction.
 - 1. Outer lite: 1/4-inch clear plate glass or tempered safety glass as shown or specified, with low-emissivity (low-E) coating equal to Viracon's Solarscreen 80 on the number-two (inside) surface.
 - 2. Inner lite: 1/4-inch clear plate glass or tempered safety glass as shown or specified.
- C. Safety Plastic: Clear, monolithic polycarbonate sheet complying with the following:
 - 1. Abrasion resistance: Maximum 3.1 percent change in haze when tested in accordance with ASTM D1044 for both surfaces.

2. UV-resistance: Maximum 2.0 yellowing index after three years exposure per ASTM D1925.
3. Flammability: Meet BOCA combustibility classification C1: Horizontal burn rate of one inch per minute or less when tested at a nominal thickness of 0.060 inch, or in the thickness intended for use, in accordance with ASTM D635.

D. Glazing Accessories:

1. Sealant: Multi-component polyurethane; ASTM C920, Type M, Grade NS, Class 25, Use G; colored as required to match framing system in which installed.
2. Glazing compound: Single-component polyurethane; ASTM C920, Type S, Grade NS, Class 25, Use G; colored as required to match framing system in which installed.
3. Glazing tape: Preformed butyl tape, ASTM C1281; 100 percent solids, nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod (pre-shimming) as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; by 3M Company, Tremco Manufacturing Co., or equal.
4. Pressure-sensitive tape: Vinyl electrical tape, 3M Company or equal.
5. Lock-Strip Gaskets: ASTM C542 dense neoprene extrusions; profile shown or required.
6. Compression Seal Gaskets: ASTM C864 neoprene extrusions; profile and hardness as shown or as required to maintain watertight seal.
7. Setting blocks: ASTM C864 neoprene extrusions, 70-90 durometer Shore A hardness; approximately full channel width, four inches long and high enough to afford correct cover and 3/8-inch edge clearance for the glass.
8. Edge blocks (spacers): ASTM C864 neoprene extrusions, 40-50 durometer Shore A hardness; approximately full channel width, three inches long and providing 3/8-inch edge clearance for the glass.
9. Glazing clips and points: Type, material and quantities as required and recommended by the manufacturers of the glazing media.
10. Glazing (face) gasket: Neoprene, formulated of compound meeting or exceeding physical property requirements of ASTM C509, continuous, 50 durometer hardness, providing 3/16-inch face clearance inside and outside.
11. Dielectric screw shield: Nylon expansion anchor, round head, sized to ensure snug fit in predrilled hole and to accommodate size of screw used.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Verify dimensions before proceeding; obtain measurements at structure for work to be fitted to other construction, including wall-to-wall dimensions, floor-to-ceiling dimensions and those controlled by other trades.
- B. Remove dirt, dust, oil, moisture and other foreign substances from surfaces to receive glass and glazing accessories.
- C. Clean glass surfaces and wipe dry.

3.02 INSTALLATION:

- A. Coordinate work of this section with work of other trades.
- B. Use only tempered safety glass in doors, sidelights and transoms.
- C. Use only fire-rated glass in doors and windows located in fire-rated wall construction, except where wire glass is shown.
- D. Size glass by measuring actual frames or sash. Sizes shown are approximate and are intended for estimating purposes only. Cut glass to form 3/8-inch bite on all sides, except as otherwise required by manufacturer's product data as submitted and approved.
- E. Install glass or plastic using glazing gaskets or other glazing accessories as shown.
- F. Set glass on setting blocks at each quarter point of sill with equal bearing for entire width of each panel. Accurately cut glass to fit frames and provide smooth edges with no sharp or ragged surfaces. Provide edge blocks to prevent glass from contact with side frames.
- G. Unless otherwise shown, set glass in metal interior frames and doors or by back-face glazing with glazing compound; tape to prevent rattling. Reset glazing beads, if necessary, without marring or injuring finish.
- H. Tape Glazing:
 - 1. Position tape on fixed stops so that, when compressed by glass, exposed edges of tape are flush with or protrude slightly above sightline of stops.
 - 2. Install tape continuously, but not necessarily in one continuous length. Do not stretch tape to make it fit opening. Do not overlap butt ends. Cut tape with sharp shears. Place joints in tape at corners of opening with adjoining lengths butted together, not lapped.
 - 3. Seal joints in tape with compatible sealant approved by tape manufacturer.
 - 4. Where framing joints are vertical, cover these joints by applying tape to head and sill first and then to jambs. Where framing joints are horizontal, cover these joints by applying tape to jambs and then to head and sill.
 - 5. Place spacer or centering shims, three inches in length, 3/16 inch in height and 3/32 inch in thickness, every 18 inches under tape. Hold spacers in position by gently placing them in contact with underedge of tape.
 - 6. Position setting blocks for installation of glass. Use setting blocks 1/4 inch in height.
 - 7. Do not remove release paper from tape until just before each glazing unit is installed.
 - 8. Align glass carefully to opening and press glass firmly in place. Apply removable stops and repeat application of spacers or centering shims. Ensure that they are seated as deeply as possible in channel. Fill interior opening in conventional manner with glazing compound.
 - 9. Apply cap bead of sealant over exterior exposed edge of tape.
- I. Set glass in exterior metal windows and doors with neoprene setting blocks at quarter points and neoprene spacers two inches long placed 18 inches on center, and glaze with sealants.
- J. Install glass and glazing accessories in accordance with manufacturer's recommendations. Neatly apply sealants, compounds and tapes in straight lines parallel with glazing rebates and as shown.
- K. Perform direct glazing in dry weather, 40F or warmer.



- L. Tape edges of laminated glass and insulating glass with pressure-sensitive tape if sealant or glazing tape is incompatible with interlayer or seals of insulating glass. Do not expose edges of laminated glass to solvents, cleaners or prolonged contact with water.
- M. Set lead-shim rings on lips at bottom of openings and glass lenses. Set glass lenses to bring flat face level with the top of granite, centered in openings. Use spacers to maintain lenses in position while filling the annular space with backer rod and sealant as shown.

3.03 FIELD QUALITY CONTROL:

- A. Hose Tests:
 - 1. Upon completion of glazing and sealing, perform hose test against exterior glazing and framing members in the presence of the Engineer.
 - 2. Use 5/8-inch minimum diameter hose operated at 40-psi pressure for a minimum of 10 minutes. Repair leaks as soon as surfaces are dry; retest until approved.
- B. Breakage: Prior to final acceptance, replace damaged glass.
- C. Dielectric Testing:
 - 1. After installation at elevator hoistways, test for electrical isolation between screws and hoistway metal, using ohmmeter.
 - 2. Resistance requirement: 10,000 ohms.
 - 3. Replace screws and shields that do not meet resistance requirements and retest as for initial installation. Repeat as necessary until all screws meet resistance requirement.

3.04 CLEAN-UP:

- D. At completion of work, remove labels, except fire labels, clean glass and remove excess glazing compound and sealant from frames and surrounding finish work.
- E. Remove from site rubbish and debris resulting from work of this section.
- F. Leave areas surrounding work in broom-clean condition.

END OF SECTION

SECTION 09255

DRYWALL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing non-loadbearing drywall systems, including metal studs, metal furring and acoustical insulation.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Seals and Sealants: Section 07900.
- B. Building Insulation: Section 07210.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements for approval and with the additional requirements as specified for each.

- A. Product Data: For each type of the product indicated.
- B. Samples:
 - 1. Trim Accessories: Full-size sample in 12-inch long length for each trim accessory indicated.
 - 2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.
- C. Certification.
 - 1. Certificates from the gypsum-wallboard manufacturer verifying that materials furnished meet specified requirements.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM: C36, C423, C475, C641, C645, C665, C754, C834, C840, C931, C954, C919, C1002, C1177, C1047, D226, E84, E90, E119, E413, E497.
 - 3. ASTM A 118.9, C 919.
- B. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.06 JOB CONDITIONS:

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.01 STEEL PARTITION AND SOFFIT FRAMING:

- A. Components, General: As follows:
 - 1. Comply with ASTM C 754 for conditions indicated.
 - 2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with manufacturer's standard corrosion-resistant zinc coating.
- B. Steel Studs and Runners: ASTM C 645, non-loadbearing
 - 1. Minimum Base Metal Thickness: 20 ga.
 - 2. Depth: As shown.
- C. Deep-Leg Deflection Track: ASTM C 645 top runner with 2-inch- deep flanges.
- D. Proprietary Deflection Track: Steel sheet top runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs.
- E. Proprietary Firestop Track: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
- G. Cold-Rolled Channel Bridging: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange.
 - 1. Depth: As shown.
 - 2. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch-thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
- I. Resilient Furring Channels: 1/2-inch deep, steel sheet members designed to reduce sound transmission.
- J. Cold-Rolled Furring Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch- wide flange.

1. Depth: As indicated.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch diameter wire.

K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

L. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.02 INTERIOR GYPSUM WALLBOARD

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

B. Gypsum Wallboard: ASTM C 36.

1. Regular Type: Regular-type gypsum panels are also available in 1/4- and 3/8-inch (6.4- and 9.5-mm) thicknesses for limited applications.
 - a. Thickness: 1/2 inch, unless otherwise indicated.
 - b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
 - c. Location: As indicated.
2. Type X:
 - a. Thickness: 5/8 inch.
 - b. Long Edges: Tapered and featured (rounded or beveled) for prefilling.
 - c. Location: Where required for fire-resistance-rated assembly or as indicated

C. Flexible Gypsum Wallboard: ASTM C 36, manufactured to bend to fit tight radii and to be more flexible than standard regular-type panels of the same thickness.

1. Thickness: 1/4 inch.
2. Long Edges: Tapered.
3. Location: As indicated

D. Sag-Resistant Gypsum Wallboard: ASTM C 36, manufactured to have more sag resistance than regular-type gypsum board.

1. Thickness: 1/2 inch.
2. Long Edges: Tapered.
3. Location: Ceiling surfaces

E. Proprietary, Special Fire-Resistive Type: ASTM C 36, having improved fire resistance over standard Type X.

F. Foil-Backed Gypsum Wallboard: ASTM C 36.

G. Proprietary Abuse-Resistant Gypsum Wallboard: ASTM C 36, manufactured to produce greater resistance to surface indentation and through-penetration than standard gypsum panels.

2.03 EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Exterior Gypsum Soffit Board: ASTM C 931/C 931M, with manufacturer's standard edges.
 - 1. Core: ½ inch, regular type or 5/8 inch Type X.
- C. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M.

2.04 TILE BACKING PANELS

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Cementitious Backer Units: ASTM A 118.9

2.05 TRIM ACCESSORIES:

- A. Interior Trim: ASTM C 1047
 - 1. Material: , manufacturer's standard metal trim, formed from galvanized or aluminum-coated steel, or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead: Use at outside corners.
 - b. Bullnose Bead: Use where indicated.
 - c. LC-Bead (J Bead): Use at exposed panel edges.
 - d. L-Bead: Use where indicated.
 - e. U-Bead: Use where indicated.
 - f. Expansion Joint Use where indicated.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges; use at curved openings.
- B. Exterior Trim: ASTM C 1047.
 - 1. Material: Hot-dip galvanized steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead: Use at outside corners.
 - b. LC-Bead (J-Bead): Use at exposed panel edges.
 - c. Expansion (Control) Joint.

2.06 JOINT TREATMENT MATERIALS:

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
 - 2. Exterior Gypsum Soffit Board: Paper.
 - 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
- D. Joint Compound for Exterior Applications:
 - 1. Exterior Gypsum Soffit Board: Use setting-type taping and setting-type, sandable topping compounds.

2. Glass-Mat Gypsum Sheathing Board: As recommended by manufacturer.
- E. Joint Compound for Tile Backing Panel:
1. Cementitious Backer Units: As recommended by manufacturer

2.07 ACOUSTICAL SEALANT:

- A. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction.

2.08 AUXILIARY MATERIALS

- A. General : Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Isolation Strip at Exterior Walls:
1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.
- E. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- F. Thermal Insulation: As specified in Section 07210.
- G. Vapor Barrier: As specified in Section 07210.

2.09 TEXTURE FINISHES

- A. Primer: As recommended by textured finish manufacturer.
- B. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indices of not more than 25 when tested according to ASTM E 84.
- C. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.

- D. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application:
1. Application Thickness: 1/2 inch.
 2. Fire-Test-Response Characteristics: Indices when tested according to ASTM E 84 as follows:
 - a. Flame Spread: Less than 25.
 - b. Smoke Developed: Less than 450.
 3. NRC: 0.55 according to ASTM C 423.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLING STEEL PARTITION AND SOFFIT FRAMING:

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
1. Where studs are installed directly against exterior walls, install asphalt-felt or foam-gasket isolation strip between studs and wall.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch3 mm from the plane formed by the faces of adjacent framing.
- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
1. Cut studs 1/2 inch13 mm short of full height to provide perimeter relief.
 2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
 - a. Terminate partition framing at suspended ceilings where indicated
- D. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- E. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
1. Install two studs at each jamb, unless otherwise indicated.
 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint.
 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.

4. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- F. Z-Furring Members:
1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches o.c.
 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
 4. Until gypsum board is installed, hold insulation in place with 10-inch staples fabricated from 0.0625-inch- diameter, tie wire and inserted through slot in web of member.
- G. Vapor Barrier: Install to comply with requirements specified in Section 07210.

3.03 APPLYING AND FINISHING PANELS, GENERAL:

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.
- I. Form control and expansion joints with space between edges of adjoining gypsum panels.
- J. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

- K. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. 0.7 sq. m in area.
- L. Fit gypsum panels around ducts, pipes, and conduits.
- M. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- N. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- O. Floating Construction: Where feasible, including where recommended in writing by manufacturer, install gypsum panels over wood framing, with floating internal corner construction.
- P. STC-Rated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.
- Q. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
 - 1. Space screws a maximum of 12 inches o.c. for vertical applications.
- R. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.

3.04 PANEL APPLICATION METHODS:

- A. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of board.
 - b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
- B. Multilayer Application on Ceilings: Apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16

inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

- C. **Multilayer Application on Partitions/Walls:** Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 1. **Z-Furring Members:** Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
- D. **Single-Layer Fastening Methods:** Apply gypsum panels to supports with steel drill screws.
- E. **Multilayer Fastening Methods:** Fasten base layers and face layers separately to supports with screws.
- F. **Laminating to Substrate:** Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.
- G. **Curved Partitions:**
 - 1. Install panels horizontally and unbroken, to the extent possible, across curved surface plus 12-inch/300-mm-long straight sections at ends of curves and tangent to them.
 - 2. On convex sides of partitions, begin installation at one end of curved surface and fasten gypsum panels to studs as they are wrapped around curve. On concave side, start fastening panels to stud at center of curve and work outward to panel ends. Fasten panels to framing with screws spaced 12 inches o.c.
 - 3. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.
- H. **Exterior Soffits and Ceilings:** Apply exterior gypsum soffit board panels perpendicular to supports, with end joints staggered and located over supports.
 - 1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
 - 2. Fasten with corrosion-resistant screws.
- I. **Tile Backing Panels:**
 - 1. **Cementitious Backer Units:** ANSI A108.11, at locations indicated to receive tile.
 - 2. **Areas Not Subject to Wetting:** Install standard gypsum wallboard panels to produce a flat surface except at showers, tubs, and other locations indicated to receive water-resistant panels.
 - 3. Where tile backing panels abut other types of panels in the same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.05 INSTALLING TRIM ACCESSORIES:

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations shown or indicated. Install control joints according to ASTM C 840 and in specific locations approved by the Engineer for visual effect.

3.06 FINISHING GYPSUM BOARD ASSEMBLIES:

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 - 1. Level 1: At joints and angles, embed tape in joint compound. Panel surfaces must be free of excess joint compound.
 - 2. Level 2: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges in concealed spaces such as ceiling plenums..
 - 3. Level 3: Embed tape and apply separate first and fill coats of joint compound to tape, fasteners, and trim flanges at surfaces receiving textured finish.
 - 4. Level 4: At joints and angles, embed tape in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads, and flanges of trim accessories at surfaces receiving a smooth painted finish. Panel surfaces must and joint compound must be smooth and free of tool marks and ridges.
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- F. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.07 APPLYING TEXTURE FINISHES:

- A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.
- B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture matching approved mockup and free of starved spots or other evidence of thin application or of application patterns.
- C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture finish manufacturer's written recommendations.

3.08 FIELD QUALITY CONTROL:

- A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
1. Notify the Engineer in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 2. Before notifying the Engineer, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation.
 - b. Installation, insulation, and leak and pressure testing of water piping systems.
 - c. Installation of air-duct systems.
 - d. Installation of air devices.
 - e. Installation of mechanical system control-air tubing.
 - f. Installation of ceiling support framing.

END OF SECTION

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SECTION 09265

GYPSUM BOARD SHAFT-WALL ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This Section includes shaft enclosures.

1.02 DEFINITIONS

- A. Gypsum Board Construction Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board construction not defined in this Section or in other referenced standards.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance:
 - 1. Provide gypsum board shaft-wall assemblies capable of withstanding the full air-pressure loads indicated for maximum heights of partitions without failing and while maintaining an airtight and smoke-tight seal. Evidence of failure includes deflections exceeding limits indicated, bending stresses causing studs to break or to distort, and end-reaction shear causing track (runners) to bend or to shear and studs to become crippled.
 - 2. Provide gypsum board shaft-wall assemblies for horizontal duct enclosures capable of spanning distances indicated within deflection limits indicated.
 - 3. Air-pressure loads and deflection limits are specified in "Gypsum Board Shaft Wall" Article in Part 2.

1.04 SUBMITTALS

- A. Product Data: For each gypsum board shaft-wall assembly indicated.
- B. Fire-Test-Response Reports: From a qualified independent testing and inspecting agency substantiating each gypsum board shaft-wall assembly's required fire-resistance rating.
 - 1. Include data substantiating that elevator entrances and other items that penetrate each gypsum board shaft-wall assembly do not negate fire-resistance rating.
- C. Research/Evaluation Reports: Evidence of compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction that substantiate required fire-resistance rating for each gypsum board shaft-wall assembly.
- B. Acoustical-Test-Response Reports: From a qualified independent testing agency substantiating required STC rating for each gypsum board shaft-wall assembly.

1.05 QUALITY ASSURANCE

- A. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory," or GA-600, "Fire Resistance Design Manual."
- B. STC-Rated Assemblies: For gypsum board shaft-wall assemblies indicated to have STC ratings, provide assembly materials and construction complying with requirements of assemblies whose STC ratings were determined according to ASTM E 90 and classified according to ASTM E 413

by a qualified independent testing agency.

- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Management and Coordination." Review methods and procedures for installing work related to gypsum board shaft-wall assemblies including, but not limited to, the following:
1. Fasteners proposed for anchoring steel framing to building structure.
 2. Sprayed fire-resistive materials applied to structural framing.
 3. Elevator equipment, including hoistway doors, elevator call buttons, and elevator floor indicators.
 4. Wiring devices in shaft-wall assemblies.
 5. Doors and other items penetrating shaft-wall assemblies.
 6. Items supported by shaft-wall-assembly framing.
 7. Mechanical work enclosed within shaft-wall assemblies.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, and bundles bearing brand name and identification of manufacturer or supplier.
- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat on leveled supports off the ground to prevent sagging.

1.07 PROJECT CONDITIONS

- A. Comply with requirements for environmental conditions, room temperatures, and ventilation specified in Division 9 Section "Drywall Systems."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Gypsum Co.
 2. G-P Gypsum Corp.
 3. National Gypsum Company.
 4. United States Gypsum Co.

2.02 ASSEMBLY MATERIALS

- A. General: Provide materials and components complying with requirements of fire-resistance-rated assemblies indicated.
1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
 2. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.
- B. Steel Framing: ASTM C 645.
1. Protective Coating: Manufacturer's standard corrosion-resistant zinc coating.
- C. Gypsum Liner Panels: Manufacturer's proprietary liner panels in 1-inch (25.4-mm) thickness and with moisture-resistant paper faces.
- D. Gypsum Wallboard: ASTM C 36, core type as required by fire-resistance-rated assembly

indicated.

1. Edges: Tapered.
- E. Gypsum Base for Gypsum Veneer Plaster: ASTM C 588, core type as required by fire-resistance-rated assembly indicated, with edges as standard with manufacturer.
- F. Water-Resistant, Gypsum Backing Board: ASTM C 630/C 630M, core type as required by fire-resistance-rated assembly indicated.
- H. Accessories: Cornerbead, edge trim, and control joints of material and shapes specified in Division 9 Section "Drywall Systems" that comply with gypsum board shaft-wall assembly manufacturer's written recommendations for application indicated.
- I. Gypsum Wallboard Joint-Treatment Materials: ASTM C 475 and as specified in Division 9 Section "Drywall Systems."
- L. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- M. Track (Runner) Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
1. Powder-Actuated Fasteners: Provide powder-actuated fasteners with capability to sustain, without failure, a load equal to 10 times that imposed by shaft-wall assemblies, as determined by testing conducted by a qualified independent testing agency according to ASTM E 1190.
 2. Postinstalled Expansion Anchors: Where indicated, provide expansion anchors with capability to sustain, without failure, a load equal to 5 times that imposed by shaft-wall assemblies, as determined by testing conducted by a qualified independent testing agency according to ASTM E 488.
- N. Acoustical Sealant: As specified in Division 9 Section "Drywall Systems."
- O. Sound Attenuation Blankets: ASTM C 665 for Type I, unfaced mineral-fiber-blanket insulation produced by combining thermosetting resins with mineral fibers manufactured from slag or rock wool.

2.03 GYPSUM BOARD SHAFT WALL

- A. Basis-of-Design Product: As indicated on Drawings by design designation of a qualified testing and inspecting agency.
- B. Sustained Air-Pressure Loads: 7.5 lbf/sq. ft. (0.36 kPa).
- C. Deflection Limit: $L/360$.
- D. Studs: Manufacturer's standard profile for repetitive members and corner and end members and for fire-resistance-rated assembly indicated.
1. Depth: 2-1/2 inches (63.5 mm).
 2. Minimum Base Metal Thickness: Manufacturer's standard thicknesses that comply with structural performance requirements for stud depth indicated.

- E. Track (Runner): Manufacturer's standard J-profile track with long-leg length as standard with manufacturer, but at least 2 inches (51 mm), in depth matching studs.
 - 1. Minimum Base Metal Thickness: Manufacturer's standard thicknesses that comply with structural performance requirements for stud depth indicated.
- F. Jamb Struts: Manufacturer's standard J-profile strut with long-leg length of 3 inches (76.2 mm), in depth matching studs, and not less than 0.0341 inch (0.87 mm) thick.
- G. Room-Side Finish: Gypsum board.
- H. Shaft-Side Finish: As indicated by fire-resistance-rated assembly design designation.
- I. Cavity Insulation: Sound attenuation blankets.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates to which gypsum board shaft-wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Sprayed Fire-Resistive Materials: Coordinate with gypsum shaft-wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft-wall assemblies to comply with requirements specified in Division 7 Section "Sprayed Fire-Resistive Materials."
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (600 mm) o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of gypsum board assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.03 INSTALLATION

- A. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:
 - 1. ASTM C 754 for installing steel framing.
 - 2. Division 9 Section "Drywall Systems" for applying and finishing panels.
- B. Do not bridge building expansion joints with shaft-wall assemblies; frame both sides of joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
 - 1. At elevator hoistway door frames, provide jamb struts on each side of door frame.
 - 2. Where handrails directly attach to gypsum board shaft-wall assemblies, provide galvanized

steel reinforcing strip with 0.0312-inch (0.79-mm) minimum thickness of base (uncoated) metal, accurately positioned and secured behind at least 1 face-layer panel.

- D. Integrate stair hanger rods with gypsum board shaft-wall assemblies by locating cavity of assemblies where required to enclose rods.
- E. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
- F. Isolate gypsum finish panels from building structure to prevent cracking of finish panels while maintaining continuity of fire-rated construction.
- G. Install control joints to maintain fire-resistance rating of assemblies.
- H. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with manufacturer's written instructions or ASTM C 919, whichever is more stringent.
- I. In elevator shafts where gypsum board shaft-wall assemblies cannot be positioned within 2 inches (51 mm) of the shaft face of structural beams, floor edges, and similar projections into shaft, install 1/2- or 5/8-inch- (12.7- or 15.9-mm-) thick, gypsum board cants covering tops of projections.
 - 1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches (610 mm) o.c. with screws fastened to shaft-wall framing.
 - 2. Where steel framing is required to support gypsum board cants, install framing at 24 inches (610 mm) o.c. and extend studs from the projection to the shaft-wall framing.

END OF SECTION

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SECTION 09320

TILE

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. This section specifies providing ceramic tile, ceramic mosaic tile, quarry tile and marble thresholds, typically in restricted areas as shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Cast-in-Place Structural Concrete: Section 03300.
- B. Seals and Sealants: Section 07900.

1.03 PERFORMANCE REQUIREMENTS:

- A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C1028:
 - 1. Level Surfaces: Minimum 0.6.
 - 2. Ramp Surfaces (slope greater than 1:20): Minimum 0.8.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For each type of tile, mortar, grout, and other products specified. Include recommendations for product application and use.
- B. Shop Drawings: For the following:
 - 1. Tile patterns and locations.
 - 2. Widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Tile Samples for Initial Selection: Manufacturer's color charts consisting of actual tiles or sections of tiles showing the full range of colors, textures, and patterns available for each type and composition of tile indicated. Include Samples of accessories involving color selection.
- D. Grout Samples for Initial Selection: Manufacturer's color charts consisting of actual sections of grout showing the full range of colors available for each type of grout indicated.
- E. Samples for Verification: Of each item listed below, prepared on Samples of size and construction indicated. Where products involve normal color and texture variations, include Sample sets showing the full range of variations expected.
 - 1. Ceramic and Ceramic Mosaic Tile: Three panels of each type and composition of tile and for each color and texture required, 12 inches square, mounted on 16 inches square by 1/4-inch thick hardboard with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by the Engineer.
 - 2. Full-size units of each type of trim and accessory for each color required.

3. Quarry Tile: Four standard size units mounted on 16 inches square by 1/4-inch thick hardboard with grouted joints using product complying with specified requirements and approved for completed work in color or colors selected by the Engineer.
 4. Marble Threshold: Three 12-inch lengths showing range of color, veining and finish.
- F. Master Grade Certificates: For each shipment, type, and composition of tile, per ANSI A137.1, bearing TCA-Certification Mark, signed by tile manufacturer and Installer stating type and quality of material. Submit at time of shipment..
- G. Product Certificates: Signed by manufacturers certifying that the products furnished comply with requirements.
- H. Tile Test Reports: Certified test reports in accordance with ANSI A118.1 through A118.4.

1.05 QUALITY ASSURANCE:

- A. Codes Regulations, Reference Standards and Specifications:
1. Comply with the codes and regulations of the jurisdictional authorities.
 2. ADA: Americans with Disabilities Act.
 3. ANSI: A108.1C, A108.5, A108.6, A108.10, A118.1, A118.2, A118.3, A118.4, A118.6, A137.1.
 4. ASTM: A82, A185, C144, C150, C206, C207, C241, C503, C920, C1028, D4397.
 5. FS: UU-B-790.
 6. TCA: Handbook for Ceramic Tile Installation.
- B. Installer Qualifications: Engage an experienced installer who has completed tile installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Source Limitations for Tile: Obtain each color, grade, finish, type, composition, and variety of tile from one source with resources to provide products from the same production run for each contiguous area of consistent quality in appearance and physical properties without delaying the Work.
- D. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- E. Mockups: Before installing floor and wall tile, construct mockups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for completed Work.
1. Mockups shall be minimum four feet square and in the location as directed by the Engineer.
 2. Notify the Engineer seven days in advance of the dates and times when mockups will be constructed.
 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 4. Obtain the Engineer's approval of mockups before proceeding with final unit of Work.
 5. Approved mockups may become part of the completed Work.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver materials to the site in original unopened containers, clearly labeled with the manufacturer's name, brand designation, type, grade and color. Comply with requirement of ANSI A137.1 for labeling sealed tile packages.
- B. Store materials so as to prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.
- C. Handle materials so as to prevent breakage of containers and damage to materials.

1.07 PROJECT CONDITIONS:

- A. Environmental Limitations: Do not start tile work unless ambient temperature of area in which work occurs is at least 50 deg. F and rising and is maintained at not less than 50 deg. F without interruption while work is being done and for at least 72 hours after completion.
- B. Substrate Conditions: Do not start tile work unless surfaces to receive tile are in satisfactory condition. Commencement of tile work constitutes Contractor's acceptance of the subfloor condition in accordance with ANSI A108-AN-2, General Requirements for Subsurfaces.

1.08 EXTRA MATERIALS:

- A. Deliver extra materials to Owner. Furnish and store extra materials in locations as directed on pallets and in original containers with protective covering for storage, and are clearly identified with labels describing contents and area of placement.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 5 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.01 PRODUCTS, GENERAL:

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard Grade requirements, unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" article.
- C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:
 - 1. Provide Engineer's selections from manufacturer's full range of colors, textures, and patterns for products of type indicated.
 - 2. Provide tile trim and accessories that match color and finish of adjoining flat tile.
- D. Factory Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, blend tile in the factory and package so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples.

2.02 TILE PRODUCTS:

- A. Unglazed Ceramic Mosaic Floor Tile: Provide factory-mounted flat tile complying with the following requirements:
1. Composition: Porcelain or porcelain with abrasive admixture, as indicated.
 2. Module Size: 2 by 2 inches (nominal).
 3. Nominal Thickness: 1/4 inch.
 4. Face: Plain with cushion edges.
- B. Unglazed Quarry Tile: Provide square-edged flat tile complying with the following requirements:
1. Wearing Surface: Nonabrasive or abrasive aggregate embedded in surface, as indicated.
 2. Facial Dimensions: 6 by 6 inches (nominal).
 3. Thickness: 1/2 inch.
 4. Face: Plain.
- C. Glazed Wall Tile: Provide flat tile complying with the following requirements:
1. Module Size: 4-1/4 by 4-1/4 inches.
 2. Thickness: 5/16 inch.
 3. Face: Plain with cushion edges.
 4. Color: White.
- D. Trim Units: Provide tile trim units to match characteristics of adjoining flat tile and to comply with the following requirements:
1. Size: As indicated, coordinated with sizes and coursing of adjoining flat tile where applicable.
 2. Shapes: As follows, selected from manufacturer's standard shapes:
 - a. Base for Thin-Set Mortar Installations: Straight.
 - b. External Corners for Thin-Set Mortar Installations: Surface bullnose.
 - c. Internal Corners: Field-buttet square corners, except with coved base and cap angle pieces designed to member with stretcher shapes.

2.03 STONE THRESHOLDS:

- A. General: Provide stone thresholds that are uniform in color and finish, fabricated to sizes and profiles indicated to provide transition between tile surfaces and adjoining finished floor surfaces.
1. Fabricate thresholds to heights indicated, but not more than 1/2-inch above adjoining finished floor surfaces, with transition edges beveled on a slope of no greater than 1:2.
- B. Marble Thresholds: Provide marble thresholds complying with ASTM C503 requirements for exterior use and with a minimum abrasive-hardness value (Ha) of 10 per ASTM C241.
1. Provide white, honed marble complying with the Marble Institute of America's Group A requirements for soundness.

2.04 SETTING AND GROUTING MATERIALS:

- A. Portland Cement: ASTM C150, Type I.
- B. Sand: ASTM C144.
- C. Hydrated Lime: ASTM C206 or ASTM C207, Type S.

- D. Water: Potable.
- E. Portland Cement Mortar Installation Materials: Provide materials complying with ANSI A108.1A and as specified below:
 - 1. Cleavage Membrane: Polyethylene sheeting ASTM D4397, 4.0 mils thick.
 - 2. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A185 and ASTM A82, except for minimum wire size.
- F. Dry-Set Portland Cement Mortar: ANSI A118.1.
- G. Chemical-Resistant, Water-Cleanable, Ceramic Tile-Setting and -Grouting Epoxy: ANSI A118.3.
 - 1. Provide product capable of resisting continuous and intermittent exposure to temperatures of up to 140 deg F and 212 deg F, respectively, as certified by mortar manufacturer for intended use.
- H. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- I. Dry-Set Grout: ANSI A118.6, color as indicated.
- J. Chemical-Resistant Epoxy Grout: ANSI A118.3, color as indicated.
 - 1. Provide product capable of resisting continuous and intermittent exposure to temperatures of up to 140 deg F and 212 deg F, respectively, as certified by mortar manufacturer for intended use.

2.05 ELASTOMERIC SEALANTS AND BACKUP JOINT FILLER:

- A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements of Section 07900.
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.
- C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and temperature extremes.
- D. Multipart, Pourable Urethane Sealant for Use T: ASTM C920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.
- E. Backup Material: As recommended by sealant manufacturer and as required in Section 07900.
- F. Prime and Joint Cleaner: Use products as recommended by sealant manufacturer.

2.06 MISCELLANEOUS MATERIALS:

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland-cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

- B. Concrete Leveling Bed: In accordance with Section 03300, Class 3500 concrete, pea gravel course aggregate 1/4-inch minimum to 3/8-inch maximum. Adjust slump with plasticizers to maintain proper water-cement ratio.
- C. Building Paper: FS UU-B-790, red-rosin-sized building, Type I, Style 1B.
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.07 MIXING MORTARS AND GROUT:

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free from oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 series of tile installation standards for installations indicated.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
 - 3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust latter in consultation with the Engineer.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION:

- A. Remove coatings, including curing compounds, and other substances that contain soap, wax, oil, or silicone and are incompatible with tile-setting materials by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.
- B. Provide concrete substrates for tile floors installed with dry-set or latex-portland cement mortars that comply with flatness tolerances specified in referenced ANSI A108 series of tile installation standards for installations indicated.
 - 1. Use trowelable leveling and patching compounds per tile-setting material manufacturer's written instructions to fill cracks, holes, and depressions.
 - 2. Remove protrusions, bumps, and ridges by sanding or grinding.

- C. Provide leveling course for masonry or concrete-wall when variation exceeds 1/4-inch in eight feet. Leveling course shall consist of dry-set mortar to which an equal volume of a mixture of one-part portland cement and 1-1/2 parts sand has been added. Apply leveling course to maximum thickness of 1/4-inch.
- D. Blending: For tile exhibiting color variations within the ranges selected during Sample submittals, verify that tile has been blended in the factory and packaged so tile units taken from one package show the same range in colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.03 INSTALLATION, GENERAL:

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 series of tile installation standards in "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Coordinate tile work with work of other trades.
- D. Extend tile work into recesses and under or behind equipment and fixtures to form a complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- F. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are the same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
 - 1. For tile mounted in sheets, use plastic spacers to make joints between tile sheets the same width as joints within tile sheets so joints between sheets are not apparent in finished work.

3.04 FLOOR TILE INSTALLATION:

- A. General: Install floor tile by the portland cement mortar method in accordance with ANSI A108.1C.
- B. Tile Type: Unglazed ceramic mosaic tile and quarry tile.
- C. Setting Bed and Grout: ANSI A108.1C with the following mortar and grout:
 - 1. Dry-set portland cement mortar.
 - 2. Dry-set grout.
- D. Joint Widths: Install tile on floors joint widths as recommended by the tile manufacturer.

- E. Grout: Dry-set grout in accordance with ANSI A108.10.
- F. Where depression is not provided for mortar setting bed, install floor tile by the epoxy method in accordance with ANSI A108.6.

3.05 WALL TILE INSTALLATION:

- A. General: Install wall tile by the dry-set mortar method in accordance with ANSI A108.5.
- B. Tile Type: Glazed wall tile.
- C. Setting Bed and Grout: ANSI A108.5 with the following mortar and grout:
 - 1. Dry-set portland cement mortar.
 - 2. Dry-set grout.
- D. Joint Widths: Install tile on floors joint widths as recommended by the tile manufacturer.
- E. Grout: Dry-set grout in accordance with ANSI A108.10.
- F. Where inside corners are shown as flat tiles, make corner joint a sealant joint as specified for expansion joints below.

3.06 STONE THRESHOLD INSTALLATION:

- A. Stone Thresholds: Install stone thresholds at locations indicated; set in same type of setting bed as abutting field tile, unless otherwise indicated.
 - 1. Set thresholds in latex-portland cement mortar for locations where mortar bed would otherwise be exposed above adjacent nontile floor finish.

3.07 EXPANSION AND CONTROL JOINT INSTALLATION:

- A. Provide expansion and control joints around floor perimeters, at interior corners of tiled walls, in tile surfaces directly above joints in concrete substrates and where recommended by the TCA Handbook for Ceramic Tile Installation.
- B. Do not saw-cut joints after installing tiles.
- C. Install removable divider strips of the same depth as the finished tile system, including setting bed, to keep sealant joints free of setting bed, mortar and grout. Remove strips after grouting and curing operations in order to install sealant.
- D. Install and cure sealant in accordance with manufacturer's instructions. Use primer unless sealant manufacturer recommends against priming.

3.08 CLEANING AND PROTECTING:

- A. Cleaning: On completion of placement and grouting, clean tile surfaces with warm water and washing compound in accordance with recommendations of tile manufacturer. Sponge and wash tile thoroughly and polish with clean dry cloths.
 - 1. The use of acid or acid cleaners on tile is prohibited.

- B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, and otherwise defective tile work.
- C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure tile is without damage or deterioration at the time of Substantial Completion.
 - 1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with building paper taped to tile to prevent staining, damage, and wear. Lay board walkways on floors to be used as passageways.
 - 2. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

END OF SECTION

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SECTION 09511

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing lay-in acoustical panels and exposed suspension systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. NOT USED

1.03 DEFINITIONS:

- A. CAC: Ceiling Attenuation Class.
- B. LR: Light Reflectance coefficient.
- C. NRC: Noise Reduction Coefficient.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For each type of product specified provide manufacturer's printed product information including maintenance information.
- B. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension system members.
 - 2. Method of attaching suspension system hangers to building structure.
 - 3. Ceiling-mounted items including light fixtures; air outlets and inlets; speakers; sprinklers; and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
 - 4. Minimum Drawing Scale: 1/8 inch = 1 foot.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of actual acoustical panels or sections of acoustical panels, suspension systems, and moldings showing the full range of colors, textures, and patterns available for each type of ceiling assembly indicated.
- D. Samples for Verification: Full-size units of each type of ceiling assembly indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics. Provide three of each type.
 - 1. Full-size samples of each acoustical panel type, pattern, and color.
 - 2. Set of 12-inch-long samples of exposed suspension system members, including moldings, for each color and system type required.

3. Fasteners: Each type.
 4. Accessories.
- E. Product Test Reports: Indicate compliance of acoustical panel ceilings and components with requirements based on comprehensive testing of current products.

1.05 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Codes and regulations of the jurisdictional authorities.
 2. ASTM: A635, A641, B633, C635, CC636, 834, E84, E90, E488, E795, E1190, E1264.
 3. Cisca: Ceiling Systems Handbook.
 4. NAAMM: Metal Finishes Manual for Architectural and Metal Products.
- B. Installer Qualifications: Engage an experienced installer who has completed acoustical panel ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- C. Source Limitations for Ceiling Units: Obtain each acoustical ceiling panel from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
- D. Source Limitations for Suspension System: Obtain each suspension system from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
- E. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:
1. Fire-response tests were performed by UL, ITS/Warnock Hersey, or another independent testing and inspecting agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.
 2. Surface-burning characteristics of acoustical panels comply with ASTM E1264 for Class A materials as determined by testing identical products per ASTM E84.
 3. Products are identified with appropriate markings of applicable testing and inspecting agency.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver acoustical panels and suspension system components to Project site in original, unopened packages, clearly labeled with the manufacturer's name, brand designation, specification number, type, class and ratings as applicable.
- B. Store acoustical panels and suspensions system components in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.
- C. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- D. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.07 PROJECT CONDITIONS:

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet-work in spaces is complete and dry, and work above ceilings is complete. Maintain temperature of 70 deg F minimum and relative humidity of 55-percent maximum in spaces in which acoustical panel work is being done.

1.08 COORDINATION:

- A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.09 EXTRA MATERIALS:

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Full-size units equal to 5.0 percent of amount installed.
 - 2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS:

2.01 ACOUSTICAL PANELS, GENERAL:

- A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
 - 1. Mounting Method for Measuring Noise Reduction Coefficient: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E795.

2.02 METAL SUSPENSION SYSTEMS, GENERAL:

- A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C635 requirements.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
- C. Attachment Devices: Size for five times design load indicated in ASTM C635, Table 1, Direct Hung, unless otherwise indicated.
 - 1. Cast-in-Place and Post-installed Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling

construction, as determined by testing per ASTM E488, conducted by a qualified testing and inspecting agency.

- a. Type: Cast-in-place anchors.
 - b. Type: Post-installed expansion anchors.
 - c. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B633, Class Fe/Zn 5 (0.005 mm) for Class SC service condition (mild).
2. Post-installed Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190, conducted by a qualified testing and inspecting agency.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at five times hanger design load (ASTM C635, Table 1, Direct Hung) will be less than yield stress of wire, but provide not less than 12 gauge.
- E. Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners. Provide moldings with exposed flange of the same width as exposed runner.
- F. Metal Finish: Baked-Enamel Finish. Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with not less than 1.0-mil dry film thickness for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2.0 mils.
1. Color and Gloss: Matte white or as selected by the Engineer from manufacturer's full range of colors and glosses.

2.03 ACOUSTICAL SEALANT:

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C834 and the following requirements:
1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine substrates and structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage, and other conditions affecting performance of acoustical panel ceilings.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

- A. Coordination: Furnish layouts for cast-in-place anchors, clips, and other ceiling anchors whose installation is specified in other Sections.
 1. If indicated, furnish cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.
- B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.03 INSTALLATION:

- A. General: Install acoustical panel ceilings to comply with publications referenced below per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 1. Standard for Ceiling Suspension System Installations: Comply with ASTM C636.
- B. Suspend ceiling hangers from building's structural members and as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure; that are appropriate for substrate; and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, powder-actuated fasteners, or drilled-in anchors that extend through forms into concrete.
 6. Do not attach hangers to steel deck tabs.
 7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; and provide hangers not more than 6 inches from ends of each member.
- C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter inside and outside corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 2. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated or required.

3.04 FIELD QUALITY CONTROL OF POWER-ACTUATED FASTENERS AND POST-INSTALLED ANCHORS:

- A. Testing Agency: Contractor will engage a qualified independent testing agency to perform field quality-control testing.
- B. Extent and Testing Frequency: Testing will take place in successive stages in areas described below. Proceed with installation of acoustical panel ceilings only after test results for previously installed hangers comply with requirements.
1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
 2. Within each test area, testing agency will select one of every 10 powder-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
 3. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 consecutively pass and then will resume initial testing frequency.
- C. Testing agency will report test results promptly and in writing to Contractor and Engineer.
- D. Remove and replace those fasteners and anchors that test results indicate do not comply with specified requirements
- E. Additional Testing: Where fasteners and anchors are removed and replaced, additional testing will be performed to determine compliance with specified requirements.

3.05 CLEANING:

- A. Replace damaged and broken acoustical panels.

- B. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.
- C. Clean up rubbish and debris and remove from site.
- D. Leave work areas in a broom clean condition.

END OF SECTION

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SECTION 09650

RESILIENT FLOORING

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing rubber floor covering, vinyl composition floor tile, vinyl wall base, rubber stair treads and accessories.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For each type of product specified provide manufacturer's printed product information.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors and patterns available for each type of product indicated.
- C. Samples for Verification: Four of each type, color and pattern of the following materials used in the Work, showing the full range of variations expected:
 - 1. Floor Tile: 12 inches square.
 - 2. Wall Base: 12 inches long.
 - 3. Edge Strips: 12 inches long.
 - 4. Adhesive: Pint container.
- D. Product Certificates: Signed by manufacturers of resilient products certifying that each product furnished complies with requirements.
- E. Maintenance Data: For each type of product specified.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASTM: D2240, E648, E662, F710, F1066, F1344.
 - 3. FS: RR-T-650, SS-T-312, SS-W-40, UU-B-790.
- B. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing resilient products similar to those required for this Project and with a record of successful in-service performance.
- C. Source Limitations: Obtain each type, color, and pattern of product specified from one source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

- D. Fire-Test-Response Characteristics: Provide products with the following fire-test-response characteristics as determined by testing identical products per test method indicated below by a testing and inspecting agency acceptable to authorities having jurisdiction.
1. Critical Radiant Flux: 0.45 W/sq. cm or greater when tested per ASTM E648.
 2. Smoke Density: Maximum specific optical density of 450 or less when tested per ASTM E662.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver products to Project site in manufacturer's original, unopened cartons and containers, clearly labeled with manufacturer's name and brand designation, referenced specification number, type and color, and shipping and handling instructions.
- B. Store products in dry spaces protected from the weather, with ambient temperatures maintained between 50 and 90 deg F.
- C. Store tiles on flat surfaces.
- D. Handle products to prevent breakage of containers and damage to products.
- E. Move products into spaces where they will be installed at least 48 hours before installation, unless longer conditioning period is recommended in writing by manufacturer.

1.05 PROJECT CONDITIONS:

- A. Maintain a temperature of not less than 70 deg F or more than 90 deg F in spaces to receive products for at least 48 hours before installation, during installation, and for at least 48 hours after installation, unless manufacturer's written recommendations specify longer time periods. After post-installation period, maintain a temperature of not less than 55 deg F or more than 95 deg F.
- B. Do not install products until they are at the same temperature as
- C. Do not install base until plaster or other backing material has thoroughly dried.
- D. Close spaces to traffic during flooring installation and for time period after installation recommended in writing by manufacturer.
- E. Install tiles and accessories after other finishing operations, including painting, have been completed. Where demountable partitions and other items are indicated for installation on top of resilient tile flooring, install tile before these items are installed.
- F. Do not install flooring over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive, as determined by flooring manufacturer's recommended bond and moisture test.

1.06 EXTRA MATERIALS:

- A. Furnish and store where directed extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 - 1. Furnish not less than one percent of the total quantity of each type, color, pattern, class, wearing surface, and size of resilient tile flooring installed, but not less than one full unopened container.
 - 2. Furnish not less than one percent of the total quantity of each type, color, and size of base material installed, but not less than one full unopened container.

PART 2 - PRODUCTS

2.01 RESILIENT FLOORING:

- A. Rubber Floor Covering: Products complying with ASTM F1344 and with requirements specified.
 - 1. Manufacturers: including but not limited to:
 - a. R.C.A. Rubber Company.
 - b. Or equal.
 - 2. Color and Pattern: Terra Cotta.
 - 3. Class: I-A.
 - 4. Hardness: Durometer hardness not less than 85 Shore, Type A per ASTM D2240 as required according to ASTM F1344.
 - 5. Wearing Surface: Textured.
 - 6. Thickness: 3/16 inch.
 - 7. Fabrication: Fabricate heavy duty rubber mat with interlocking joints in five pieces to fit area shown, with edges square and true, without overlap.
- B. Vinyl Composition Floor Tile: Products complying with ASTM F1066 and with requirements specified:
 - 1. Manufacturers: including but not limited to
 - a. Armstrong.
 - b. Azrock.
 - c. GAF.
 - d. Kentile.
 - e. Or equal.
 - 2. Color and Pattern: As selected by the Engineer from manufacturer's full range of colors and patterns produced for tile complying with requirements indicated.
 - 3. Class: Class 2 (through-pattern tile).
 - 4. Wearing Surface: Smooth unless otherwise indicated.
 - 5. Thickness: 1/8 inch.
 - 6. Size: 12 by 12 inches.

2.02 RESILIENT ACCESSORIES:

- A. Vinyl Wall Base: Products complying with FS SS-W-40, Type II and with requirements specified:

1. Color and Pattern: As selected by the Engineer from manufacturer's full range of colors and patterns produced for vinyl wall base complying with requirements indicated
 2. Style: Cove with top-set toe unless otherwise indicated.
 3. Minimum Thickness: 1/8 inch.
 4. Height: 4 inches.
 5. Lengths: Cut lengths longest practicable or coils in lengths standard with manufacturer, but not less than 96 feet.
 6. Outside Corners: Job formed.
 7. Inside Corners: Job formed.
 8. Surface: Smooth.
- B. Rubber Stair Treads: Products of style suitable for use indicated and complying with FS RR-T-650, Composition A and with requirements specified:
1. Manufacturers: including but not limited to:
 - a. R.C.A. Rubber Company.
 - b. Or equal.
 2. Color and Pattern: Terra Cotta.
 3. Design: Type 1 (smooth).
 4. Abrasive Strips: Provide abrasive strips as specified by the product designation indicated above in color selected by the Engineer from manufacturer's full range of colors.
 5. Nosing Style: Round.
 6. Nosing Height: ½ inch light color.
 7. Thickness: 5/16-inch tapering to 3/16-inch at back edge.
 8. Size: Lengths and depths to fit each stair tread in one piece.
 9. Fabrication: Fabricate nosing of stair tread to wrap around curved ends of step, to provide a uniform elevation appearance on three sides of step. Abrade at least 80 percent of the back of tread and nosing to assure adhesion to substrate. Fabricate nosing so that it will not delaminate or otherwise separate from the stair tread material.

2.03 INSTALLATION ACCESSORIES:

- A. Tile Reducer Edge Strip: Products complying with FS SS-T-312, beveled, one-inch wide, 1/8-inch thick. Color to match vinyl wall base.
- B. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based formulation provided or approved by flooring manufacturer for applications indicated.
- C. Tile Adhesive: Waterproof asphalt cut-back cement recommended by manufacturer to suit resilient products and substrate conditions indicated.
- D. Stair Tread Adhesive: Permanent, as recommended by tread manufacturer for adhesion to galvanized steel substrate.
- E. Stair Tread Nose Filler: Two-part epoxy compound recommended by tread manufacturer to fill nosing substrates that do not conform to tread contours.
- F. Primer: As recommended by adhesive manufacturer.

- G. Base Cement: Water-resistant, type recommended by manufacturer of vinyl wall base.
- H. Building Paper: FS UU-B-790.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine substrates, areas, and conditions where installation of resilient products will occur, with Installer present, for compliance with manufacturer's requirements. Verify that substrates and conditions are satisfactory for resilient product installation and comply with requirements specified
- B. Concrete Sub-floors: Verify that concrete slabs comply with ASTM F710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by flooring manufacturer.

3.02 PREPARATION:

- C. General: Comply with resilient product manufacturer's written installation instructions for preparing substrates indicated to receive resilient products.
- D. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.
- E. Remove coatings, including curing compounds, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- F. Broom and vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.03 RESILIENT FLOORING INSTALLATION:

- A. General: Comply with flooring manufacturer's written installation instructions.
- B. Leveling Floor: Level floor by grinding high spots and filling low spots with leveling and patching compound following manufacturer's recommendations to ensure plane surface free of imperfections.
- C. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half of a tile at perimeter.
 - 1. Lay tiles square with room axis, unless otherwise indicated.
- D. Uniformity of Color: Use tiles alternately from at least two cartons so that pattern will be uniform and not spotty due to variation that may be found in different cartons. Match tiles for

color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Cut tiles neatly around all fixtures. Discard broken, cracked, chipped, or deformed tiles.

- E. Application of Primer: Unless adhesive manufacturer recommends against priming, apply primer at rate and by method recommended.
- F. Application of Adhesive: Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to comply with tile manufacturer's written instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.
 - 1. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- G. Laying of Tile:
 - 1. Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.
 - 2. Extend tiles into toe spaces, door reveals, closets, and similar openings.
 - 3. Provide joints cut straight and true. Seal tile joints at pipes with waterproof cement.
 - 4. Embed tiles level, flush with surface and with tightly butted joints against adjoining tiles.
 - 5. Hand roll tiles according to tile manufacturer's written instructions.
- H. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use chalk or other nonpermanent, nonstaining marking device.

3.04 RESILIENT ACCESSORY INSTALLATION:

- A. General: Install resilient accessories according to manufacturer's written installation instructions.
- B. Vinyl Wall Base: Apply resilient wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required. Extend wall base into closets and offsets adjoining areas to receive wall base.
 - 1. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
 - 2. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
 - 3. Do not stretch base during installation.
 - 4. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.
 - 5. Form outside corners on job from straight pieces of maximum lengths possible, without whitening at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
 - 6. Form inside corners on job, from straight pieces of maximum lengths possible, by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.

- C. Rubber Stair Tread: Adhere nosing so that it will not delaminate or otherwise separate from the stair tread material.
- D. Tile Reducer Edge Strip: Install edge strips at edges of flooring that would otherwise be exposed.
 - 1. Where tile stops at doorways without saddles or thresholds, set edge strips directly under doors.
- E. Place resilient accessories so they are butted to adjacent materials and bond to substrates with adhesive.

3.05 CLEANING AND PROTECTING:

- A. Perform the following operations immediately after installing resilient products:
 - 1. Remove adhesive and other surface blemishes using cleaner recommended by resilient product manufacturers.
- B. After flooring is laid and adhesive thoroughly cured, clean and finish resilient floors as recommended by the resilient product manufacturer with approved compatible products.
- C. Keep traffic off finished floors during the remainder of construction period.
- D. Protect flooring against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by flooring manufacturer.
 - 1. Cover products installed on floor surfaces with reinforced kraft building paper and tape joints. Maintain such cover and otherwise protect floor until final acceptance.
 - 2. Do not move heavy and sharp objects directly over floor surfaces. Place plywood or hardboard panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

3.06 MAINTENANCE MATERIALS:

- A. After completion of the work, furnish and store where directed at least one percent of the total quantity of tile and one percent of base material, but not less than one full unopened container of each, for future maintenance.
- B. Include proportional quantities of each type and color in original containers clearly marked to show contents and area of placement of each type and color.

END OF SECTION

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SECTION 09680

CARPET

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This Section includes tufted carpet.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 1 Section "Selective Demolition" for removing existing floor coverings.
- B. Division 9 Section "Resilient Flooring" for resilient wall base and accessories installed with carpet.
- C. Division 9 Section "Carpet Tile."

1.03 SUBMITTALS

- A. Product Data: For the following, including installation recommendations for each type of substrate:
 - 1. Carpet: For each type indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
- B. Shop Drawings: Show the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet.
 - 2. Existing flooring materials to be removed.
 - 3. Existing flooring materials to remain.
 - 4. Seam locations, types, and methods.
 - 5. Type of subfloor.
 - 6. Type of installation.
 - 7. Pattern type, repeat size, location, direction, and starting point.
 - 8. Pile direction.
 - 9. Transition details to other flooring materials.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet: 12-inch- (300-mm-) square Sample.
 - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.
- D. Product Schedule: For carpet. Use same designations indicated on Drawings.
- E. Qualification Data: For Installer.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- G. Maintenance Data: For carpet to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining carpet, including cleaning and stain-removal products and

- procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet.

H. Warranties: Special warranties specified in this Section.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
- B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to carpet installation including, but not limited to, the following:
 1. Review delivery, storage, and handling procedures.
 2. Review ambient conditions and ventilation procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."

1.06 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet over concrete slabs until slabs have cured, are sufficiently dry to bond with adhesive, and have pH range recommended by carpet manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet, install carpet before installing these items.

1.07 WARRANTY

- A. Special Warranty for Carpet: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.
 1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, and delamination.
 3. Warranty Period: Lifetime of carpet.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing

contents.

1. Carpet: Full-width rolls equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

PART 2 - PRODUCTS

2.01 TUFTED CARPET CPT-1

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis of Design: Subject to compliance with requirements, provide one of the following
 1. Lees faculty IV Dk166 - broadloom.
 - a. Color: As selected by Architect from manufacturer's full range, minimum color per location (3).
- C. Fiber Content: 100 percent nylon 6, 6 or 100 percent nylon 6.
- D. Fiber Type: DuPont: Antron Legacy with duratech soil protection.
- E. Pile Characteristic: Level-loop pile.
- F. Pile Thickness: 0.145 inches for finished carpet per ASTM D 6859.
- G. Stitches: 8.3 per inch.
- H. Gage: 1/8"
- I. Face Weight: 26 oz./sq.yd.
- J. Total Weight: 72.2 oz./sq.yd. for finished carpet.
- K. Primary Backing: Woven polypropylene.
- L. Secondary Backing: Woven polypropylene.
- M. Backcoating: Thermoplastic copolymer.
- N. Backing System: Unibond by Lees.
- O. Width: 12 feet (3.7 m).
- P. integral Soil-Resistance Treatment: Duratech soil treatment by Dupont
- Q. Antimicrobial Treatment: Manufacturer's standard material.
- R. Performance Characteristics: As follows:
 1. Flamability: passes DOC-FF-1-70 Pill Test
 2. Flooring Radiant Panel Test: Meets NFPA Class I when tested under ASTM E-648.
 3. Smoke Density: NFPA 258-Less than 450 Flaming Mode.
 4. Electrostatic Propensity: Less than 3.5kV per AATCC 134.

2.02 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet manufacturer.
- C. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.
- D. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet[cushion] manufacturer.
 - 2. Subfloor finishes comply with requirements specified in Division 3 Section "Cast-in-Place Concrete" for slabs receiving carpet.
 - 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.03 INSTALLATION

- A. Comply with CRI 104 and carpet manufacturer's written installation instructions for the following:
 - 1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
- B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.
- C. Do not bridge building expansion joints with carpet.
- D. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.
- E. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.
- H. Comply with carpet cushion manufacturer's written recommendations.

3.04 CLEANING AND PROTECTING

- A. Perform the following operations immediately after installing carpet:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
 - 2. Remove yarns that protrude from carpet surface.
 - 3. Vacuum carpet using commercial machine with face-beater element.
- B. Protect installed carpet to comply with CRI 104, Section 16, "Protection of Indoor Installations."
- C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet manufacturer.

END OF SECTION

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SECTION 09920

FIELD PAINTING

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. This section specifies furnishing and applying paint at the site.
 - 1. Specific surfaces and areas which require field painting and required paint systems are listed in the schedule of painting.
 - 2. Unless an item is shown not to be field painted or specified otherwise paint it in accordance with these specifications.

1.02 DEFINITIONS:

- A. Paint: Includes primers and undercoaters, sealers, stains, paint, varnish, enamel, epoxy and special coatings.

1.03 ITEMS NOT INCLUDED IN FIELD PAINTING:

- A. Stainless steel, ornamental metals, glass, resilient tile, ceramic tile, paving, acoustical tile, plastic laminate and similar items which are prefinished.
- B. Mill-, factory- and shop-applied primers and finishes.
- C. Corrosion-resistant structural steel, ASTM A242.
- D. High-strength structural corrosion-resistant steel shapes, plates and bars, ASTM A588.
- E. Galvanized-metal surfaces except fire stand pipes, unless exposed to public view.
- F. UL labels on fire-rated doors and frames.
- G. Precast or prestressed concrete with a sandblast finish, concrete sealer, or other special finish unless noted otherwise.
- H. Steel intended to be encased in concrete or otherwise coated with sprayed-on fire protective materials.

1.04 RELATED WORK SPECIFIED ELSEWHERE:

- A. Mill-, factory- and shop-applied prime and finish coats: Specified with the product.

1.05 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Samples:
 - 1. Three each of each color and texture, with identification of materials keyed to those specified and application methods.
 - 2. Samples of paint scheduled for application to smooth finishes applied to 12-inch square hardboard or metal panels.

3. Samples of paint scheduled for application to concrete masonry units applied to 16-inch square by two-inch thick panel of concrete masonry units, including one tooled masonry joint. Subdivide panel to define prime or filler, intermediate and finish coats.

1.06 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 1. Comply with codes and regulations of the jurisdictional authorities.
 2. FS: TT-E-489, TT-E-490, TT-E-509, TT-F-336, TT-F-1098, TT-P-19, TT-P-29, TT-P-636, TT-P-641, TT-P-645, TT-P-650, TT-P-664, TT-P-1510, TT-P-001984, TT-S-71, TT-S-300, TT-V-86, TT-V-119.
 3. ASME: A13.1.
 4. ANSI: Z535.1.
 5. ASTM: A242, A588, B117, C476, C920.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to the jobsite in their original unopened containers clearly labeled with the manufacturer's name and brand designation, referenced specification number and type, as applicable.
- B. Store products in an approved ventilated dry area, protect from contact with soil and from exposure to the elements. Always keep products dry. Do not allow paint to freeze.
- C. Handle products in a manner that will prevent breakage of containers and damage to products.

1.08 JOB CONDITIONS:

- A. Environmental Requirements:
 1. Do not apply paint to non-protected surfaces in wet weather or to surfaces on which ice, frost, water or dampness is visible.
 2. Do not apply exterior paint when the temperature is below 40F or expected to fall below this temperature. Do not apply interior paint when the temperature is lower than 60F or expected to fall below this temperature.
 3. Avoid painting steel which is at a temperature which can cause blistering, porosity, or otherwise be detrimental to the life of the paint. When paint is applied in hot weather or thinned in cold weather ensure that the specified thickness of paint coating is obtained.
 4. Do not apply paint in rain, wind, snow, fog or mist or when the steel surface temperature is below the dew point, resulting in condensation of moisture.
 5. Do not apply interior paint when, in the Engineer's opinion, satisfactory results cannot be obtained due to high humidity and excessive temperature; however, failure of the Engineer to notify the Contractor of the conditions will not relieve the Contractor of responsibility to produce satisfactory results.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. To the maximum extent practicable, use the materials of one manufacturer throughout the project. No claims as to the suitability of a material specified, or of inability to produce first-

class work with these materials, will be considered unless such claims are made in writing and submitted with the Contractor's Bid Proposal.

- B. Provide a primer suitable for each substrate type and which is manufactured or recommended by the paint manufacturer as part of a complete painting system.
- C. Previously Primed Surfaces:
 - 1. If surfaces have been primed off-site at the mill, factory or shop, omit specified primer, but only if the off-site primer is acceptable to the paint system manufacturer for best performance of the specified paint system.
 - 2. For touch-up of off-site primer, use primer of the same composition as the mill, factory or shop primer.
- D. VOC Requirements: Provide products in compliance with local volatile organic compound regulations. If the listed product of a manufacturer does not comply, provide an accepted equivalent product which does comply.
- E. Colors:
 - 1. Prior to beginning work, the Contractor will be furnished sample color chips and a Color and Material Schedule for surfaces to be painted.
 - 2. Match the colors of the chips and submit samples before proceeding. Label samples for surface finishes such as satin, flat or gloss as listed in the Color and Material Schedule.
 - 3. Tint each coat of paint slightly lighter or darker than the preceding coat or the finish coat.
 - 4. Final approval of colors will be made by the Engineer on samples applied on the job.
 - 5. Safety Colors: Items specified to be safety colors, e.g. OSHA red (safety red) and ANSI orange, to be in compliance with ANSI Z535.1, Safety Color Code.
- F. Listed materials are a guide to quality intended. Substitute materials and paint systems acceptable to the Engineer, as an equal or of superior quality for each intended use, may be used in the work at no additional cost to the Authority.
- G. Accessory Materials:
 - 1. General: Provide miscellaneous materials and accessories, whether listed or not, as necessary to complete the work in an approved manner.
 - 2. Caulk: Single-component, chemically curing, synthetic rubber, non-sag, ASTM C920, Type S, NS, Class 25.
 - 3. Spackling compound: Ready-mixed type, U.S. Gypsum Ready-Mixed Joint Compound - Topping, ASTM C476 or equal.
 - 4. Thinner: As recommended by the paint manufacturer.

2.02 EXTERIOR PAINTING SYSTEMS:

- A. Exterior Paint Schedule: Provide the paint systems scheduled below for the various substrates, as indicated. Provide a complete paint system by one manufacturer for each substrate. Unless otherwise indicated, provide the following:
 - 1. Concrete and masonry (except concrete masonry units): Acrylic, flat.
 - 2. Concrete masonry units: Acrylic, flat.
 - 3. Portland cement plaster (soffits): Acrylic, flat.
 - 4. Ferrous metal: Silicone-alkyd, semigloss.
 - 5. Zinc-coated metal: Silicone-alkyd, semigloss.
 - 6. Aluminum: Alkyd, semigloss.
 - 7. Wood: Acrylic-enamel, semigloss.

8. Mechanical and electrical items (not finish painted): See substrate materials above.
- B. Concrete, Masonry (except concrete masonry units), and portland cement plaster - Acrylic, Flat: Two coats with total dry film thickness not less than 2.5 mils.
1. Undercoat: Quick-drying, flat, acrylic paint for use on the exterior over concrete, masonry, and portland cement plaster (FS TT-P-19):
 - a. Con-Lux: Mason-Plex 800 Series.
 - b. Devoe: 15XX Wonder-Shield Exterior Acrylic Latex Flat House Paint.
 - c. Moore: Moore's Flat Exterior Latex Masonry & House Paint #105.
 2. S-W:A-100 Acrylic Latex Flat Exterior Finish, A-6 Series. Finish Coat: Quick-drying, flat, acrylic paint for use on the exterior over concrete, masonry, and portland cement plaster (FS TT-P-19)
 - a. Con-Lux: Mason-Plex 800 Series.
 - b. Devoe: 15XX Wonder-Shield Exterior Acrylic Latex Flat House Paint.
 - c. Moore: Moore's Flat Exterior Latex Masonry & House Paint #105.
 - d. S-W: A-100 Acrylic Latex Flat Exterior Finish, A-6 Series.
- C. Concrete Masonry Units - Acrylic, Flat: Two coats over block filler with total dry film thickness not less than 2.5 mils, excluding the block filler.
1. Block Filler: High performance latex block filler used for filling open textured concrete masonry block before application of top coats:
 - a. Con-Lux: Block-Plex 85 White.
 - b. Devoe: 52901 Bloxfil Acrylic Latex Block Filler.
 - c. Moore: Moorcraft Block Filler #145.
 - d. S-W: Heavy-Duty Block Filler B42W46.
 2. Undercoat: Quick-drying, flat, acrylic paint for use on the exterior over concrete masonry block (FS TT-P-19):
 - a. Con-Lux: Mason-Plex 800 Series.
 - b. Devoe: 15XX Wonder-Shield Exterior Acrylic Latex Flat House Paint.
 - c. Moore: Moore's Flat Exterior Latex Masonry & House Paint #105.
 - d. S-W: A-100 Acrylic Latex Flat Exterior Finish, A-6 Series.
 3. Finish Coat: Quick-drying, flat, acrylic paint for use on the exterior over concrete masonry block (FS TT-P-19):
 - a. Con-Lux: Mason-Plex 800 Series.
 - b. Devoe: 15XX Wonder-Shield Exterior Acrylic Latex Flat House Paint.
 - c. Moore: Moore's Flat Exterior Latex Masonry & House Paint #105.
 - d. S-W: A-100 Acrylic Latex Flat Exterior Finish, A-6 Series
- D. Ferrous Metal - Silicone-Alkyd, Semigloss: Two coats over primer.(Apply a second coat of primer on steel which is at grade, at slab, or passing through floor slabs. Apply to a uniform line six inches above top of grade or slab.)
1. Primer: Lead and chromate-free high solids primer which chemically inhibits rusting and is recommended by the manufacturer for application to steel which has been prepared in accordance with SSPC SP2. Rated 10 (less than 0.01% surface rusting) when tested in accordance with ASTM B117 for 500 hours. Exceeds performance requirements of FS TT-P-636:
 - a. Con-Lux: Rust Arrestor 50.
 - b. S-W: Kem Kromik Universal Metal Primer B50NZ6.
 - c. Thnemec: Series P10.
 2. Undercoat: Alkyd enamel recommended by manufacturer of finish coat as an intermediate coat over specified primer for application of silicone-alkyd finish coat:

- a. Con-Lux: Ferrox Primer.
 - b. S-W: Silicone Alkyd Enamel B-56 Series.
 - c. Tnemec: Series 23 Enduratone.
 - 3. Finish Coat: Silicone-alkyd enamel with a minimum of 30% silicone content meeting the qualitative requirements of FS TT-E-490:
 - a. Con-Lux: Steel-Master 9500 Series.
 - b. S-W: Silicone Alkyd Enamel B-56 Series.
 - c. Tnemec: Series 82 Silicone-Alkyd Enamel.

- E. Ferrous Metal - Alkyd, Semigloss: Two coats over primer (primer is not required on shop-primed items):
 - 1. Primer: Quick-drying, rust-inhibiting primer for priming ferrous metal under alkyd enamel (FS TT-P-664):
 - a. Con-Lux: Ferrox Primer, 25 Red.
 - b. Devoe: 41820 Bar-Ox Alkyd Shop/Field Primer.
 - c. Moore: Ironclad Retardo Rust-Inhibitive Paint #163.
 - d. S-W: Kem Kromik Metal Primer B50N2/B50W1.
 - 2. Undercoat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated ferrous metal (FS TT-E-489, Class A):
 - a. Con-Lux: Enamelite Semi-Luster Series
 - b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
 - c. Moore: Impervo Enamel #133.
 - d. S-W: Industrial Enamel, B-54Z Series.
 - 3. Finish Coat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated ferrous metal (FS TT-E-489, Class A):
 - a. Con-Lux: Enamelite Semi-Luster Series.
 - b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
 - c. Moore: Impervo Enamel #133.
 - d. S-W: Industrial Enamel, B-54Z Series.

- F. Zinc-Coated Metal - Silicone-Alkyd, Semigloss: Two coats over factory-applied primer:
 - 1. Primer: Galvanized metal primer used to prime zinc-coated (galvanized) metal surfaces (FS TT-P-641), or one of the following.
 - a. Con-Lux: Bond-Plex 46 Barrier Green.
 - b. Devoe: 13201 Mirrolac Galvanized Metal Primer.
 - c. Moore: Ironclad Galvanized Metal Latex Primer #155.
 - d. S-W: Industrial Water Based Acrylic Paint B42W110.
 - 2. Undercoat: Alkyd enamel recommended by manufacturer of finish coat as an intermediate coat over factory-applied primer for application of silicone-alkyd finish coat:
 - a. Con-Lux: Ferrox Primer.
 - b. S-W: Silicone Alkyd Enamel B-56 Series.
 - c. Tnemec: Series 23 Enduratone.
 - 3. Finish Coat: Silicone-alkyd enamel with a minimum of 30% silicone content meeting the qualitative requirements of FS TT-E-490:
 - a. Con-Lux: Steel-Master 9500 Series.
 - b. S-W: Silicone Alkyd Enamel B-56 Series.
 - c. Tnemec: Series 82 Silicone-Alkyd Enamel.

- G. Zinc-Coated Metal - Alkyd, Semigloss: Two coats over primer:
 - 1. Primer: Galvanized metal primer used to prime zinc-coated (galvanized) metal surfaces (FS TT-P-641), or one of the following:
 - a. Con-Lux: Bond-Plex 46 Barrier Green.
 - b. Devoe: 13201 Mirrolac Galvanized Metal Primer.
 - c. Moore: Ironclad Galvanized Metal Latex Primer #155.

- d. S-W: Industrial Water Based Acrylic Paint B42W110.
 2. Undercoat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated zinc-coated (galvanized) metal (FS TT-E-489, Class A):
 - a. Con-Lux: Enamelite Semi-Luster Series.
 - b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
 - c. Moore: Impervo Enamel #133.
 - d. S-W: Industrial Enamel, B-54Z Series.
 3. Finish Coat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated zinc-coated (galvanized) metal (FS TT-E-489, Class A):
 - a. Con-Lux: Enamelite Semi-Luster Series.
 - b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
 - c. Moore: Impervo Enamel #133.
 - d. S-W: Industrial Enamel, B-54Z Series.
- H. Aluminum - Alkyd, Semigloss: Two coats over primer:
1. Primer: Alkyd-type zinc chromate primer used for priming aluminum under alkyd enamels (FS TT-P-645), or one of the following.
 - a. Con-Lux: Bond-Plex 46 Barrier Green.
 - b. Devoe: 41839 Bar-Ox Zinc Chromate Primer.
 - c. Moore: Ironclad Retardo Rust Inhibitive Paint #163.
 - d. S-W: Zinc Chromate Primer B50Y1.
 2. Undercoat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated aluminum (FS TT-E-489, Class A):
 - a. Con-Lux: Enamelite Semi-Luster Series.
 - b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
 - c. Moore: Impervo Enamel #133.
 - d. S-W: Industrial Enamel, B-54Z Series.
 3. Finish Coat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated aluminum (FS TT-E-489, Class A):
 - a. Con-Lux: Enamelite Semi-Luster Series
 - b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
 - c. Moore: Impervo Enamel #133.
 - d. S-W: Industrial Enamel, B-54Z Series.
- I. Wood - Acrylic Enamel, Semigloss: Two coats over primer with total dry film thickness not less than 2.5 mils:
1. Primer: Exterior alkyd or latex primer made for use on wood under an acrylic enamel (FS TT-P-001984):
 - a. Con-Lux: Wood-Plex 700 Primer.
 - b. Devoe: 1102 All-Weather Exterior Alkyd House Paint Primer.
 - c. Moore: Moorwhite Primer #100.
 - d. S-W: A-100 Exterior Latex Wood Primer
 2. Undercoat: Semigloss, waterborne, exterior, acrylic enamel made for use as an undercoat over a primer on wood under an acrylic enamel (FS TT-P-1510):
 - a. Con-Lux: Weather-Plex 700 Series
 - b. Devoe: 17XX Wonder-Shield Semi-Gloss Exterior Acrylic latex House and Trim Paint.
 - c. Moore: MoorGlo Latex House and Trim Paint #096.
 - d. S-W: A-100 Exterior Latex Satin.
 3. Finish Coat: Semigloss, waterborne, exterior, acrylic enamel made for use as a finish coat over an acrylic enamel (FS TT-P-1510):
 - a. Con-Lux: Weather-Plex 700 Series.
 - b. Devoe: 17XX Wonder-Shield Semi-Gloss Exterior Acrylic latex House and Trim Paint.
 - c. Moore: MoorGlo Latex House and Trim Paint #096.

- d. S-W: A-100 Exterior Latex Satin.
- J. Wood - Stained-Varnish: Two coats over sealer over stain plus filler on open-grain wood. Wipe filler before applying first varnish coat.
1. Stain Coat: Match interior stained-varnish finish.
 2. Sealer: Phenolic varnish for use on exterior natural-finished woodwork (FS TT-V-119), thinned as recommended by manufacturer:
 - a. Con-Lux: Imperial 71 Spar Varnish.
 - b. Devoe: 87 Spar Varnish.
 - c. Moore: Impervo 440 Spar Varnish.
 - d. S-W: Exterior Varnish A67V4
 3. Undercoat: Phenolic varnish for use on exterior natural-finished woodwork (FS TT-V-119):
 - a. Con-Lux: Imperial 71 Spar Varnish.
 - b. Devoe: 87 Spar Varnish.
 - c. Moore: Impervo 440 Spar Varnish.
 - d. S-W: Exterior Varnish A67V4.
 4. Finish Coat: Phenolic varnish for use on exterior natural-finished woodwork (FS TT-V-119):
 - a. Con-Lux: Imperial 71 Spar Varnish.
 - b. Devoe: 87 Spar Varnish.
 - c. Moore: Impervo 440 Spar Varnish.
 - d. S-W: Exterior Varnish A67V4.

2.03 INTERIOR PAINTING SYSTEMS:

- A. Interior Paint Schedule: Provide the paint systems scheduled below for the various substrates, as indicated. Provide a complete paint system by one manufacturer for each substrate. Unless otherwise indicated, provide the following:
1. Concrete and masonry (except concrete masonry units and concrete floors): Latex, flat.
 2. Concrete masonry units (except ground-faced CMU, which is to be left unpainted): Latex, flat.
 3. Concrete floors: Epoxy, gloss, with anti-slip aggregate.
 4. Gypsum plaster, veneer plaster, and GFRG: Latex, eggshell.
 5. Acoustical plaster: Unpainted.
 6. Gypsum board: Latex, flat.
 7. Woodwork: Stained-varnish finish, except alkyd, semigloss where painted is indicated.
 8. Ferrous metal:
 - a. Exposed steel structure: Silicone-alkyd, semigloss.
 - b. Other interior ferrous metal: Alkyd, semigloss.
 9. Zinc-coated metal: Alkyd, semigloss; except silicone-alkyd where part of ferrous metal assemblies painted with silicone-alkyd.
 10. Non-ferrous metal: Alkyd, semigloss.
 11. Cotton and canvass covering over insulation: Latex, flat.
 12. Mechanical and electrical items (not finish painted): See substrate materials above.
- B. Concrete and Masonry (Except concrete masonry units) - Latex, Flat: Two coats.
1. Undercoat: Flat latex-based paint made for use as an undercoat over concrete and masonry under a flat latex paint (FS TT-P-29):
 - a. Con-Lux: Jet-Plex 495 Primer.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Moore's Latex Quick-Dry Prime Seal 201.

- d. S-W: Pro-Mar 200 Latex Flat B30W200.
 - 2. Finish Coat: Flat latex-based paint made for use as a flat finish over concrete and masonry (FS TT-P-29):
 - a. Con-Lux: Wall-Plex 400 Series.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Regal Wall Satin 215.
 - d. S-W: Pro-Mar 200 Latex Flat Wall Paint B30W200 Series.
- C. Concrete and Masonry (Except concrete masonry units) - Alkyd, Semigloss: Two coats over primer with total dry film thickness not less than 3.5 mils.
 - 1. Primer: Flat latex-based paint made for use as a primer over concrete and masonry under an odorless alkyd enamel (FS TT-P-29):
 - a. Con-Lux: Wall-Plex 400 Series.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Moore's Latex Quick-Dry Prime Seal 201.
 - d. S-W: Pro-Mar 200 Latex Flat B30W200.
 - 2. Undercoat: Enamel undercoat made for use on the interior as an undercoat over a primer on concrete or masonry under an odorless alkyd enamel:
 - a. Con-Lux: Enamel Underbase 54 White.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Alkyd Enamel Underbody 217.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
 - 3. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on concrete and masonry (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
- D. Concrete and Masonry (Except concrete masonry units) - Epoxy, Semi-Gloss: Two coats over primed surface.
 - 1. Primer: Sealer made for use as a primer over masonry wall surfaces and under an epoxy enamel:
 - a. Con-Lux: Jet-Plex 495 Primer.
 - b. Duron: Acrylic Enamel Undercoater.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: Kem Cati-Coat Epoxy Filler/Sealer.
 - 2. Undercoat: Epoxy enamel undercoat made for use under a semi-gloss epoxy enamel:
 - a. Con-Lux: Epolon Semi-Luster Series.
 - b. Duron: Polyamide Epoxy.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: Heavy Duty Epoxy.
 - 3. Finish Coat: Semi-gloss epoxy enamel finish coat made for use over an epoxy enamel undercoat:
 - a. Con-Lux: Epolon Semi-Luster Series.
 - b. Duron: Polyamide Epoxy.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: Heavy Duty Epoxy.
- E. Concrete Masonry Units (Except ground-faced CMU, which is to be left unpainted) - Latex, Flat: Two coats over filled surface.
 - 1. Block Filler: High-performance latex block filler made for use for filling open textured concrete masonry block before application of top coats (FS TT-F-1098):
 - a. Con-Lux: Block-Plex 85 White.

- b. Devoe: 52901 Bloxfil Acrylic Latex Block Filler.
 - c. Moore: Moorcraft Interior and Exterior Block Filler 173.
 - d. S-W: Heavy-Duty Block Filler B42W46.
 - 2. Undercoat: Flat latex-based paint made for use as an undercoat over filled concrete masonry block under a flat latex paint (FS TT-P-29):
 - a. Con-Lux: Wall-Plex 400 Series.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Moore's Latex Quick-Dry Prime Seal 201.
 - d. S-W: Pro-Mar 200 Latex Flat B30W200.
 - 3. Finish Coat: Flat latex-based Paint made for use as a flat finish over filled concrete masonry block (FS TT-P-29):
 - a. Con-Lux: Wall-Plex 400 Series.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Regal Wall Satin 215.
 - d. S-W: Pro-Mar 200 Latex Flat Wall Paint B30W200 Series.
- F. Concrete Masonry Units (Except ground-faced CMU, which is to have clear anti-graffiti coating over unfilled surface) - Alkyd, Semigloss: Two coats over filled surface with total dry film thickness not less than 3.5 mils, excluding filler coat
 - 1. Block Filler: High-performance latex block filler made for use for filling open textured concrete masonry block before application of top coats (FS TT-F-1098):
 - a. Con-Lux: Block-Plex 85 White.
 - b. Devoe: 52901 Bloxfil Acrylic Latex Block Filler.
 - c. Moore: Moorcraft Interior and Exterior Block Filler 173.
 - d. S-W: Heavy-Duty Block Filler B42W46.
 - 2. Undercoat: Enamel undercoat made for use on the interior as an undercoat over a block filler on concrete masonry block under an odorless alkyd enamel:
 - a. Con-Lux: Enamel Underbase 54 White.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Alkyd Enamel Underbody 217.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
 - 3. Finish Coat: Semigloss odorless alkyd enamel made for use over a block filler and undercoat on concrete masonry block (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
- G. Concrete Masonry Units (Except ground-faced CMU, which is to have clear anti-graffiti coating over unfilled surface) - Epoxy, Semi-Gloss: Two coats over filled surface.
 - 1. Filler: Filler made for use as a primer over masonry wall surfaces and under an epoxy enamel:
 - a. Con-Lux: Jet-Plex 495 Primer; or Block-Plex Block Filler.
 - b. Duron: Acrylic Enamel Undercoater; or Block Kote Latex Block Filler.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel; or Moorcraft Interior and Exterior Block Filler.
 - d. S-W: Kem Cati-Coat Epoxy Filler/Sealer; or Heavy Duty Block Filler.
 - 2. Undercoat: Epoxy enamel undercoat made for use under a semi-gloss epoxy enamel:
 - a. Con-Lux: Epolon Semi-Luster Series.
 - b. Duron: Polyamide Epoxy.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: Heavy Duty Epoxy.

3. Finish Coat: Semi-gloss epoxy enamel finish coat made for use over an epoxy enamel undercoat:
 - a. Con-Lux: Epolon Semi-Luster Series.
 - b. Duron: Polyamide Epoxy
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: Heavy Duty Epoxy.

- H. Concrete Floor Surfaces - Epoxy, Gloss: Two coats over primer, with anti-slip aggregate in finish coat:
 1. Primer: Epoxy sealer made for use as a primer over concrete floor surfaces and under an epoxy enamel:
 - a. Con-Lux: None required.
 - b. Duron: Acrylic Enamel Undercoater
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: ArmorSeal 3300LV Epoxy Primer/Sealer.
 2. Undercoat: Epoxy enamel undercoat made for use over an epoxy primer and under a gloss epoxy enamel:
 - a. Con-Lux: Epolon Series with Epolon 145 Reducer.
 - b. Duron: Polyamide Epoxy.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: ArmorSeal 1000HS.
 3. Finish Coat: Epoxy enamel finish coat made for use over an epoxy enamel undercoat:
 - a. Con-Lux: Epolon Series with anti-slip aggregate.
 - b. Duron: Polyamide Epoxy with anti-slip aggregate.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel with anti-slip aggregate.
 - d. S-W: ArmorSeal 1000HS with anti-slip aggregate.

- I. Gypsum Plaster, Veneer Plaster, and GFRG - Latex, Eggshell (Low-Gloss): Two coats over primer; plus sealer for GFRG.
 1. Sealer for GFRG: Same as primer coat, to expose hot spots and facilitate sanding to remove "fiber bloom".
 2. Primer: Flat latex-based paint made for use as a primer on plaster under an eggshell latex paint (FS TT-P-29):
 - a. Con-Lux: Jet-Plex 495 Primer.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Moore's Latex Quick-Dry Prime Seal 201.
 - d. S-W: Wall and Wood Primer B99WZ2.
 3. Undercoat: Eggshell latex paint made for use over a primer on plaster (Performance requirements of FS TT-P-29):
 - a. Con-Lux: Luster-Plex 2000 Series.
 - b. Devoe: 34XX Wonder-Tones Interior Latex Eggshell Enamel.
 - c. Moore: Regal AquaVelvet 319.
 - d. S-W: Pro-Mar 200 Latex Eggshell Enamel B20W200 Series.
 4. Finish Coat: Eggshell latex paint made for use over a primer and undercoat on plaster (Performance requirements of FS TT-P-29):
 - a. Con-Lux: Luster-Plex 2000 Series.
 - b. Devoe: 34XX Wonder-Tones Interior Latex Eggshell Enamel.
 - c. Moore: Regal AquaVelvet 319.
 - d. S-W: Pro-Mar 200 Latex Eggshell Enamel B20W200 Series.

- J. Gypsum Plaster, Veneer Plaster, and GFRG - Alkyd, Semigloss: Two coats over primer with total dry film thickness not less than 2.5 mils; plus sealer for GFRG.

1. Sealer for GFRG: Same as primer coat, to expose hot spots and facilitate sanding to remove "fiber bloom".
 2. Primer: Flat latex-based paint made for use as a primer on plaster under an odorless alkyd enamel (FS TT-P-29):
 - a. Con-Lux: Jet-Plex 495 Primer.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Moore's Latex Quick-Dry Prime Seal 201.
 - d. S-W: Wall and Wood Primer B99WZ2.
 3. Undercoat: Enamel undercoat made for use as an undercoat over a primer on plaster under an odorless alkyd enamel:
 - a. Con-Lux: Enamel Underbase 54 White.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel
 - c. Moore: Moore's Alkyd Enamel Underbody 217.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series
 4. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on plaster (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
- K. Gypsum Board - Latex, Flat: 1 coat over primer.
1. Primer: Latex-based white primer made for use on interior gypsum board under a flat latex paint (FS TT-P-650):
 - a. Con-Lux: Jet-Plex 495 Primer.
 - b. Devoe: 50801 Wonder-Tones Latex Primer and Sealer.
 - c. Moore: Moore's Latex Quick-Dry Prime Seal 201.
 - d. S-W: Pro-Mar 200 Latex Wall Primer B28W200.
 2. Finish Coat: Flat latex-based paint made for use as a flat finish over prime-coated gypsum board (FS TT-P-29):
 - a. Con-Lux: Wall-Plex 400 Series.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Regal Wall Satin 215.
 - d. S-W: Pro-Mar 200 Latex Flat Wall Paint B30W200 Series.
- L. Gypsum Board - Alkyd, Semigloss: Two coats over primer with total dry film thickness not less than 2.5 mils.
1. Primer: Latex-based white primer made for use on interior gypsum board under an odorless alkyd enamel (FS TT-P-650):
 - a. Con-Lux: Jet-Plex 495 Primer.
 - b. Devoe: 50801 Wonder-Tones Latex Primer and Sealer.
 - c. Moore: Moore's Latex Quick-Dry Prime Seal 201.
 - d. S-W: Pro-Mar 200 Latex Wall Primer B28W200.
 2. Undercoat: Enamel undercoat made for use on the interior as an undercoat over a primer on interior gypsum board under an odorless alkyd enamel:
 - a. Con-Lux: Enamel Underbase 54 White.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Alkyd Enamel Underbody 217.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
 3. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on interior gypsum board (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.

- M. Woodwork, Stained-Varnish: Two coats over sealer over stain plus filler on open-grain wood. Wipe filler before applying first varnish coat.
1. Stain Coat: Slow-penetrating oil-type wood stain made for general use on interior wood surfaces under a varnish finish (FS TT-S-71):
 - a. Devoe: 96XX Wonder Woodstain Alkyd Stain.
 - b. Moore: Moore's Interior Wood Finishes Penetrating Stain 241.
 - c. S-W: Oil Stain A-48 Series.
 2. Sealer: Quick-drying, rosin-free, clear, general-purpose shellac varnish made for use on the interior over stained-finished woodwork under a varnish finish (FS TT-S-300, Grade A):
 - a. Devoe: 4900 Wonder Woodsealer Quick-Dry Sealer.
 - b. Moore: Moore's Interior Wood Finishes, Quick-Dry Sanding Sealer 413.
 - c. S-W: Pro-Mar Varnish Sanding Sealer B26V3.
 3. Filler: Solvent-based, air-drying, paste-type wood filler made for use on open-grain wood on interior wood surfaces (FS TT-F-336):
 - a. Devoe: 4800 Wonder Woodstain Interior Paste Wood Filler.
 - b. Moore: Benwood Paste Wood Filler.
 - c. S-W: Sher-Wood Fast-Dry Filler.
 4. Undercoat: Clear varnish made for use on interior stained-finished woodwork (FS TT-V-86):
 - a. Devoe: 4600 Wonder Wood Satin Alkyd Satin Varnish.
 - b. Moore: Benwood Satin Finish Varnish 404.
 - c. S-W: Oil Base Varnish, A66V91/A66F90.
 5. Finish Coat: Clear varnish made for use on interior stained-finished woodwork (FS TT-V-86):
 - a. Devoe: 4600 Wonder Wood Satin Alkyd Satin Varnish.
 - b. Moore: Benwood Satin Finish Varnish 404.
 - c. S-W: Oil Base Varnish, A66V91/A66F90.
- N. Woodwork, Painted - Alkyd, Semigloss: Two coats over primer.
1. Primer: Enamel undercoat made for use as a primer over wood under an odorless alkyd enamel:
 - a. Con-Lux: Enamel Underbase 54 White.
 - b. Devoe: 50501 Interior Alkyd Primer and Vapor Barrier
 - c. Moore: Moore's Alkyd Enamel Underbody 217.
 - d. S-W: Wall and Wood Primer B49WZ2.
 2. Undercoat: Semigloss odorless alkyd enamel made for use over a primer on wood (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
 3. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on wood (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
- O. Ferrous Metal - Silicone-Alkyd, Semigloss: Two coats over primer:
1. Primer: Lead and chromate-free high solids primer which chemically inhibits rusting and is recommended by the manufacturer for application to steel which has been prepared in accordance with SSPC SP2. Rated 10 (less than 0.01% surface rusting)

when tested in accordance with ASTM B117 for 500 hours. Exceeds performance requirements of FS TT-P-636:

- a. Con-Lux: Rust Arrestor 50.
 - b. S-W: Kem Kromik Universal Metal Primer B50NZ6.
 - c. Tnemec: Series P10.
2. Undercoat: Alkyd enamel recommended by manufacturer of finish coat as an intermediate coat over specified primer for application of silicone-alkyd finish coat:
 - a. Con-Lux: FerroX Primer.
 - b. S-W: Silicone Alkyd Enamel B-56 Series.
 - c. Tnemec: Series 23 Enduratone.
 3. Finish Coat: Silicone-alkyd enamel with a minimum of 30% silicone content meeting the qualitative requirements of FS TT-E-490:
 - a. Con-Lux: Steel-Master 9500 Series.
 - b. S-W: Silicone Alkyd Enamel B-56 Series.
 - c. Tnemec: Series 82 Silicone-Alkyd Enamel.
- P. Ferrous Metal - Alkyd, Semigloss: Two coats over primer with total dry film thickness not less than 2.5 mils.
1. Primer: Quick-drying, rust-inhibiting primer made for priming ferrous metal under an odorless alkyd enamel (FS TT-P-664):
 - a. Con-Lux: FerroX Primer.
 - b. Devoe: 41820 Bar-Ox Alkyd Shop/Field Primer.
 - c. Moore: Ironclad Retardo Rust-Inhibitive Paint 163
 - d. S-W: Kem Kromik Metal Primer B50N2/B50W1.
 2. Undercoat: Enamel undercoat made for use as an undercoat over a primer on ferrous metal under an odorless alkyd enamel:
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Alkyd Enamel Underbody 217.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
 3. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on ferrous metal surfaces (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
- Q. Ferrous Metal - Epoxy, Gloss: Two coats over primer:
1. Primer: Corrosion-inhibitive primer recommended by manufacturer for priming ferrous metal under an epoxy undercoat:
 - a. Con-Lux: Epolon Mastic 36 White.
 - b. Duron: Dura Clad Universal Phenolic Alkyd Fast Dry Metal Primer.
 - c. Moore: IronClad Epoxy Rust Inhibitive Primer
 - d. S-W: Recoatable Epoxy Primer.
 2. Undercoat: Epoxy undercoat made for use as an undercoat over a primer on metal under a gloss epoxy enamel:
 - a. Con-Lux: Epolon Series.
 - b. Duron: Dura Clad Polyamide Epoxy.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: ArmorSeal 100HS Series.
 3. Finish Coat:
 - a. Gloss epoxy enamel made for use over a primer and epoxy undercoat on metal surfaces.
 - 1) When the finish coat is applied to a floor surface, add anti-slip aggregate.

- b. Con-Lux: Epolon Series.
 - c. Duron: Dura Clad Polyamide Epoxy.
 - d. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - e. S-W: ArmorSeal 100HS Series.
- R. Zinc-coated Metal - Alkyd, Semigloss: Two coats over primer, with total dry film thickness not less than 2.5 mils.
- 1. Primer: Galvanized metal primer made for use on zinc-coated (galvanized) metal surfaces (FS TT-P-641), or one of the following:
 - a. Con-Lux: Bond-Plex 46 Barrier Green.
 - b. Devoe: 13201 Mirrolac Galvanized Metal Primer.
 - c. Moore: Ironclad Galvanized Metal Latex Primer 155.
 - d. S-W: Industrial Water Based Acrylic Paint B42W110.
 - 2. Undercoat: Enamel undercoat made for use as an undercoat over a primer on zinc-coated metal under an odorless alkyd enamel:
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Alkyd Enamel Underbody 217.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
 - 3. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on zinc-coated (galvanized) metal surfaces (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
- S. Zinc-Coated Metal - Silicone-Alkyd, Semigloss: Two coats over factory-applied primer:
- 1. Primer: Galvanized metal primer used to prime zinc-coated (galvanized) metal surfaces (FS TT-P-641), or one of the following.
 - a. Con-Lux: Bond-Plex 46 Barrier Green.
 - b. Devoe: 13201 Mirrolac Galvanized Metal Primer.
 - c. Moore: Ironclad Galvanized Metal Latex Primer #155.
 - d. S-W: Industrial Water Based Acrylic Paint B42W110.
 - 2. Undercoat: Alkyd enamel recommended by manufacturer of finish coat as an intermediate coat over factory-applied primer for application of silicone-alkyd finish coat:
 - a. Con-Lux: FerroX Primer.
 - b. S-W: Silicone Alkyd Enamel B-56 Series.
 - c. Tnemec: Series 23 Enduratone.
 - 3. Finish Coat: Silicone-alkyd enamel with a minimum of 30% silicone content meeting the qualitative requirements of FS TT-E-490:
 - a. Con-Lux: Steel-Master 9500 Series.
 - b. S-W: Silicone Alkyd Enamel B-56 Series.
 - c. Tnemec: Series 82 Silicone-Alkyd Enamel.
- T. Zinc-Coated Metal - Epoxy, Gloss: Two coats over primer:
- 1. Primer: Primer recommended by manufacturer for priming galvanized metal under an epoxy undercoat:
 - a. Con-Lux: Metal Bond 47 Primer.
 - b. Duron:
 - 1) Vinyl Wash Primer for surfaces subject to abrasion;
 - 2) Dura Clad Acrylic Galvanized Metal Primer for surfaces not subject to abrasion.
 - c. Moore: IronClad Galvanized Metal latex Primer.
 - d. S-W: ArmorSeal 100HS Series.

2. Undercoat: Epoxy undercoat made for use as an undercoat over a primer on metal under a gloss epoxy enamel:
 - a. Con-Lux: Epolon Series.
 - b. Duron: Dura Clad Polyamide Epoxy.
 - c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - d. S-W: ArmorSeal 100HS Series.
 3. Finish Coat;
 - a. Gloss epoxy enamel made for use over a primer and epoxy undercoat on metal surfaces.
 - 1) When the finish coat is applied to a floor surface, add anti-slip aggregate.
 - b. Con-Lux: Epolon Series.
 - c. Duron: Dura Clad Polyamide Epoxy.
 - d. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
 - e. S-W: ArmorSeal 100HS Series.
- U. Non-Ferrous Metal - Alkyd, Semigloss: Two coats over primer with total dry film thickness not less than 2.5 mils.
1. Primer: Corrosion inhibitive primer recommended by manufacturer for priming non-ferrous metal under an odorless alkyd enamel:
 - a. Con-Lux: Bond-Plex 46 Barrier Green.
 - b. Devoe: 13201 Mirrolac Galvanized Metal Primer.
 - c. Moore: Ironclad Retardo Rust-Inhibitive Paint 163.
 - d. S-W: Kem Kromik Metal Primer B50N2/B50W1.
 2. Undercoat: Enamel undercoat made for use as an undercoat over a primer on non-ferrous metal under an odorless alkyd enamel:
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Alkyd Enamel Underbody 217.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
 3. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on non-ferrous metal surfaces (FS TT-E-509):
 - a. Con-Lux: Satin-Lite 900 Series.
 - b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
 - c. Moore: Moore's Satin Impervo Enamel 235.
 - d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100
- V. Cotton or Canvas Covering over Insulation - Latex, Flat: 2 coats.
1. Undercoat: Flat latex-based paint with fungicidal agent added (to render fabric mildew-proof) made for use as a sealing coat (size) on cotton or canvas covering over insulation:
 - a. Con-Lux: Wall-Plex 400 Series.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Regal Wall Satin 215.
 - d. S-W: Pro-Mar 200 Latex Flat Wall Paint B30W200 Series.
 2. Finish Coat: Flat latex-based paint with fungicidal agent added (to render fabric mildew-proof) made for use as a sealing coat (size) on cotton or canvas covering over insulation:
 - a. Con-Lux: Wall-Plex 400 Series.
 - b. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint.
 - c. Moore: Regal Wall Satin 215.
 - d. S-W: Pro-Mar 200 Latex Flat Wall Paint B30W200 Series.

PART 3 - EXECUTION

3.01 PREPARATORY WORK:

- A. Inspect surfaces for their suitability to receive a finish. In the event that imperfections due to materials or workmanship appear on surfaces, make the appropriate corrections at no additional cost to the Authority. Correct damage to painted or decorated finishes due to carelessness or negligence of other trades.
- B. Protect hardware, hardware accessories, plates, lighting fixtures and similar items installed prior to painting; remove protection upon completion of each space. Where necessary to remove installed products to ensure their protection, arrange for removal and reinstallation by mechanics of the trade involved. Disconnect equipment adjacent to walls; where necessary, move to permit painting of wall surfaces, and following completion of painting, replace and reconnect.
- C. Clean surfaces to be painted as necessary to remove dust and dirt. Sand as necessary to properly prepare surfaces to receive paint or varnish.
- D. Wash metal surfaces with benzine or mineral spirits to remove dirt, oil or grease before applying paint. Where rust or scale is present, wire brush or sandpaper clean before painting. Apply galvanized metal primer to degreased galvanized metal before applying additional coats.
- E. Prepare masonry surfaces to be painted by removing dirt, dust, oil and grease stains and efflorescence. The method of surface preparation is at the discretion of the Contractor provided that the results are approved. Clean masonry and plaster surfaces to be painted until they are free from alkali and thoroughly dry before applying paint. Test masonry and plaster surfaces for alkali, using red litmus paper, prior to painting.
- F. Clean concrete surfaces free from dirt, or film left from form oil or concrete curing compounds, or loose or excess mortar. Steam clean or wash the surfaces with water. Use cleaning additive with discretion, in accordance with paint manufacturer's recommendation and to the satisfaction of Engineer.
- G. Cut out cracks, scratches and other imperfections in plaster surfaces as required, fill with spackling compound and sand flush with adjacent surface. Fill voids in concrete with cement grout before painting.
- H. Fill nail holes and cracks after first coat with non-shrinking putty of a color to match that of the finish.
- I. Sand, dust and touch up scratches, abrasions or other disfigurements and remove foreign matter from prime coats before proceeding with the following coat. Feather edge spot priming or spot coating into adjacent coatings to produce a smooth and level surface.
- J. Test concrete and plaster surfaces for moisture, using moisture meter, prior to painting. Do not apply paint to surfaces having meter reading above 15.
- K. Caulk joints between door and window frames and walls, and other joints as necessary.
- L. Coordinate the work of this section with the work of other trades.

3.02 APPLICATION:

- A. Touch-up painting of structural steel, miscellaneous metal, hollow-metal doors and frames, and other materials which have been prime coated as may be required where the shop coat

has been damaged by welding or abrasion during the handling and erection operations; also rivets, bolts and welds which are unpainted after assembly and erection.

- B. Apply paint by spray in accordance with the manufacturer's directions to achieve required dry film thickness (DFT). Where specifically approved by the Engineer, use rollers or brushes as best suited for material being applied. For covers on rollers use carpet with velvet back and high-pile sheep's wool or use short-hair covers, as best suited for material and texture specified. Except where otherwise noted, apply paint to a minimum dry-film thickness (DFT) of five mills, excluding filler coats, using no less than the number of coats specified in Part 2 – Products.
- C. Apply material evenly and smoothly without runs, sags or other defects with edges of paint adjoining other materials or color sharp and clean, without overlapping.
- D. Do not paint and finish while surfaces are damp. Allow sufficient time between coats, in accordance with manufacturer's directions to produce an evenly smooth finish.
- E. Do not apply final coats until after other trades, whose operations would be detrimental to finish painting, have finished their work in the areas to be painted and the areas have been approved for painting.

3.03 PROTECTION:

- A. Dispose of soiled cleaning rags and waste at the close of each day's work or store such soiled rags and waste in metal containers with tight-fitting covers. Provide buckets of sand during painting operations for use in the event of fire. Post NO SMOKING signs as necessary and as directed.
- B. Protect the work of other trades against damage or injury by use of suitable covering during the progress of the painting and finishing work. Repair damage to the satisfaction of the Engineer.

3.04 CLEANING:

- A. Upon completion of work, remove staging, scaffolding and containers from the site. Remove paint spots, oil or stains from glass, floors and other surfaces not to be painted, and leave job clean and acceptable to the Engineer.

3.05 COLOR CODING OF PIPING AND EQUIPMENT:

- A. General Requirements:
 - 1. Color coding is required for accessible piping systems and related equipment, except associated supports, brackets, hangers and similar accessories.
 - 2. Identify piping systems and related equipment which are to be color coded as follows:
 - a. Apply color to entire length of piping.
 - b. Apply lettered legends indicating the name of the contents of the system as specified.
- B. Location of Legends and Bands:
- C. Stencil lettered legends on the piping at the horizontal or vertical centerline. Where pipe lines are too close together and where located above the operator's normal line of vision, place the lettering below the horizontal centerline at a point which will be easily visible.
 - 1. Locate lettered legends and bands at points where pipes enter and leave rooms or spaces, at junction points and points of distribution, close to valves and equipment, at changes in direction, and at intervals along piping where necessary for identification.

2. Stencil piping in accordance with ASME A13.1 and as follows to show service and direction of flow, space within sight of each other and not more than 40 feet apart on long runs.

D. Size of Stencil Letters for Piping Identification:

Outside Diameter of Pipe Covering in Inches	Size of Letter in Inches	Width of Color Band in Inches
3/4 to 1-1/4	1/2	4
1-1/2 to 2-1/2	3/4	6
3 to 6	1-1/4	8
7 to 10	2-1/2	12
Over 10	3-1/2	12

E. Schedule of Colors and Legends:

Line	Pipe Color	Black Stenciled Legend
Hot water lines	Yellow	HW, HWR
Potable cold water lines	Blue	CW
Chilled water lines	Blue with yellow band	CHWS, CHWR
Fire lines	Red	F (use White Stencil instead of black)
Condensate lines	White	C
Condenser water lines	White with blue band	CWS, CWR
Soil and waste lines	White	S
Vent lines	Grey with white band	V
Storm Water lines	White	ST-W
Air and control air lines	Green	A

END OF SECTION

SECTION 10155

TOILET COMPARTMENTS AND SCREENS

PART1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing metal toilet compartments, urinal screens and metal screens for portable eye wash and body spray.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Toilet Accessories: Section 10810.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For each type and style of toilet compartment and screen specified include details of construction relative to materials, fabrication, and installation. Include details of anchors, hardware, and fastenings.
- B. Shop Drawings: For fabrication and installation of toilet compartment and screen assemblies. Include plans, elevations, sections, details, and attachments to other work. Submit prior to ordering materials or beginning fabrication.
 - 1. Show locations of reinforcement and cutouts for compartment-mounted toilet accessories.
 - 2. Samples for Verification:
 - a. Three of each type of the following products used in the Work:
 - 1) Hardware.
 - 2) Sheet metal: Three inches by five inches.
 - b. Approved full-size samples will be returned and may be used in the Work.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ADA: Americans with Disabilities Act.
 - 3. ASTM: A666.
 - 4. NAAMM: Metal Finishes Manual for Architectural and Metal Products.
- B. Manufacturer Qualifications: Provide products of an established manufacturer regularly engaged in the production of toilet accessories.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver the products to the job site in original unopened containers clearly labeled with the manufacturer's name, brand designation and type as applicable.

- B. Store products in an approved dry area, protect from contact with soil and from exposure to the elements. Keep products dry.
- C. Handle products so as to prevent breakage of containers and damage to products.

1.06 PROJECT CONDITIONS:

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

PART 2- PRODUCTS

2.01 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ampco Products, Inc.
 - 2. General Partitions Mfg. Corp.
 - 3. Global Steel Products Corp.
 - 4. Knickerbocker Partition Corporation.
 - 5. Sanymetal
 - 6. Or equal.

2.02 MATERIALS:

- A. General: Provide materials that have been selected for surface flatness and smoothness. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discolorations, telegraphing of core material, or other imperfections on finished units are unacceptable.
- B. Stainless-Steel Sheet: ASTM A666, Type 302 or 304, that is leveled to stretcher-leveled flatness, finished on exposed faces as indicated in the "Stainless-Steel Sheet Finishes" Article, and of the following minimum thicknesses:
 - 1. Pilasters (Overhead Braced): 0.0375 inch.
 - 2. Pilasters (Unbraced): 0.0500 inch.
 - 3. Panels and Screens: 0.0312 inch.
 - 4. Doors: 0.0312 inch.
 - 5. Tapping Reinforcement: 0.0781 inch.

- C. Core Material for Metal-Faced Units: Manufacturer's standard sound-deadening honeycomb of resin-impregnated kraft paper in thickness required to provide finished thickness of 1 inch minimum for doors, panels, and screens and 1-1/4 inches minimum for pilasters.
- D. Pilaster Shoes and Sleeves (Caps): ASTM A666, Type 302 or 304 stainless steel, not less than 0.0312 inch thick and 3 inches high, finished to match hardware.
- E. Stirrup Brackets: Manufacturer's standard ear or U-brackets for attaching panels and screens to walls and pilasters of the following material:
 - 1. Material: Stainless steel.
 - 2. Material: Chrome-plated brass.
- F. Full-Height (Continuous) Brackets: Manufacturer's standard design for attaching panels and screens to walls and pilasters of the following material:
 - 1. Material: Stainless steel.
 - 2. Material: Chrome-plated brass.
- G. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories of the following material:
 - 1. Material: Stainless steel.
 - 2. Material: Chrome-plated brass.
- H. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile in manufacturer's standard finish.
- I. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.03 COMPARTMENT AND SCREEN FABRICATION:

- A. General: Provide standard doors, panels, screens, and pilasters fabricated for compartment system. Provide units with cutouts and drilled holes to receive compartment-mounted hardware, accessories, and grab bars, as indicated.
 - 1. Provide internal reinforcement in metal units for compartment-mounted hardware, accessories, and grab bars.
- B. Metal-Faced Toilet Compartments and Screens: Pressure laminate seamless face sheets to core material and provide continuous, interlocking molding strip or lapped and formed edges. Seal corners by welding or clips. Grind exposed welds smooth.
- C. Overhead-Braced-and-Floor-Anchored Compartments: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, fasteners, and anchors at pilasters to suit floor conditions. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.
- D. Floor-Anchored Compartments: Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.

- E. Ceiling-Hung Compartments: Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.
 - 1. Provide manufacturer's standard 4-inch-high, overhead cross bracing.
- F. Floor-and-Ceiling-Anchored Compartments: Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.
- G. Wall-Hung Urinal Screens and Eyewash Screens: Provide units 18 inches wide by 42 inches high, nominal, or of size as indicated of same construction and finish as compartment panels, unless otherwise indicated.
 - 1. Provide metal-faced screens with integral full-height flanges for attachment to wall.
- H. Floor-Anchored Screens: Provide pilasters and panels of same construction and finish as toilet compartments. Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- I. Ceiling-Hung Screens: Provide pilasters and panels of same construction and finish as toilet compartments. Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with threaded rods, lock washers, and leveling adjustment nuts at pilasters for connection to structural support above finished ceiling. Provide assemblies that support pilasters from structure without transmitting load to finished ceiling. Provide sleeves (caps) at tops of pilasters to conceal anchorage.
- J. Floor-and-Ceiling-Anchored Screens: Provide pilasters and panels of same construction and finish as toilet compartments. Provide manufacturer's standard corrosion-resistant anchoring assemblies complete with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.

2.04 DOOR FABRICATION:

- A. General: Unless otherwise indicated, provide 24-inch-wide in-swinging doors for standard toilet compartments and 36-inch-wide out-swinging doors with a minimum 32-inch-wide clear opening for compartments indicated to be handicapped accessible.
- B. Hardware: Provide doors with the following:
 - 1. Hinges: Manufacturer's standard self-closing type that can be adjusted to hold door open at any angle up to 90 degrees.
 - 2. Latch: Concealed latch unit designed for emergency access. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be handicapped accessible.
 - 3. Combination Stop/Keeper.
 - 4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
 - 5. Door Pull: Manufacturer's standard unit that complies with accessibility requirements of authorities having jurisdiction at out-swinging doors. Provide units on both sides of doors at compartments indicated to be handicapped accessible.

2.05 STAINLESS-STEEL SHEET FINISHES:

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.
 - 1. Remove or blend tool and die marks and stretch lines into finish.
 - 2. Grind and polish surfaces to produce uniform, directional textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- B. Finish: Manufacturer's standard No. 4 directional polish.
- C. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- D. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

PART 3 - EXECUTION

3.01 PREPARATION:

- A. Verify dimensions before proceeding and obtain measurements at the structure for work to be accurately fitted to other construction, including wall-to-wall dimensions, floor-to-ceiling dimensions and those controlled by other trades.
- B. Examine surfaces and parts of structure to which work is to be applied. Notify the Engineer of defects or conditions detrimental to proper installation so that remedial measures may be accomplished by trades involved.
- C. Remove foreign substances from surfaces to receive specified work.

3.02 INSTALLATION:

- A. General: Install units to the adjoining construction as shown on Contract Drawings and approved shop drawings.
- B. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, plumb, and level. Provide clearances of not more than 1/2 inch between pilasters and panels and not more than 1 inch between panels and walls. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Secure panels to walls and panels with not less than 2 stirrup brackets attached near top and bottom of panel. Locate wall brackets so holes for wall anchors occur in masonry or tile joints. Align brackets at pilasters with brackets at walls.
- C. Overhead-Braced-and-Floor-Anchored Compartments: Secure pilasters to floor and level, plumb, and tighten. Secure continuous head rail to each pilaster with not less than 2 fasteners. Hang doors level and plumb without twist or warp and adjust so tops of doors are parallel with overhead brace when doors are in closed position and with maximum clearance of 3/16-inch at vertical edges.
- D. Floor-Anchored Compartments: Set pilaster units with anchors penetrating not less than 2 inches into structural floor, unless otherwise indicated in manufacturer's written instructions.

Level, plumb, and tighten pilasters. Hang doors level and plumb without twist or warp and adjust so tops of doors are parallel with overhead brace when doors are in closed position and with maximum clearance of 3/16-inch at vertical edges.

- E. Ceiling-Hung Compartments: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors level and plumb without twist or warp and adjust so tops of doors are parallel with overhead brace when doors are in closed position and with maximum clearance of 3/16-inch at vertical edges.
- F. Floor-and-Ceiling-Anchored Compartments: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors level and plumb without twist or warp and adjust so tops of doors are parallel with overhead brace when doors are in closed position and with maximum clearance of 3/16-inch at vertical edges.
- G. Screens: Attach with anchoring devices according to manufacturer's written instructions and to suit supporting structure. Set units level and plumb and to resist lateral impact.
- H. Clean finished surfaces according to manufacturer's written instructions and leave them free from imperfections. Touch up marred painted surfaces with matching materials furnished by manufacturer.
- I. After installation, Provide final protection and maintain conditions that ensure toilet compartments and screens are without damage or deterioration at the time of Substantial Completion.

3.03 TESTING AND ADJUSTING OF COMPLETED WORK:

- A. Hardware:
 - 1. Test proper operation of hardware by opening and closed each door through ten cycles.
 - 2. Adjust and lubricate hardware according to manufacturer's written instructions for proper operation.
 - 3. Set hinges on in-swinging doors to hold open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors and swing doors in entrance screens to return to fully closed position.
 - 4. Adjust, repair or replace malfunctioning hardware.

3.04 CLEANING:

- A. Leave areas surrounding the work in broom-clean condition.

END OF SECTION

SECTION 10200

METAL LOUVERS

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing fixed, extruded aluminum and formed-metal louvers, blank-off panels and accessories.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Seals and Sealants: Section 07900.
- B. Metal Doors and Frames: Section 08110.
- C. Field Painting: Section 09920.
- D. Mechanical Equipment: Division 15.

1.03 DEFINITIONS:

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section, unless otherwise defined in this Section or in referenced standards.
- B. Standard Free Area: Free area of a louver 48 inches wide by 48 inches high, identical to that provided.
- C. Maximum Standard Airflow: Airflow at point of beginning water penetration through a louver 48 inches wide by 48 inches high, identical to that provided.
- D. Drainable-Blade Louver: Louver designed to collect and drain water to exterior at sill by means of gutters in front edges of blades and channels in jambs and mullions.

1.04 PERFORMANCE REQUIREMENTS:

- A. Structural Performance: Provide exterior metal louvers capable of withstanding the effects of loads and stresses from wind and normal thermal movement without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter; or permanent damage to fasteners and anchors.
 - 1. Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward or outward.
 - 2. Thermal Movements: Provide louvers that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, and other detrimental effects:

- a. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- B. Air-Performance, Water-Penetration, and Air-Leakage Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units 48 inches wide by 48 inches high. Test units according to AMCA 500.
 - 1. Perform testing on unpainted, cleaned, degreased units.
 - 2. Perform water-penetration testing on louvers without screens.

1.05 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: For each type of product specified provide manufacturer's printed product information.
- B. Shop Drawings: For louver units and accessories. Include plans; elevations; sections; and details showing profiles, angles, and spacing of louver blades. Show unit dimensions related to wall openings and construction; free area for each size indicated; profiles of frames at jambs, heads, and sills; and anchorage details and locations.
 - 1. For installed louvers and vents indicated to comply with design loadings, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
- D. Samples for Verification: Of each type of metal finish required, prepared on Samples of same thickness and material indicated for final Work. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.
- E. Product Certificates: Signed by manufacturers of louvers certifying that the products furnished comply with requirements and are licensed to bear the AMCA seal based on tests made according to AMCA 500 and complying with AMCA's Certified Ratings Program.

1.06 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. AAMA: 603.8, 605.2, 607.1.
 - 3. AMCA: 500, 501.

4. ASTM: A653, a780, B26, B209, B221, C612, D1187.
5. AWS: D1.2, D1.3.
6. NAAMM: Metal Finishes Manual for Architectural and Metal Products.
7. SMACNA: Architectural Sheet Metal Manual.
8. SSPC: Paint 12.Codes, Regulations, Reference Standards and Specifications:
9. Codes and regulations of the jurisdictional authorities.
10. ASTM:
11. AWS: D1.2., D1.3.
12. NAAMM: Metal Finishes Manual for Architectural and Metal Products.SMACNA: Architectural Sheet Metal Manual.

- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for installations of louvers that are similar to those indicated for this Project in material, design, and extent.
- C. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where alike in one or more respects regarding type, design, or factory-applied color finish.
- D. Welding Standards: As follows:
1. Comply with AWS D1.2, "Structural Welding Code--Aluminum."
 2. Comply with AWS D1.3, "Structural Welding Code--Sheet Steel." Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- E. SMACNA Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures.

1.07 PROJECT CONDITIONS:

- A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

PART 2 -PRODUCTS

2.01 MATERIALS:

- A. Aluminum Extrusions: ASTM B221, alloy 6063-T5 or T-52
- B. Aluminum Sheet: ASTM B209, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish
- C. Aluminum Castings: ASTM B26/B26M, alloy 319.
- D. Galvanized Sheet Steel: ASTM A653/A653M, G90 zinc coating, mill phosphatized.
- E. Fasteners: Of same basic metal and alloy as fastened metal or 300 series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.
 - 2. Use Phillips flat-head screws for exposed fasteners, unless otherwise indicated.
- F. Anchors and Inserts: Of type, size, and material required for loading and installation indicated. Use nonferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as needed for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.
- G. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12 but containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187.

2.02 FABRICATION, GENERAL:

- A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
 - 1. Continuous Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates and without interrupting blade-spacing pattern.
- B. Maintain equal louver blade spacing to produce uniform appearance.
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining materials' tolerances, and perimeter sealant joints.

- D. Include supports, anchorages, and accessories required for complete assembly. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less. At horizontal joints between louver units, provide horizontal mullions, unless continuous vertical assemblies are indicated.
- E. Provide sill extensions and loose sills made of same material as louvers where indicated or required for drainage to exterior and to prevent water penetrating to interior.
- F. Join frame members to one another and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view; unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.03 FIXED, EXTRUDED-ALUMINUM LOUVERS:

- A. Louver Construction: Provide fixed-blade louvers with extruded-aluminum frames and blades.
- B. Horizontal Louvers: Either drainable- or nondrainable-blade (as indicated) type complying with the following:
 - 1. Louver Depth: As indicated.
 - 2. Frame Thickness: 0.125 inch, or as indicated.
 - 3. Blade Thickness: 0.125 inch, or as indicated.
 - 4. Performance Requirements: As indicated.
 - 5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
- C. Continuous, Horizontal, Drainable-Blade Louvers: Fabricated with close-fitting, field-made splice joints in blades designed to permit expansion and contraction without deforming blades or framework and with mullions recessed from front edges of blades so blades have continuous appearance.
 - 1. Louver Depth: As indicated.
 - 2. Frame Thickness: 0.125 inch, or as indicated.
 - 3. Blade Thickness: 0.125 inch, or as indicated.
 - 4. Blade Profile: As indicated.
 - 5. Blade Angle and Spacing: As indicated.

2.04 FIXED, FORMED-METAL LOUVERS:

- A. Louver Construction: Provide fixed-blade louvers with frames and blades formed from metal sheet of metal indicated.

- B. Horizontal Louvers: Either drainable- or nondrainable-blade type (as indicated) complying with the following
1. Louver Depth: As indicated.
 2. Frame and Blade Material: Galvanized steel sheet, 0.052 inch.
 3. Performance Requirements: As indicated.

2.05 LOUVER SCREENS:

- A. General: Provide each exterior louver with louver screens complying with the following requirements:
1. Screen Location for Fixed Louvers: Interior face.
 2. Screening Type: Bird screening, unless otherwise indicated.
 3. Screening Type: Insect screening, as indicated.
- B. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate screen frames with mitered corners to louver sizes indicated and to comply with the following requirements:
1. Metal: Same kind and form of metal as indicated for louver to which screens are attached..
 - a. Reinforce extruded-aluminum screen frames at corners with clips.
 2. Finish: Same finish as louver frames to which louver screens are attached.
 3. Type: Rewirable frames with a driven spline or insert for securing screen mesh.
- D. Louver Screening for Aluminum Louvers: As follows:
1. Bird Screening: Aluminum, ½-inch-square mesh, 0.063-inch wire
 2. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.
- E. Louver Screening for Galvanized Steel Louvers: As follows:
1. Bird Screening: Galvanized steel, ½-inch square mesh, 0.047-inch wire.
 2. Insect Screening: Galvanized steel, 18-by-14 mesh, 0.011-inch wire.
 3. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.
- F. Louver Screening for Galvanized Steel Louvers: As follows:
1. Bird Screening: Galvanized steel, 1/2-inch-square mesh, 0.047-inch wire.
 2. Insect Screening: Galvanized steel, 18-by-14 mesh, 0.011-inch wire.

2.06 BLANK-OFF PANELS:

- A. General: Fabricate blank-off panels from materials and to sizes indicated and comply with the following requirements:
 - 1. Finish: Same as finish applied to louvers.
 - 2. Attach blank-off panels to back of louver frames with clips.

- B. Insulated, Blank-off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets, complying with the following requirements:
 - 1. Thickness: 1 inch.
 - 2. Metal Facing Sheets: Aluminum sheet, 0.032 inch thick.
 - 3. Insulating Core: Unfaced, rigid, glass-fiberboard insulation complying with ASTM C612, Class 1 and 2.
 - 4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames 0.081 inch -thick, with corners mitered and with same finish as panels.

2.07 FINISHES, GENERAL:

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Finish louvers after assembly.

2.08 ALUMINUM FINISHES:

- A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

- B. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 607.1.

- C. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.
 - 1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 603.8, except with a minimum dry film thickness of 1.5 mils, medium gloss.
 - 2. Color: As selected by the Engineer from manufacturer's full range of colors.

- D. High-Performance Organic Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
1. Fluoropolymer Three-Coat Coating System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.
 - a. Color and Gloss: As selected by the Engineer from manufacturer's full range of colors and glosses.

2.09 GALVANIZED STEEL SHEET FINISHES:

- A. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A780. Apply a conversion coating of type suited to organic coating applied over it.
- B. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with not less than 1.0-mil dry film thickness for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2.0 mils.
 1. Color and Gloss: As selected by the Engineer from manufacturer's full range of colors and glosses.

PART 2 - EXECUTION

3.01 PREPARATION:

- A. Coordinate Setting Drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.02 INSTALLATION:

- A. Locate and place louver units level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated
- E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- G. Install concealed gaskets, flashings, joint fillers, and insulation, as louver installation progresses, where weathertight louver joints are required. Comply with Section 07900 for sealants applied during louver installation.

3.03 ADJUSTING, CLEANING, AND PROTECTING:

- A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
- B. Periodically clean exposed surfaces of louvers and vents that are not protected by temporary covering to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.
- C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- D. Protect louvers and vents from damage during construction. Use temporary protective coverings where needed and approved by louver manufacturer. Remove protective covering at the time of Substantial Completion.
- E. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Clean and touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

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SECTION 10431

INTERIOR SIGNAGE

PART I - GENERAL

1.01 SUMMARY OF WORK

- A. This section specifies providing interior signs.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Exterior Signage: Section 10436.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. ADA: Americans with Disabilities Act.
 - 3. ANSI: A117.1.
- B. Qualifications of Sign Manufacturer. Provide the products of an established manufacturer, regularly engaged in the production of interior signage of the types specified herein.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Drawings showing sign graphics and details of fabrication and mounting for each sign type.
 - 2. Full-size layout of graphics for approval prior to fabricating signs. Include art work, symbol pictograms and inter-letter and inter-word spacings.
 - 3. Technical data and manufacturer's specifications for all sign materials, and other product data as directed.
- B. Samples: Submit three samples of each required type of sign with specified color and finish.
- C. Signage Schedule: Provide sign schedule listing sign types, door numbers, room names, and room numbering system coordinated with the Authority Representative.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to the job site in their original unopened containers clearly labeled with the manufacturer's name, brand designation and description of contents as applicable.
- B. Store products in an approved dry area, protected from contact with soil and exposure to the elements. Keep products dry at all times.
- C. Handle products in a manner that will prevent breakage of containers and damage to products.

PART 2 - PRODUCTS

2.01 MATERIALS:

2.02 INTERIOR PLAQUE SIGNS, Type A and B.

Provide matte and finish plaques in sizes as specified. Fabricate of 1/8 inch phenolic photopolymer and with raised and braille characters and symbols. Provide 1/2 inch radius corners. Comply with ADA and ANSI.

- A. Sign Type A: 4 inches by 8 inches for permanent rooms and spaces.
- B. Sign Type B: 8 inches by 8 inches for Toilet Rooms with pictograms.

2.03 GRAPHICS APPLICATION:

- A. Raised Letters:
 - 1. Raised Characters and Symbols: Raised 1/32 inch minimum and at least 5/8 inch high. Meet width/stroke to height ratios. Locate Room Number below Room Name and Braille below Room Name.
 - 2. Mounting Location and Height Locate along side door on latch side mounted 60 inches above the bottom of the door to sign center line.

2.04 BRAILLE:

- A. Grade II Braille, justified to copy, below text copy.

2.05 PLAQUE MESSAGES:

- A. Message content shall be as scheduled.
 - 1. Typeface: Standard Medium.
 - 2. Type size: 5/8 inch high minimum uppercase.
 - 3. Background color: Medium Bronze.
 - 4. Message color: White.
 - 5. Contrast: 70 percent minimum.

2.06 MOUNTING:

- A. Vinyl Tape:
 - 1. Provide 1/16 inch foam tape with adhesive on both sides in sufficient quantity to securely mount plaque to substrate.

2.07 FABRICATION:

- A. General:
 - 1. Fabricate signs to be smooth, free of scratches, gouges, bubbles, bulging, embedded materials between surface and background color, and other imperfections.
 - 2. Fabricate signs of the materials and to the dimensions shown, with straight lines, smooth curves, sharply delineated graphics and flat planes.
- B. Characters and Symbols:
 - 1. Characters (letters and numbers): Standard medium, upper case.

2. Symbols:
 - a. Symbol pictograms for men, women, and handicapped accessibility.

C. Layout:

1. Position all graphics and pictograms to comply with ADA.
2. Spacing: Inter-letter and inter-word spacing to meet sign manufacturer's standards.

PART 3 - EXECUTION:

3.01 Preparation:

- A. Examine condition of surfaces on which signs will be installed.

3.02 INSTALLATION:

- A. General:
 1. Install work plumb, level, and properly aligned.
 2. Install signs so as not to catch clothing on edges or otherwise create a hazardous condition.
 3. Provide attachments and fastenings as required for secure and rigid anchorage.

3.03 CLEANING AND PROTECTION:

- A. Thoroughly clean installed work using materials and methods recommended by the sign manufacturer.
- B. Protect installation from damage or soiling.

END OF SECTION

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SECTION 10436

EXTERIOR SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing exterior signs.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Pavement striping and handicap parking symbol: Section 02765.
- B. Interior signage: Section 10436.

1.03 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. OSHA Regulations.
 - 3. ADA: Americans with Disabilities Act.
 - 4. ANSI: A117.1
 - 5. Standard Specification for Construction of Roads and Bridges on Federal Highway Projects.
- B. Qualifications of Sign Manufacturer: Provide the products of an established manufacturer, regularly engaged in the production of exterior and interior signage of the types specified herein.
- C. Testing: Perform the following tests on 12-inch by 12-inch samples of sign materials processed in the production run. Furnish copies of test results to the Engineer.
 - 1. Sign surfaces and finishes to show no discernable color change or chalking when exposed for 1,000 hours in an Atlas Twin Arch Weatherometer Model HVDI-X or equal, when tested in accordance with ASTM D822.

1.04 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Drawings showing sign graphics and details of fabrication, erection and mounting connections, including inserts and anchors for each sign type.
 - 2. Full-size layout of graphics for approval prior to fabricating signs. Include art work for arrow forms and symbol pictograms and use proper inter-letter and inter-word spacing.
 - 3. Technical data and manufacturer's specifications for all sign materials, paints, fasteners and other product data as directed.
 - 4. Manufacturer's current recommended installation procedures for the cast aluminum characters.
- B. Samples: Submit three samples of each required type of the following products with specified color and finish:

1. Cast aluminum characters.
2. Vinyl graphics sign: 12-inch lengths.
3. Aluminum sign with shop-applied reflective vinyl graphics.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to the job site in their original unopened containers clearly labeled with the manufacturer's name, brand designation and description of contents as applicable.
- B. Store products in an approved dry area, protected from contact with soil and exposure to the elements. Keep products dry at all times.
- C. Handle products in a manner that will prevent breakage of containers and damage to products.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Cast Aluminum Characters: Aluminum Alloy 214.
 1. Textural finish:
 - a. Faces: Medium satin, NAAMM AA-M32.
 - b. Sides: Medium matte, NAMM AA-M43.
 2. Color finish: Chemical-pre-anodic cleaning followed by light bronze or gold integral color anodized class 1 finish, NAAMM AA-C12A-42, color tone as approved by Engineer.
- B. Vinyl Graphics: Adhesive-backed vinyl film with graphics screen printed with permanent vinyl inks as recommended by manufacturer, clear top coated and carrier mounted. Use 3M Company products or equal.
 1. Quality: Provide vinyl graphics materials and application that will not fade, discolor, peel, crack, blister or delaminate from the substrates for at least 5 years.
 2. Provide vinyl graphics materials, including films, adhesives, inks and coatings, by one manufacturer in order to ensure total compatibility of each sign system component.
 3. Adhesive: Pressure sensitive in accordance with the recommendations of the manufacturer. Use positionable adhesive film equal to Controlltac by 3M for all field-applied graphics.
 4. Clear Coating: Clear vinyl ink with UV inhibitors, equal to Scotchcal Screen Printing Ink by 3M.
- C. Aluminum Signs with Shop-Applied Reflective Vinyl Graphics:
 1. Sheet Aluminum: ASTM B209, Alloy 3003-H14, standard one-side bright finish, flat sheet, minimum 0.08 inch thick.
 2. Reflective Vinyl: Same as specified above for Vinyl Graphics, but with the following additional requirements:
 - a. Reflective Vinyl: High intensity reflective acrylic film containing encapsulated optical lenses. Durability and retroreflective qualities are to be equal to or exceed the following standards for at least ten years:
 - 1) FS L-S-300C, Table VIII Reflectivity 2 and Durability 2200 hours.
 - 2) Standard Specification for Construction of Roads and Bridges on Federal Highway Projects, FP-79, for sheet reflective material, Table V-A, Type III 633.06, and Testing Procedures 718.01.
 - b. Graphics: Silk-screen applied in transparent acrylic ink colors equal to 3M Scotchlite 880 series inks, in colors as shown; die cut and carrier mounted.

Clear coat in the shop all silk recommended by manufacturer.

- c. Adhesive: For shop-applied graphics, use either pressure sensitive or dry vacuum-applied and heat-activated adhesive.
- d. Quality and source: Equal to 3M Scotchlite High Intensity Grade reflective sheeting; Series 3870 (pressure sensitive adhesive) or Series 2870 (dry adhesive).

D. Paint for Sign Backs:

- 1. Epoxy Primer: High-build epoxy-polyamide corrosion-resistant prime coating for application to substrates shown.
 - a. Dry film thickness: three to five mils per coat.
 - b. Source: 66-1211 Hi-Build Epoxy Primer as manufactured by Tnemec or equal.
- 2. Urethane Paint: Aliphatic polyester polyurethane enamel, gloss finish.
 - a. Dry film thickness: 1.5 to 2.5 mils per coat.
 - b. Colors: As shown.
 - c. Source: Series 70 Endura-shield as manufactured by Tnemec or equal.

E. Colors: As shown on drawings, matching the WMATA standard colors for graphics, as approved: gloss finish, Munsell System of Color Notation, Federal Spec Color System or Pantone Matching System as applicable.

F. Concrete for Footings of Post-Mounted Signs: As specified in Section 3300, Cast-In-Place-Concrete.

G. Hardware: Non-corrosive *or* type and size shown or required, unless otherwise specified.

- 1. Bolts, nuts, screws, metal washers: Steel, ASTM A307 hot-dip galvanized per ASTM A153, or stainless steel ASTM A193 alloy 304 as shown or specified, hexagonal head, round head or flathead as shown, tamper proof.
- 2. Neoprene rubber spacer. Use at cast aluminum characters. ASTM D1056 polychloroprene synthetic rubber *or* size required. Shore durometer hardness *of* 80, plus or minus 10, in accordance with ASTM D2240.
- 3. Steel channel for fence mounting: 1 'A inch by 3/4 inch by 16 gauge, hot-dip galvanized; 1.23 ounces *o* of zinc per square foot, ASTM A123; with galvanizing repair paint at cuts MIL-P-21-35 applied in two coats.

2.02 GRAPHICS APPLICATION:

A. Raised Letters:

- 1. Raised Characters and Symbols: Raised 1/32 inch minimum and at least 5/8 inch high. Meet width/stroke to height ratios. Locate Room Number below Room Name and Braille below Room Name.

2.03 BRAILLE:

A. Grade II Braille, justified to copy, below text copy.

2.04 FABRICATION:

A. General:

- 1. Fabricate signs to be smooth, free of scratches, gouges, burrs, bubbles, bulging, embedded materials between surface and background color, and other imperfections.

2. Fabricate signs of the materials and to the dimensions shown, with straight lines smooth curves, sharply delineated graphics and flat planes.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Examine condition of surfaces on which signs will be installed
- B. Take field measurements for work fabricated to fit job conditions. Note field measurements as such on shop drawings

3.02 INSTALLATION:

- A. General:
 1. Install work plumb, level and properly aligned, securely braces as necessary until permanent anchorage is made.
 2. Carefully cut, drill and fit as necessary to produce expert results.
 3. Install signs so as not to catch clothing on edges or otherwise create a hazardous condition.
 4. Provide attachments, supports and fastenings as required for secure and rigid anchorage.
- B. Vinyl Graphics:
 1. Apply without air bubbles or other defects in accordance with film manufacturers recommendations.
 2. Shop apply graphics wherever possible. Where field application is necessary, carefully verify location, lightly touch graphic sheeting to activate tacking ability while still mounted on carrier film. Adjust position, retacking as necessary until correctly located, then finish the application.

3.03 CLEANING AND PROTECTION:

- A. Thoroughly clean installed work using materials and methods recommended by the sign manufacturer.
- B. Protect installation from damage or soiling.

END OF SECTION

SECTION 10505

METAL LOCKERS

PART 1 -GENERAL

1.01 SCOPE OF WORK:

- A. This section specifies providing metal wardrobe lockers and wood benches.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Cast-in-Place Structural Concrete: Section 03300.
- B. Concrete Unit Masonry: Section 04220.
- C. Rough Carpentry: Section 06100.
- D. Seals and Sealants: Section 07900.
- E. Tile: Section 09320.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker and bench.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
 - 1. Show locker fillers, trim, base, sloping tops, and accessories. Include locker-numbering sequence.
- C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes, showing the full range of color, texture, and pattern variations expected. Prepare Samples from the same material to be used for the Work.
 - 1. Lockers: Three samples, on metal, of each color and finish to be provided on lockers.
 - 2. Locker benches: Three samples of finished wood.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ADA: Americans with Disabilities Act.
 - 3. ASTM: A366.
 - 4. NAAMM: Metal Finishes for Architectural and Metal Products.
- B. Source Limitations: Where practical, obtain locker units and accessories through one source from a single manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Do not deliver lockers until spaces to receive them are clean, dry, and ready for locker installation
- B. Ship lockers assembled with number plates attached.
- C. Protect lockers from damage during delivery, handling, storage, and installation.
- D. Deliver master keys, control keys, and combination control charts to the Engineer.

1.06 COORDINATION:

- A. If applicable, coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Section 03300 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Cold-Rolled Steel Sheet: ASTM A366/A366M, matte finish, suitable for exposed applications, and stretcher leveled or roller leveled to stretcher-leveled flatness.
- B. Fasteners: Zinc- or nickel-plated steel, slotless-type exposed bolt heads, and self-locking nuts or lock washers for nuts on moving parts.

2.02 LOCKERS:

- A. Body: Form backs, tops, bottoms, sides and intermediate partitions from steel sheet; flanged for double thickness at back vertical corners. Comply with the following:
 - 1. Back-Material Sheet Thickness: 0.0478-inch-thick minimum.
 - 2. Side-Material Sheet Thickness: 0.0598-inch-thick minimum.
- B. Frames: Form channel frames from minimum 0.0598-inch-thick steel sheet; lapped and welded at corners. Form continuous integral door strike on vertical frame members. Provide resilient bumpers to cushion door closing.
 - 1. Latch Hooks: Form from minimum 0.1046-inch-thick steel; welded or riveted to door frames.
 - 2. Cross Frames: Form intermediate channel cross frames between tiers from minimum 0.0598-inch-thick steel sheet. Weld to vertical frame members.
- C. Solid Steel Doors: One-piece steel sheet, formed into channel shape at vertical edges and flanged at right angles at top and bottom edges. Fabricate to prevent springing when opening or closing, and to swing 180 degrees. Comply with the following:
 - 1. Sheet Thickness: 0.0598 inch minimum.
 - 2. Reinforcement: Brace or reinforce inner face of doors more than 15 inches wide.
 - 3. Louvered Vents: Stamped, louvered vents in door face, as follows:
 - a. Single-Tier Lockers: No fewer than six louver openings at top and bottom.
 - b. Double-Tier Lockers: No fewer than three louver openings at top and bottom.
- D. Shelves: Provide hat shelf in single-tier units, fabricated from minimum 0.0598-inch-thick formed-steel sheet; flanged on all edges.

- E. Hinges: Steel, full loop, five or seven knuckle; tight pin; minimum 2 inches high. Weld to inside of door frame and attach to door with at least two factory-installed fasteners that are completely concealed and tamper resistant when door is closed.
 - 1. Provide at least three hinges for each door more than 42 inches high and at least two hinges for each door 42 inches high or less.
- F. Continuous Hinges: Manufacturer's standard, steel continuous hinge mounted to door and frame.
- G. Recessed Handle and Latch: Manufacturer's standard housing, formed from 0.0359-inch-thick nickel-plated steel or stainless steel, with integral door pull, recessed for latch lifter and locking devices; nonprotruding latch lifter; and automatic, prelocking, pry-resistant latch, as follows:
 - 1. Provide minimum three-point latching for each door more than 42 inches high; minimum two-point latching for each door 42 inches high or less.
 - a. Provide strike and eye for padlock.

2.03 LOCKER ACCESSORIES:

- A. Interior Equipment: Furnish each locker with the following items, unless otherwise indicated:
 - 1. Hooks: Manufacturer's standard zinc-plated, ball-pointed steel. Provide one double-prong ceiling hook, and not fewer than two single-prong wall hooks for single-, double-, and triple-tier units. Attach hooks with at least two fasteners.
 - 2. Coat Rods: Manufacturer's standard galvanized steel. Provide rod in lieu of ceiling hook for lockers 18 inches deep or greater.
- B. Number Plates: Manufacturer's standard etched, embossed, or stamped, aluminum number plates with numerals at least 3/8 inch high. Number lockers in sequence as directed by Engineer. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
- C. Continuous Metal Base: Minimum 0.0598-inch-thick steel sheet, 4 inches high or as indicated on approved shop drawings, channel or zee profiled for stiffness, fabricated in lengths as long as practicable to enclose base and base ends of lockers, and finished to match lockers.
- D. Individually Sloping Tops: Manufacturer's standard, fabricated from minimum 0.0239-inch-thick steel sheet, for installation in place of flat locker tops. Fabricate tops in width to fit one locker frame, with integral back, finished to match lockers. Provide fasteners, filler plates, supports, and wedge-shaped divider panels for each locker upright.
- E. Recess Trim: Manufacturer's standard; fabricated from minimum 0.0478-inch-thick steel sheet, minimum 2-1/2-inch face width, and finished to match lockers. Fabricate trim in lengths as long as practicable.
- F. Filler Panels: Manufacturer's standard; fabricated from minimum 0.0478-inch-thick steel sheet in an unequal leg angle shape, and finished to match lockers. Provide slip joint filler angle formed to receive filler panel.
- G. Finished End Panels: Manufacturer's standard; fabricated from minimum 0.0239-inch-thick steel sheet, finished to match lockers, and designed for concealing exposed ends of nonrecessed lockers.

1. Provide one-piece panels for double-row (back-to-back) locker ends.

2.04 LOCKER BENCHES:

- A. Bench Tops: Provide manufacturer's standard one-piece units, of the following material, minimum 9-1/2 inches wide by 1-1/4 inches thick, with rounded corners and edges:
 1. Laminated maple with one coat of clear sealer on all surfaces, and one coat of clear lacquer on top and sides.
- B. Pedestals: Provide manufacturer's standard pedestal supports, with predrilled fastener holes, complete with fasteners and anchors, and as follows:
 1. Type: Tubular steel, minimum 1-1/2-inch diameter, threaded on both ends, with standard pipe flange at top and bell-shaped cast base; baked-enamel finish; floor anchored with concealed fasteners..
 - a. Color: As selected by the Engineer from manufacturer's full range.
- C. Furnish a minimum of two pedestals for each bench, with pedestal spacing not more than 72 inches o.c.

2.05 FABRICATION:

- A. Unit Principle: Fabricate each locker with an individual door and frame, individual top, bottom, back, and shelves, and common intermediate uprights separating compartments.
- B. All-Welded Construction: Preassemble lockers by welding all joints, seams, and connections, with no bolts, screws, or rivets used in assembly. Grind exposed welds flush.
- C. Fabricate lockers square, rigid, and without warp, with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch. Weld frame members together to form a rigid, one-piece assembly.
 1. Form locker-body panels, doors, shelves and accessories from one-piece steel sheet, unless otherwise indicated.

2.06 FINISHES, GENERAL:

- A. Finish all steel surfaces and accessories, except prefinished stainless-steel and chrome-plated surfaces.
- B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 STEEL SHEET FINISHES:

- A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond. Use manufacturer's standard methods.
- B. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-enamel finish consisting of a thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 1.4 mils on doors, frames, and legs, and 1.1 mils elsewhere.
 - 1. Color and Gloss: As selected by the Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine concrete bases for suitable conditions where metal lockers are to be installed.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

- A. Install metal lockers and accessories level, plumb, rigid, and flush according to manufacturer's written instructions.
- B. Connect groups of all-welded lockers together with standard fasteners, with no exposed fasteners on face frames.
- C. Anchor lockers to floors and walls at intervals recommended by manufacturer, but not more than 36 inches o.c. Install anchors through backup reinforcing plates where necessary to avoid metal distortion, using concealed fasteners.
- D. Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach recess trim to recessed lockers with concealed clips.
 - 2. Attach sloping top units to lockers, with closures at exposed ends.
- E. Attach finished end panels with fasteners only at perimeter to conceal exposed ends of nonrecessed lockers.
- F. Anchor locker benches to floors Uniformly space pedestals not more than 72 inches apart, and securely fasten to bench top and anchor to floor.

3.03 ADJUSTING, CLEANING, AND PROTECTION:

- A. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.
- B. Clean interior and exposed exterior surfaces and polish stainless-steel and nonferrous-metal surfaces.
- C. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit locker use during construction.

- D. Touch up marred finishes, or replace locker units that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION

SECTION 10600

STORAGE RETRIEVAL SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The general extent and scope of work to be performed under this Section consist of the furnishing and installation of a storage and retrieval system, including storage equipment noted below, in the new Component Parts Storage rooms at the Greenbelt Annex and the Shady Grove Shop. The existing storage and retrieval system in the Greenbelt Shop may be dismantled and reused in the Shady Grove Shop with modifications as necessary to generally conform to the requirements of this specification.

- 1 Storage and Retrieval System
- 2 Storage Cabinet, Drawer Type, 8-Drawer
- 3 Storage Cabinet, Drawer Type, 10-Drawer
- 4 Storage Cabinet, Drawer Type, 6-Drawer
- 5 Storage Cabinet, Drawer Type, Double Wide
- 6 Cabinet, Tool Lock-Up
- 7 Cage, Gas Cylinder
- 8 Shelving Unit, 18 in Deep
- 9 Pallet rack (4'x9')
- 10 Storage Cabinet
- 11 Safety Storage Cabinet

- B. The provisions of Section 11001 Equipment General Requirements, apply to work of this Section

1.02 QUALITY ASSURANCE:

- A. Experience: Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment
- B. Manufacturer's of drawer cabinet units shall provide documentation from an independent testing laboratory, certifying that the drawer suspension system has been tested under full rated load conditions and has experienced an average of 3,000 cycles without failure
- C. Reference Standards
- 1 ANSI - American National Standards Institute
 - 2 OSHA - Occupational Safety & Health

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each
- 1 Certificates: Fourteen days prior to shipment, submit four copies of certification that equipment to be delivered is in compliance with applicable codes

2. **Shop Drawings:** In accordance with the requirements of Section 01330; Design Construction Submittal Procedures, submit six copies of complete shop drawings to the Authority for approval, including but not limited to:
 - a. Equipment arrangement
 - b. Equipment outline dimensions
 - c. Assembly and subassemblies
 - d. Air systems
 - e. Wiring diagrams and schematics
 - f. Installation
3. **Operations and Maintenance Manual:** Submit in accordance with the requirements of General Conditions, Section 01780; Closeout Submittals.
4. **Operations and Maintenance Training:** Submit in accordance with requirements of General Conditions, Section 01820; Demonstration and Training, and Section 11001; Equipment General Requirements
5. **Contract Record Drawings:** Submit in accordance with the General Requirements, Section 01330; Design Construction Submittal Procedures, and Section 01780; Closeout Submittals

1.04 DELIVERY, STORAGE, AND HANDLING:

- A Ship equipment upon notification by the Engineer
- B Package, handle and store to prevent damage

1.05 WARRANTY

- C Furnish warranty for the work in this Section in accordance with the General Conditions
- D Provide a Manufacturer's full service, parts and labor, warranty for a period of 3 years from date of acceptance by the Authority.

1.06 TRAINING PROGRAM:

- A Design Builder is responsible for training as outlined in General Requirements Section 01820; Demonstration and Training, and Section 11001; Equipment General Requirements
- B Number of Personnel to be Trained and class size

Level of Training	Approximate Number of Individuals to be Trained	Maximum Class Size	Minimum Number of classes
Level I	8	8	1
Level II	4	4	1

PART 2 - PRODUCTS

2.01 STORAGE RETRIEVAL SYSTEM:

- A General. This specification covers a storage retrieval system employing 1) integral lifting forks mounted on top of 2) variable location racks which accept 3) removable steel pallets. It includes the physical and mechanical requirements of that equipment, as well as the engineering assistance to be supplied by the vendor.
- B Features and Construction
- 1 Storage racks
 - a The storage rack shall have a maximum capacity of 25,000 pounds per section and 50,000 pounds per bay.
 - b The overall height of the storage rack shall be 13'-0"
 - c The clear opening between columns shall be 1 1/2" greater than the pallet width
 - d The overall depth of each rack shall be 1 1/2" greater than the pallet depth
 - 2 Columns
 - a Columns shall be accurate and straight
 - b Columns shall be 13'-0" long.
 - c Roll formed front columns shall be a minimum of 3 1/2" wide (left to right) by a minimum 2 1/2" deep by a minimum 12 gauge thick steel and shall rest on a 5 1/2" by 8" (minimum of 44 sq. in.) Bearing pad
 - d Formed rear columns shall be a minimum 7-7/8" wide (left to right) by a minimum 2-5/8" deep by a minimum 10 gauge steel and shall rest on a 5 1/2" by 8" (minimum of 44 sq. in.) Bearing pad
 - e Each bearing pad shall be anchored to the floor with a minimum of two 1/2" diameter expansion anchors.
 - f Each bearing pad shall have a minimum 1/2" diameter leveling screw, independent of the anchors, with a vertical adjustment of 5/16" minimum
 - g Each column shall have pallet retainer notches spaced a maximum of 3-7/8" on center.
 - h The notches on the front columns shall be hooked for positive pallet engagement, while the notches on the rear columns shall be designed to facilitate loading and unloading without resistance or snagging.
 - i Column spacing shall be a maximum of 5" on center greater than the pallet width

3 Bridge Assembly

- a The bridge assembly shall run on rails mounted lengthwise on the top of the storage rack and shall support the trolley and mast assemblies free and clear above the floor
- b The bridge shall be constructed of rectangular welded box construction using 6" x 12 pound/ft wide flange beam construction and shall be capable of supporting 2,000 pounds live load.
- c The bridge wheels shall be 9" diameter double flange type with needle roller bearings with pressure grease fittings
- d A rail sweep shall be mounted in front of each wheel for derailment protection
- e Bridge shall have a cantilevered extension at one end

4 Trolley Assembly

- a The trolley assembly shall run on four wheels inside the flanges of the bridge beam and shall support the mast assembly
- b The wheels shall be a minimum 5" diameter flange-less wheel with permanently lubricated ball bearings
- c The trolley must be capable of supporting 2,000 pounds live load and shall be constructed of integral flanged steel plate to prevent binding of the turntables
- d In addition to the load bearing wheels, four stabilizing bearings shall be used to keep the trolley aligned within the bridge
- e Multiple trolleys shall be provided to serve all aisles

5 Rails

- a The rails shall be constructed of a minimum 20 pound per yard ASCE steel
- b The rails shall be mounted with sufficient accuracy to provide a smooth riding runway and must be capable of supporting the weight of the bridge, trolley mast assemblies, and a 2,000 pound load.
- c Rails shall terminate with stops capable of restraining a fully loaded bridge/mast assembly

6 Mast Assembly

- a The mast shall be constructed of two 6" minimum steel channels connected by ladder type truss members and shall be mounted to the trolley with a 360 degree continuous rotation turntable.
- b The turntable shall be a ball bearing type and capable of free rotation when carrying a 2,000 pound load
- c The rollers supporting the fork mounting plate assembly must operate inside the channels on high strength machined rails

- d. There shall be sufficient rollers to keep the fork assembly square and stable as it is raised and lowered by the chain hoist.
 - e. The mast shall be provided with a positive stop lock mechanism to prevent free-fall of the fork assembly in case of hoist chain breakage. The mechanism must restrain the free falling load in 3/4" travel or less.
 - f. Mast operating handles shall be mounted outboard of the mast for ease of rotation and shall be shrouded to prevent operator injury.
 - g. A minimum of 1/4" thick Plexiglass viewing window that is a minimum of 17" square shall be located in the mast at eye level.
 - h. A protective canopy and a trolley stop shall be provided over the operator for operator safety.
7. Forks
- a. The forks shall be mounted, adjustable for pitch and width, and have a 2,000 pound capacity measured 21" from the root.
 - b. The forks shall be minimum 4" wide by 1 1/4" thick by a minimum of 1" less than the depth of the pallet.
8. Pallets
- a. Steel pallets shall be capable of holding 2,000 pound uniformly distributed load
 - b. The pallets shall mate with the racks and be adjustable using the forks of the mast assembly described above.
 - c. The pallets shall be a minimum of No. 16 gauge steel and shall be reinforced with three to five "v" supports running left to right or perpendicular to the forks
 - d. The pallets shall have two-way (front to back) entry with enclosed fork guides on the front and shall have hooks at the front to provide self-centering engagement on the front columns
 - e. Provide 5 pallets per individual storage section. Design Builder to verify total number of pallets prior to shipping. Pallets shall each have a back lip 1 1/2" high and a magnetic label holder
9. Tub Kits
- a. A tub kit shall consist of four sidewalls which can be attached to a pallet to form a tub
 - b. Each tub shall be designed such that it can be divided into four equal size compartments using one partition (running back to front) and two dividers (running left to right)
 - c. Sidewalls, partitions, and dividers shall be a minimum No. 14 gauge steel

- d. Provide six tub kits, each with a wall height of 8 3/4".

10. Electrical Operation

- a. Each mast and trolley/bridge system shall be provided with an electrically operated hoist capable of raising and lowering a 2,000 pound load at a speed of 16 feet per minute.
- b. The hoist shall have a 1 HP motor and shall be dual voltage with electrical characteristics 208 volt, 3 phase, 60 hertz, or 460 volt, 3 phase, 60 hertz. The hoist shall be wired for 208 volt, 3 phase, 60 hertz for this project. All 115V power requirements for controls and lights shall be provided through a step-down transformer.
- c. The hoist shall be provided with a mechanical load brake (positive-stop type) connected to the load sheave, a solenoid-operated spring set multiple disc-type motor brake, and an overload limiting clutch (wet cone type) located in the hoist transmission.
- d. An insulated four bar power system and sliding power collector with replaceable shoes shall be provided to supply the electrical power to the trolley/bridge as specified above. Three of the bars shall supply power and the fourth bar shall be ground.
- e. Up/down controls operating with 115V control circuit shall be by push-button and located on the mast assembly convenient to a standing operator.
- f. The system shall have a key-lock power on/off switch. The key shall not be removable in the ON position. All key-lock power switches shall be keyed alike.
- g. Two 150 watt minimum reflector type flood lights shall be mounted on the trolley/bridge to provide in-use illumination. The lights shall operate on 115 VAC.
- h. The light control shall be integral with the on/off switch such that the lights are on when the system is on.
- i. Electrical components of the system shall conform to the applicable standards of UL and NEMA. All items of the same type and rating shall be identical.
- j. All electrical wiring shall conform to the standards of the National Electric Code and applicable UL standards.
- k. Protective insulated bushings shall be provided at all places where wiring passes through openings in metal panels and frames.
- l. All electrical connections shall be suitably supported to prevent breakage and other damage.
- m. Wiring shall be coded so that each wire can be easily identified from maintenance manuals, wiring schematics, and other documentation.

11. Safety Mesh

- a. Safety Mesh shall be provided to cover the rear of the individual storage bays and the open ends.

12. Finish

- a. Color shall be manufacturer's standard blue for the storage support structure, green for the pallets and safety yellow for the mast.
- b. All painted surfaces shall be cleaned and iron phosphated and shall be coated with enamel and backed in accordance with supplier's directions.
- c. The finish shall level out to produce a smooth, uniform surface without runs, wrinkles, grit areas of thin film, and separation of color.

13. Manufacturer

- a. Specifications are based on equipment identified herein by Manufacturer's name and model, and shall serve as the basis for determining acceptable standards of quality, performance, workmanship, construction and minimum features. Storage and retrieval System as manufactured by:

Stanley Vidmar
11 Grammess Road
Allentown, Pennsylvania 18103
Telephone: (215) 797-6600;
or approved equal.

2.02 DRAWER TYPE STORAGE CABINETS

- A. Drawer type storage cabinets as specified herein shall be furnished and installed as indicated on the Contract Drawings

1. Dimensions and Capacities

- a. Overall Dimensions
 - (1) 27 3/4 inches deep
 - (2) 30 inches wide
 - (3) 59 inches high
- b. Capacity 400 lbs per drawer

2. Performance Criteria

- a. Drawers, loaded to their maximum rated capacity, shall perform minimum average of 3,000 cycles each without failure
- b. Drawers, loaded to one-half their maximum rated capacity, shall perform minimum average of 12,000 cycles each without failure
- c. Test Parameters: Manufacturer shall provide documented evidence from an independent laboratory, that the drawer suspension system has been tested

under full rated load conditions and has experienced an average of 3,000 cycles without failure. A cycle shall be defined as full extension and return with a maximum required pull force of 50 pounds.

- d. All drawers shall extend 100% out of the housing exposing all contents to reach and visibility.
- e. **Useable Drawer Space:** Drawers shall be square measuring 25.5" x 25.5" with a minimum base drawer area of 650 sq. in. Drawers shall have a minimum 631 square inches of usable drawer space. Total useable drawer space of 631 square inches times the total number of drawers specified per each unit, times the quantity of units, establishes the total square inches of drawer space for this Project

3 Features and Construction

- a. Draw cabinet shall be of unitary design and unwelded construction. Provide welded on pallet base with detachable kick-plates
- b. All drawer runners and carriage brackets shall be manufactured from high strength steel to provide a hardened surface for bearing wear. All drawers shall have a capacity rating of 400 pounds and a fail-safe carriage and drawer stop system which is strong enough to repeatedly contain working drawers without damage. All drawers shall have full suspension carriage systems
- c. Each drawer front shall have a drawer pull and label system at least 22" long, and so designed to accept a label at least 1-1/8" high. Label and its clear plastic shield shall be retained in a positive manner, with plastic end caps that shield the drawer pull end from sharp edges and contribute to an enclosed system.
- d. Each drawer cabinet shall have matching shelf cabinet securely mounted on top. The shelf cabinet shall be from the same manufacturer as the drawer unit. The shelf cabinet shall be 33 inches high and have matching width and depth dimensions with the drawer unit. Each shelf cabinet shall be equipped with two (2) shelves each with a capacity of 800 lbs
- e. Each drawer cabinet shall be lockable with a single built-in lock cylinder. One key for each cabinet shall be supplied
- f. All free standing cabinets shall be bolted together following manufacturer's recommendations and using manufacturer's hardware
- g. All cabinets shall be fully assembled with all partitions screwed in place and dividers installed
- h. The finish shall be of durable enamel in the Manufacturer's standard color

4 Model Numbers

- a. Eight (8) drawer cabinets, Stanley Vidmar Model #SEP 3163-AL with 104 compartments, or equal
- b. Ten (10) drawer cabinets, Stanley Vidmar Model #SEP 3110-AL with 164 compartments, or equal

- c Six (6) drawer cabinets, Stanley Vidmar Model #SEP 3203-AL with 64 compartments, or equal.

2.03 CABINETS, DRAWER, DOUBLE WIDTH

- A Double wide, drawer type storage cabinets as specified herein shall be furnished and installed as indicated on the Contract Drawings
 - 1 Dimensions and Capacities:
 - a Dimensions:
 - (1) 60 inches wide
 - (2) 27-3/4 inches deep
 - (3) 59 inches high
 - b Capacities: 400 lbs per drawer
 - 2 Performance Criteria:
 - a Drawers, loaded to their maximum rated capacity, shall perform minimum average of 3,000 cycles each without failure
 - b Drawers, loaded to one-half their maximum rated capacity, shall perform minimum average of 12,000 cycles each without failure
 - c Test Parameters: Manufacturer shall provide documented evidence from an independent laboratory, that the drawer suspension system has been tested under full rated load conditions and has experienced an average of 3,000 cycles without failure. A cycle shall be defined as full extension and return with a maximum required pull force of 50 pounds
 - d All drawers shall extend 100% out of the housing exposing all contents to reach and visibility
 - e Useable Drawer Space: Drawers shall be square measuring 55 7/8" x 25 5/8" with a minimum base drawer area of 1422 sq. in. Drawers shall have a minimum 1391 square inches of usable drawer space. Total useable drawer space of 1391 square inches times the total number of drawers specified per each unit, times the quantity of units, establishes the total square inches of drawer space for this Project.
 - 3 Features and Construction:
 - a Draw cabinet shall be of unitary design and uniweld construction. Provide welded on pallet base with detachable kick-plates
 - b All drawer runners and carriage brackets shall be manufactured from high strength steel to provide a hardened surface for bearing wear. All drawers shall have a capacity rating of 400 pounds and a fail-safe carriage and drawer stop system which is strong enough to repeatedly contain working drawers without damage. All drawers shall have full suspension carriage systems
 - c Each drawer front shall have a drawer pull and label system at least 22" long, and so designed to accept a label at least 1-1/8" high. Label and its clear

plastic shield shall be retained in a positive manner, with plastic end caps that shield the drawer pull end from sharp edges and contribute to an enclosed system. Provide label and covers.

- d. Each drawer cabinet shall have matching shelf cabinet securely mounted on top. The shelf cabinet shall be from the same manufacturer as the drawer unit. The shelf cabinet shall be 33 inches high and have matching width and depth dimensions with the drawer unit. Each shelf cabinet shall be equipped with two (2) shelves each with a capacity of 800 lbs.
 - e. Each drawer cabinet shall be lockable with a single built-in lock cylinder. One key for each cabinet shall be supplied.
 - f. All free standing cabinets shall be bolted together following manufacturer's recommendations and using manufacturer's hardware.
 - g. All cabinets shall be fully assembled with all partitions screwed in place and dividers installed.
 - h. The finish shall be of durable enamel in the Manufacturer's standard color.
4. Model Numbers:
- a. Seven (7) drawer cabinets, Stanley Vidmar Model Number RP 3457, with 68 compartments, or equal.

2.04 CABINET, TOOL LOCK-UP

- A. Tool Lock-Up/Storage cabinets, as specified here shall be furnished and installed as indicated on the Contract Drawings.
- 1. Dimensions and Capacities:
 - a. Dimensions
 - (1) 27 3/4 inches deep
 - (2) 30 inches wide
 - (3) 59 inches high
 - b. Capacities: 800 lbs per shelf
 - 2. Features and Construction:
 - a. Tool cabinet shall be a Stanley Vidmar Model SD-340, with three (3) shelves, model CS-80L, or equal.
 - b. Each cabinet shall have a lockable door.
 - c. Each drawer cabinet shall have matching shelf cabinet securely mounted on top. The shelf cabinet shall be from the same manufacturer as the drawer unit. The shelf cabinet shall be 33 inches high and have matching width and depth dimensions with the drawer unit. Each shelf cabinet shall be equipped with two (2) shelves each with a capacity of 800 lbs.

- d. The finish shall be of durable enamel in the Manufacturer's standard color.

2.05 GAS CYLINDER CAGE

A. Portable gas cylinder cage as specified herein shall be furnished and installed as indicated on the Contract Drawings.

1. Dimensions and Capacity:

a. Dimensions:

- (1) 56 inches wide
- (2) 42 inches deep
- (3) 68-1/2 inches high

b. Capacity Sixteen (16), 9-inch diameter tanks

2. Features and Construction:

- a. All welded heavy angle frame construction with flattened expanded mesh on all four sides, and top.
- b. Two hinged doors, lockable
- c. The finish shall be of durable enamel in the Manufacturer's standard color
- d. "NO SMOKING" sign riveted to door
- e. Gas cylinder cage shall be a Hodge Manufacturing Co. Model EVC-4256, or equal

2.06 GENERAL SHELVING UNITS-36" WIDE

A. Closed offset shelving unit shall be furnished, assembled and installed as indicated on the Contract Drawings

1. Dimensions and Capacities

a. Dimensions

- (1) 36 inches wide
- (2) 18 inches deep
- (3) 84 inches high
- (4) The installed shelf height from finish floor shall be

- (a) Top shelf; 84 inches
- (b) Second shelf; 75 inches
- (c) Third shelf; 66 inches
- (d) Fourth shelf; 52.5 inches
- (e) Fifth shelf; 36 inches
- (f) Sixth shelf; 19.5 inches
- (g) Bottom shelf; 1.5 inches

b. Capacity

- (1) Shelf: Minimum 1300 lbs per shelf for an evenly distributed load
- (2) Upright: Minimum 10,000 lbs per upright.

2. Features and Construction:

- a. The shelf shall be of a Class 2 rating and constructed of 18 gauge steel with continuous roll formed channel along the shelf perimeters. Front and back edges shall be triple flanged, sides shall be double flanged. Front and rear shelf edge reinforcing angles shall be installed for all shelves.
- b. The uprights shall consist of T-Post rear and front upright, constructed of minimum 16 gauge steel with bracket slots punched on 1-1/2 inch centers for vertical shelf adjustment. The shelves shall be secured by slip-in shelf brackets to reinforce and securely lock shelves into place on all four corners.
- c. The shelving units shall be equipped with a back panel and side panels. Where shelving unit are placed back to back or side to side, one back panel for the two units will be acceptable.
- d. Label holders shall be provided for the length of each shelf.
- e. These units shall be designed for assembly and adjustment without tools.
- f. All units shall be anchored to the floor.
- g. The finish shall be of durable enamel in the Manufacturer's standard color.
- h. Shelving unit as manufactured by Lyon Metal Products, Aurora Illinois, or Lista International, Holliston, Massachusetts, or equal.

2.07 PALLET RACK (4'x 9')

A Pallet racks with wire metal decks shall be furnished and installed as indicated on the Contract Drawings

1 Dimensions and Capacities

a Dimensions

- (1) Beams 108 inches long x 6 inches high, minimum
- (2) Upright 48 inches deep x 144 inches high
- (3) Upright Post 3 inches x 3 inches, minimum.
- (4) Installed height, top of beam to finished floor

- (a) 48 inches
- (b) 96 inches
- (c) 144 inches

b Capacity

- (1) Beams 10,000 lbs per pair, with max. deflection of 0.60" for an evenly distributed load
- (2) Uprights 32,000 lbs per upright, with 60" max. vertical spacing of beams. Minimum 3 inch x 3 inch post constructed of 13 gauge steel
- (3) Decking Minimum 4,000 lbs. capacity per section

2 Features and Construction

- a The upright frame shall be continuous steel uprights with heavy duty cross and diagonal members, fabricated from minimum 13 gauge steel. They shall be punched to accept horizontal beams, adjustable at 4 inch increments on center
- b The base plate shall be of heavy gauge steel arc welded to uprights with holes for anchoring to the floor
- c The beam construction shall be of a minimum 6" high, welded step-type minimum 14 gauge steel box channel. Step shall measure 1-5/8"H x 3/4"D. There shall be three pair per section
- d Decking shall be heavy wire mesh type. Decking shall measure 48"D x 52"W and shall be constructed of minimum #4 gauge wire on a 2" x 4" pattern, with reinforcing channels as required to support specified capacity. The reinforcing channels shall be designed to fit the step beam specified above. Decking shall be finished with an aluminum paint
- e The pallet racks shall be anchored to the floor using a minimum of two 1/2" x 3" expansion bolts per anchor plate
- f Post protectors shall be provided for the aisle side of the upright frame
- g The finish shall be of durable enamel in the Manufacturer's standard color
- h Pallet rack as manufactured by Material Storage Products, Valdosta, Georgia, or Republic Storage Systems Company, Canton, Ohio, or Lyon Metal Products, Aurora, Illinois, or equal

2.08 STORAGE CABINET

A Storage Cabinets shall be furnished and installed as indicated on the Contract Drawings

1 Dimensions and Capacities

a Dimensions

- (1) Width 36 inches
- (2) Depth 20 inches
- (3) Height 42 inches

b Capacity Minimum 1400 pounds per shelf

2 Features and Construction

- a Full welded construction
- b Shelves adjustable in two inch increments
- c Shelves - 14 gauge steel
- d Sides and Bottom Shelf 12 gauge, one piece wrap-around construction

- e Doors - 12 gauge; 8 gauge welded hinges; 200 degree swing
- f Handle: 3 point locking device
- g Storage cabinets, Strong Hold Products Model Number 33 5-202, or equal

2.09 SAFETY STORAGE CABINET

A. Safety storage cabinets shall be furnished and installed as specified herein and indicated on the Contract Drawings.

1. Dimensions and Capacities

a. Dimensions:

- (1) 43 inches wide
- (2) 18 inches deep
- (3) 65 inches high

b. Capacity: 45 gallons per cabinet

2. Features and Construction:

- a. Flammable storage cabinets shall meet NFPA code #30 and OSHA requirements
- b. Cabinets shall have two middle shelves adjustable on 1 5/8 inch centers
- c. Each cabinet shall be equipped with self-closing doors
- d. The finish shall be of durable enamel in safety yellow
- e. Each cabinet shall be marked "FLAMMABLE MATERIALS" with minimum 3" red letters
- f. Safety storage cabinet as manufactured by Equipto, Aurora, Illinois, Model Number 1792SC or equal

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install equipment specified herein in strict accordance with the approved shop drawings and manufacturer's installation instructions
- B. Install material storage units at locations indicated on the approved Design and Shop Drawing following installation procedures recommended by the manufacturer. Provide mounting hardware as required.

3.02 FIELD QUALITY CONTROL:

- A. Provide the services of a qualified manufacturer's representative to perform the following
 - 1. Supervise installation

2. Supervise testing, in the presence of the Engineer to ensure proper operation of the equipment.
3. Provide instruction to the Authority's personnel in the proper operation and maintenance of the equipment.

END OF SECTION

SECTION 10605

WIRE MESH PARTITIONS

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing woven wire mesh panels for the following:
 - 1. Wire mesh partitions.
 - 2. Wire mesh window guards.
 - 3. Wire mesh railing insert panels.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Handrails and Railings: Section 05521.
- B. Aluminum Entrances and Storefronts: Section 08410 for lock cylinders.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm experienced in manufacturing wire mesh partitions similar to those indicated for this Project and that have a record of successful in-service performance.
- B. Structural Performance: As specified in Section 05521 for railing insert panels.
- C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of wire mesh partitions and wire mesh insert panels that are similar to those indicated for this Project in material, design, and extent.

1.02 DEFINITIONS

- A. The types of weaves for the wire mesh specified in this Section and defined in ASTM E 437 and its Appendix X4.2:
 - 1. Plain Weave: Wires pass over one and under the next adjacent wire in both directions.
 - 2. Lock Crimped: Deep crimps at points of intersection to lock the wires securely in place.
 - 3. Intercrimped: Similar to plain weave with extra crimps between the intersections.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the Special Conditions and with the additional requirements as specified for each:

- A. Product Data for each type of product specified, consisting of manufacturer's specification, technical data, and installation instructions.

- B. Shop Drawings showing fabrication and installation of wire mesh partitions, window guards, railing insert panel and access panels, including plans, elevations, and large-scale details showing anchorage and accessory items. Provide location template drawings for items supported or anchored to permanent construction.
 - 1. For steel channel and tube framing of wire mesh partitions and railing insert guards, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Samples of a 12-by-12-inch-300-by-300-mm wire mesh panel constructed of specified frame members, wire mesh, and color charts.

1.04 JOB CONDITIONS

- A. Field Measurements: Check actual locations for wire mesh products by accurate field measurements before fabrication and show recorded measurements on Shop Drawings. Coordinate fabrication and delivery schedules with construction progress to avoid delaying the Work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee location dimensions and proceed with fabricating wire mesh products without field measurements. Coordinate wall, column, floor, and ceiling construction to ensure that actual location dimensions correspond to guaranteed dimensions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Woven wire partitions, Window Guards and Insert Panels: Manufactured by the G - S Company, or provide systems, as approved by the Engineer, of similar quality and appearance to match construction quality and appearance of the specified manufacturer.

2.02 MATERIALS

- A. Steel Channels, Angles, Plates, and Bars: ASTM A 36ASTM A 36M.
- B. Steel Sheet: ASTM A 568ASTM A 568M.
- C. Cold-Rolled Steel Channels: Formed from steel sheet.
- D. Square Steel Tubing: Cold-formed structural steel tubing, ASTM A 500.
- E. Galvanized Steel Wire: ASTM A 641ASTM A 641M.
- F. Galvanized Steel Sheet: Commercial-quality, hot-dip-coated steel sheet, ASTM A 653, with G60 or A60ASTM A 653M, with Z180 or ZF180 coating.
- G. Bent Plate Channel: Formed from galvanized steel sheet.

2.03 WIRE MESH PARTITIONS:

- A. Mesh: 0.135-inch-3.4-mm- diameter, plain-weave, galvanized steel wire woven into 3 inch38-mm square pattern, insert through frame members, and welded into frame square pattern, inserted through.
- B. Frames: Provide galvanized steel fasteners and other items shown or necessary for partition

installation.

1. Vertical Members: 1-1/4-by-5/8-by-0.108-inch hot dipped galvanized steel C-Section channels with 1/4-inch- diameter bolt holes approximately 18 inches 450 mm o.c.
 2. Horizontal Members: 1-by-1/2-by-1/8-inch hot dipped galvanized steel channels, mortised and tenoned to vertical members.
 3. Horizontal Reinforcing Members: 1-by-1/2-by-1/8-inch hot dipped galvanized steel channels with wire woven through or two 1-by-1/2-inch galvanized steel channels bolted or riveted toe-to-toe through mesh, and secured to vertical members. Provide number of horizontal reinforcing members to suit panel height as recommended by partition manufacturer.
- C. Top Capping Bars: 2-1/4-by-1-inch hot dipped galvanized steel channels, secured to top framing channels with 1/4-inch- diameter, galvanized "U" bolts spaced not more than 28 inches o.c.
- D. Corner Posts: 1-1/4-by-1-1/4-by-1/8-inch hot dipped galvanized steel angles with floor shoe galvanized per ASTM A 123 and 1/4-inch- diameter bolt holes to align with bolt holes in vertical frame members.
- E. Floor Shoes: Cast aluminum or steel galvanized per ASTM A 123, sized to suit vertical framing and to provide approximately 3 inches 75 mm of clear space between finished floor and bottom horizontal frame members. Furnish units with set screws for leveling adjustment.

2.04 DOORS:

- A. Hinged Door: Door frame of 1-1/4-by-1/2-by-1/8-inch hot dipped galvanized steel c-section channels with 1-1/4-by-1/8-inch flat steel bar cover plates on 3 sides, and 1/8-inch- thick angle strike bar and cover on lock side. Provide 1-1/2 pairs of 3-by-3-inch butt hinges riveted or welded to door and frame, and mortise-type cylinder lock operated by key outside with recessed knob inside. Align bottom of door with bottom of adjacent panels.
- B. Provide manufacturer's standard cylinders for lock.

2.05 WINDOW GUARDS

- A. Mesh: 0.135-inch-diameter, lock-crimped galvanized steel wire woven into a 4-inch , 45 degree pattern, inserted through frame holes and welded into frame.
- B. Frames:
1. Frames 1 1/4-by-1/2-by-1/8-inch hot dipped galvanized, cold-rolled steel channels.
 2. Frames at Window Guards: Hot dipped galvanized bent plate channel, sized to fit adjacent to curtainwall framing.
- C. Anchorage Devices: Furnish appropriate types and quantities of anchorage devices to provide adequate anchorage to adjacent structures.
- D. Access Panels: Provide the following at bridge walkway guards where shown:
1. Jamb: Provide 1-1/4-by-1-1/4-by-1/8-inch steel angle jamb bars with bolt holes for anchorage spaced a maximum of 24 inches o.c.
 2. Hinging: Furnish 1 pair of 3-by-3-inch butt hinges.
 3. Locking Device: mortise l- type cylinder lock as specified in Section 08410.

2.06 STAIRWAY PARTITIONS RAILING INSERT PANELS:

- A. Mesh: 0.135-inch-diameter, plain-weave galvanized steel wire woven into a 3-inch square pattern, inserted through frame holes and welded into frame. Vertical wires are plumb. Horizontal wires are perpendicular to vertical wires.
- B. Frames: 1 1/4 -by-1/2-by-1/8-inch hot dipped galvanized cold-rolled steel channels.

2.07 FABRICATION:

- A. Do not use components less than sizes indicated. Use larger-size components as recommended by partition component manufacturer.
- B. Provide bolts, hardware, and accessories for complete installation.

2.08 FINISHES:

- A. Wire Mesh Partitions and Doors: Manufacturer's standard shop - applied enamel finishes.
- B. Stairway Partitions and Railing insert panels:
 - 1. Manufacturer's standard shop - applied enamel finish.
- C. Window Guards:
 - 1. Manufacturer's standard polyester powered coat finish.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.02 INSTALLATION

- A. Erect partitions plumb, rigid, properly aligned, and securely fastened in place, complying with Drawings and manufacturer's recommendations.
- B. Provide additional field bracing as shown on approved shop drawings or necessary for rigid, secure installation. Installer to provide additional clips and bracing as required.
- C. Attach window guards to inside face of aluminum curtain wall as shown on approved shop drawings. Fasten screws into pre-drilled holes with vinyl insert to prevent contact between dissimilar metals. Provide fasteners spaced evenly to screw to curtain wall system as shown on the approved shop drawings.

3.03 ADJUSTING AND CLEANING

- A. Adjust moving components for smooth operation without binding.
- B. Touch up damaged finish after completing installation using field-applied paint to match color of shop-applied finish.

END OF SECTION

SECTION 10810

TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY OF WORK:

- A. This section specifies providing toilet accessories, including:
 - 1. Sanitary napkin vendors.
 - 2. Sanitary napkin disposal units.
 - 3. Framed mirrors with shelves.
 - 4. Framed mirrors without shelves.
 - 5. Liquid soap dispensers.
 - 6. Toilet paper dispensers.
 - 7. Clothes hook and bumpers.
 - 8. Paper towel dispensers.
 - 9. Waste receptacles.
 - 10. Grab bars.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Tile: Section 09320.
- B. Toilet Compartments: Section 10155.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop drawings: Detailed shop drawings, including fastenings, manufacturer's installation instructions and other information. Submit prior to ordering materials or beginning installation.
- B. Samples:
 - 1. For each accessory item to verify design, operation, and finish requirements. One each
 - 2. Special anchors, plates or embedded items required because of the conditions in this project. One each. Submit with the related accessory samples. Delete subparagraph below if not applicable.
- C. Setting Drawings: For cutouts required in other work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.. Retain paragraph below for large, complicated projects. Revise to suit Project.

1.04 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ADA (Americans with Disabilities Act).

3. ASTM: A666, C1036, F446.
 4. FS: DD-M-411.
- B. Manufacturer Qualifications: Provide products of an established manufacturer regularly engaged in the production of toilet accessories.
- C. Source Limitations: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise approved by the Engineer. Retain paragraph below if products are listed in schedule at the end of Part 3. See Evaluations. Retain one of three subparagraphs below, depending on Specification method selected. Correlate with Part 2 "Manufacturers" Article and schedule at the end of Part 3. See descriptions of specifying methods and examples of completed schedules in the Evaluations.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver products to the job site in original unopened containers clearly labeled with the manufacturer's name, brand designation and type as applicable.
- B. Store products in an approved dry area, protect from contact with soil and from exposure to the elements. Keep products dry.
- C. Handle products so as to prevent breakage of containers and damage to products.

1.06 COORDINATION:

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work..

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL:

- A. Provide toilet accessories of an approved manufacturer; provided complete with fasteners appropriate for surface which applied. Satin-finish stainless steel unless otherwise noted.
- B. Exposed fastenings finished to match accessories.
- C. Labels, decals and cast-in or embossed identification in conspicuous places on accessories is prohibited.
- D. Use only products which comply with barrier-free accessibility guidelines of ADA.
- E. Quantity and location are as shown.

2.02 MATERIALS:

- A. Stainless Steel: ASTM A666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Mirror Glass: ASTM C1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.
- C. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.03 PRODUCTS:

- A. Sanitary Napkin Vendor: Provide stainless-steel sanitary napkin vendor complying with the following:
 - 1. Products: Bobrick B-2800, or equal.
 - 2. General: Fabricate cabinet of all-welded construction. Provide seamless door with returned edges and secured by tumbler lockset. Provide identification reading "Napkins" and "Tampons"; brand-name advertising is not allowed. Capacity not less than 15 napkins and 20 tampons.
 - 3. Mounting: Surface-mounted type.
 - 4. Operation: Single-coin operation, 10 cents.
- B. Sanitary Napkin Disposal Unit: Provide stainless-steel sanitary napkin disposal unit complying with the following:
 - 1. Products: Bobrick 270, or equal.
 - 2. Surface-Mounted Type: With seamless exposed walls; self-closing top cover; locking bottom panel with stainless-steel, continuous hinge; and removable, reusable receptacle.
- C. Framed Mirror with Shelf: Provide framed mirror with shelf complying with the following:
 - 1. Products: Bobrick B-166-1836, or equal.
 - 2. Glass: 1/4-inch float/plate glass, No. 1 quality.
 - 3. Stainless-Steel, Channel-Framed Mirror: Fabricate frame from stainless-steel channels in manufacturer's standard satin finish with square corners mitered to hairline joints and mechanically interlocked. Provide concealed wall mounting bracket for theft-proof installation.
 - a. Integral Shelf: Stainless steel in thickness recommended by manufacturer, but not less than thickness of mirror frame, approximately 5 inches deep by width of mirror, with edges turned down and returned for rigidity; secure shelf to bottom of mirror frame.
- D. Framed Mirror without Shelf: Provide framed mirror without shelf complying with the following:
 - 1. Products: Bobrick B-165-1836, or equal.
 - 2. Glass: 1/4-inch float/plate glass, No. 1 quality.
 - 3. Stainless-Steel, Channel-Framed Mirror: Fabricate frame from stainless-steel channels in manufacturer's standard satin finish with square corners mitered to hairline joints and mechanically interlocked. Provide concealed wall mounting bracket for theft-proof installation.
- E. Liquid Soap Dispenser: Provide liquid soap dispenser complying with the following:
 - 1. Products: Bobrick B-2112, or equal.

2. Liquid Soap Dispenser, Horizontal-Tank Type: Surface-mounted type, minimum 40-oz. capacity tank with stainless-steel piston, springs, and internal parts designed to dispense soap in measured quantity by pump action; and stainless-steel cover with unbreakable window-type refill indicator. Vandal resistant.
 - a. Soap Valve: Designed for dispensing soap in liquid form.
- F. Toilet Tissue Dispenser: Provide toilet tissue dispenser complying with the following:
1. Products: Bobrick B-274, or equal.
 2. Type: Double-roll dispenser.
 3. Mounting: Surface mounted with concealed anchorage.
 4. Material: Satin-finish aluminum bracket with plastic spindle.
 5. Operation: Eccentric-shaped, molded-plastic spindle revolves one-half revolution per dispensing operation for controlled delivery; core cannot be removed until roll is empty.
 6. Capacity: Designed for tissue rolls up to 6-inch-diameter.
- G. Clothes Hook and Bumper: Provide clothes hook and bumper complying with the following:
1. Products: Bobrick B-212, or equal.
 2. Material: Solid aluminum casting with matte finish. Rubber bumper protects wall or partition surfaces.
- H. Paper Towel Dispenser: Provide stainless-steel paper towel dispenser complying with the following:
1. Products: Bobrick B-262, or equal.
 2. Surface-Mounted Type: Sized for minimum of 400 C-fold or 525 multifold paper towels without using special adapters; with hinged front equipped with tumbler lockset; and with refill indicators that are pierced slots at sides or front.
- I. Waste Receptacle: Provide stainless-steel waste receptacle complying with the following:
1. Products: Bobrick B-275, or equal.
 2. Surface-Mounted Type: With seamless exposed walls; continuously welded bottom pan; and minimum 20-gal. capacity, reusable, vinyl liner secured at not less than four points with grommets and hooks.
- J. Grab Bar: Provide stainless-steel grab bar complying with the following:
1. Products: Bobrick B-6106, or equal. Comply with ADA.
 2. Material: Bar 18-gauge wall Type 304 stainless steel.
 3. Mounting: Exposed with manufacturer's standard flanges and anchors.
 4. Gripping Surfaces: Smooth, satin finish, unless otherwise noted.
 5. Outside Diameter: 1-1/2 inches for heavy-duty applications.
 6. At water closets for the handicapped, provide the following unless otherwise shown:
 - a. Back wall: 36-inch minimum length grab bar behind the water closet.
 - b. Side wall: 42-inch minimum length grab bar to the side of the water closet.

2.04 FABRICATION:

- A. General: Names or labels are not permitted on exposed face of accessories. On interior surface not exposed to view or back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

- B. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
- C. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.
 - 1. Provide galvanized steel backing sheet, not less than 0.034 inch and full mirror size, with nonabsorptive filler material. Corrugated cardboard is not an acceptable filler material.
- D. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:
 - 1. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove
- E. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to the Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Coordinate with other trades for concealed back plates, blocking and anchoring devices embedded or built into work of other trades.
- B. After mounting surfaces have been painted, install accessories in accordance with manufacturer's recommendations.
- C. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights recommended by the manufacturer unless otherwise shown or required by regulations. Comply with ADA.
 - 1. At water closets for the handicapped, mount grab bars as follows unless otherwise shown:
 - a. Back wall: Mount grab bar at a height between 33 and 36 inches above finish floor and to extend a minimum of 12 inches beyond the center of the water closet toward the side wall and a minimum of 24 inches toward the open side for either a left or right side approach.
 - b. Side wall: Mount grab bar at a height between 33 and 36 inches above finish floor and spaced 12 inches maximum from the back wall and extending a minimum of 54 inches from the back wall.
 - 2. At water closets for the handicapped, mount toilet paper dispenser at a minimum height of 19 inches above finish floor.
- D. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.
- E. Install grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F446.

- F. After installation, protect the toilet accessories from damage and soiling.

3.02 TESTING AND ADJUSTING OF COMPLETED WORK:

- A. Test accessories for unencumbered, smooth operation and verify that mechanisms function properly.
- B. Replace damaged or defective items.
- C. Test for required strength and for pull-out and pull-off of grab bars. Remove and reattach as needed.

3.02 CLEANING:

- A. Remove temporary labels and protective coatings.
- B. Before final acceptance, clean and polish exposed surfaces according to manufacturer's written recommendations.
- C. Leave areas surrounding the work in broom-clean condition.

END OF SECTION

SECTION 11001

EQUIPMENT GENERAL REQUIREMENTS

PART 1 - GENERAL

RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract apply to this section.
- B. Coordinate with Division 1, Section 01810 and 01820.
- C. Coordinate with Sections under Divisions 11 and 14.

1.01 DESCRIPTION:

- A. Furnish and install where shown all equipment as specified, complete and ready for operation. Each item shall be specifically designed for the intended function. Provide necessary accessories, items of equipment, mechanical, electrical and structural items, whether specified or not in order to provide properly installed and functional equipment.
- B. Equipment provided shall be suitable for installation in the space shown and operation on the available building utilities. Any modification or redesign to the building elements (i.e. structure, foundation) or utilities shown on the Contract Drawings because of a specific equipment selection by the Contractor shall be provided by the Contractor at no additional cost to the Authority and shall be as approved by the Engineer.
- C. In all cases where a device or part of the equipment is referred to in the singular number, it is intended that such reference shall apply to as many such devices as are required to complete the installation.
- D. Major Shop Equipment: Appendix 'A' of this Section 11001 identifies the Major Shop Equipment to be evaluated in accordance with Section 00204.D, Phase II, Technical Evaluation Factors.

1.02 QUALITY ASSURANCE:

- A. General:
 - 1. When two or more items of equipment are required, they shall be products of a single manufacturer.
 - 2. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.
 - 3. Touch-up or repaint to match original finish, all factory finishes or painted equipment and materials which are scratched or marred during shipment or installation.
 - 4. For purposes of designating type and quality of work under Divisions 11 and 14, the Drawings and Specifications are based on products by manufacturers listed first in Part 2 - Products, of each individual Section. Contractor shall be responsible for modifying the building structure, foundations, and utilities as required to accommodate products of manufacturers listed second or third for the individual equipment items, or equipment approved as equal.
- B. Certificates of Compliance: Upon delivery of the equipment, submit certificates of compliance.

Each certificate shall be signed by an authorized representative of the manufacturer stating that the equipment complies in all respects with the Contract requirements.

1.03 SUBMITTALS:

- A. Submit the following in accordance with the requirements of General Requirements, and as specified in the various Sections of Equipment Specifications.
 - 1. Shop drawings.
 - 2. Product data.
 - 3. Samples.
 - 4. Installation instructions.
 - 5. Operations and Maintenance Data.
 - 6. Equipment Manual.

- B. Sequence of Approval:
 - 1. Tentative Approval of Equipment: Before submittal of shop drawings, submit to the Engineer for approval, drawings, specifications and lists of equipment to be incorporated in the work. This list shall include catalog numbers, cuts, and such other descriptive data as may be required to assure compliance with these specifications. No consideration will be given to partial lists submitted from time to time. Approval of equipment will be tentative subject to submission of complete shop drawings indicating compliance with the Contract Documents.
 - 2. Final Approval of Equipment: After receiving tentative approval of the equipment lists, submit shop drawings, product data and installation instructions for final approval.

- C. Shop Drawings: Shop drawings shall consist of the following as applicable:
 - 1. Layout drawings showing equipment layout, elevations, conduit runs, utility layout and hook-ups, and all required dimensions.
 - 2. Fabrication drawings, including bill of materials.
 - 3. Detail drawings.
 - 4. Foundation and structural support drawings including anchor bolt plan and elevation.
 - 5. Utility connection plan.
 - 6. Electrical control diagram.
 - 7. Electrical wiring diagram.
 - 8. Electrical equipment layout, with all motors, limit switches, solenoid valves, disconnect, control panels, etc. located and labeled.
 - 9. Piping systems including pipe routing, sizing, valving, lubricators, regulators, pumps, nozzles etc., fully noted and scheduled.
 - 10. HVAC and exhaust air systems including duct routing, duct sizes, fittings, dampers, grilles, supports, etc., fully noted and scheduled including elevations, in addition to details of penetrations and equipment connections.

- D. Product Data: Manufacturer's literature including catalog cuts, pamphlets, descriptive literature, equipment specifications, performance *and* test data, and brochures which adequately describe the piece of equipment or product.

- E. Installation Instructions: Manufacturer's recommended installation instructions and manufacturer's installation drawings.

- F. Equipment Manual: After receiving final approval of all equipment items specified herein, Contractor shall submit two complete Equipment Manuals to the Authority prior to final acceptance of the Equipment. Equipment Manual shall consist of at least one clear catalog cut sheet or manufacturer's product data sheet for each equipment item furnished under this Contract. Cut-sheets or data forms shall include as a minimum, machine manufacturer, model

number, machine specifications and capacities. Each catalog cut shall be marked with the name of the item and the Equipment Identification Number shown on the Drawings. Arrange catalog cut-sheets by shop and provide dividers to separate each shop within the manual. Manual shall be prepared using a three ring binder with appropriate title sheet and table of contents. Cut-sheet pages shall be reinforced near punched holes.

1.04 OPERATIONS AND MAINTENANCE DATA:

- A. Manuals shall be submitted for each equipment item in accordance with the requirements of General Requirements and as follows:
- B. General Requirements for Manuals:
 - 1. Manufacturer's operating manuals giving complete instructions relative to assembly, installation, operation, adjustment, lubrication, maintenance, and complete parts list shall be furnished by the Contractor for every item of machinery and equipment furnished by the Contractor.
 - 2. Manuals furnished may be manufacturer's standard publications in regard to size and binding provided they comply with specified requirements relative to quantity of information and data.
 - 3. Manuals shall be bound in hard or flexible covers. Illustrations shall be clear, and printed matter, including dimensions and lettering on drawings, shall be easily legible. If reduced drawings are incorporated into manuals, original lines and letters shall be heaved-up as necessary to retain their legibility after reduction. Larger drawings may be folded into manuals to page size.
- C. Format Manuals in accordance with the requirements set forth in General Requirements Section 01780, and as follows:
 - 1. Title page: Include the name and function of the equipment, manufacturer's name, address, and telephone number, Contractor's name, address, and telephone number and the Project Specifications number and title.
 - 2. Table of contents, in numerical order listing each section and subsection title of the Operations and Maintenance Manual with reference to the page on which each starts and a list of included diagrams and drawings.
 - 3. Index, in alphabetical order.
 - 4. Frontispiece: Recognition illustration of the equipment described in the Operation and Maintenance Manual.
 - 5. Catalog, model and serial number of equipment installed. Include WMATA unit numbers where applicable.
 - 6. Manufacturer's literature describing each piece of equipment, including major assemblies and subassemblies, and giving manufacturer's model number and drawing number.
 - 7. Operation instructions including step-by-step preparation for starting, operation, shutdown and draining, and emergency requirements.
 - 8. Control diagrams, as-installed by the manufacturer.
 - 9. Sequence of operation by the control manufacturer.
 - 10. Wiring diagrams, as-installed and color codes, of electrical motor controllers, connections and interlock connections.
 - 11. Diagrammatic location, function and tag numbers of each valve.
 - 12. Maintenance instructions: Include step-by-step procedures for inspection, operation checks, cleaning, lubrication, adjustments, repair, overhaul, disassembly, and reassembly of the equipment for proper operation of the equipment. Include list of special tools which are required for maintenance with the maintenance information.
 - 13. Possible breakdowns and repairs.
 - 14. Manufacturer's parts list of functional components, control diagrams and wiring

- 15. diagrams, giving manufacturer's model number and manufacturer's part number.
- 16. "Long-Lead-Time" spare parts list for spare parts not readily available on the open market or for which it is anticipated ordering and delivery time will exceed 10 days.
- 17. List of nearest local suppliers of all equipment parts.
- 18. Lubrication schedule indicating type and frequency of lubrication.
- 19. Manufacturer's warranty and guarantee data in accordance with the General Conditions.
- 20. Spare parts data in accordance with the General Requirements Section 01780.
 - a. Complete list of parts and supplies, with current unit prices and sources of supply.
- 21. Appendix: Include safety precautions, a glossary, and, if available at time of submittal, copies of test reports, and other relevant material not specified to be submitted.
- 22. Delete information on material or equipment not used in the work from the Operations and Maintenance Manual.

D. Operating Diagrams:

- 1. Piping systems, electrical wiring diagrams, fuel oil, lubricating oil, water capacity diagrams, and other diagrams necessary for operation of machinery and equipment shall be furnished and installed where designated by the Engineer.
- 2. No single diagram shall show more than one system, or parts thereof.
- 3. Diagrams shall be reproduced by photographic process to a size not to exceed 18 inches by 24 inches and shall be complete and legible in all respects. Systems shall be subdivided into portions which are operable from location where diagrams are installed, and to provide intelligible information within specified size. They shall be made on white paper and vacuum-sealed in transparent plastic material impervious to moisture and oil, and resistant to abrasion. Other formats which are equal in clarity, sharpness, durability and permanence will be considered.

1.05 TRAINING PROGRAM:

- A. General Requirements: The Contractor is responsible for training as outlined in General Requirements, Section 01820 and as follows:
 - 1. Maintenance management classes shall take place two weeks prior to the occupancy of the facility by the Authority.
 - 2. Mechanics training will commence only after installation of equipment is complete and is fully operational as determined by the Engineer.
 - 3. Training shall be conducted at a WMATA facility as directed by the Authority.
 - 4. Hours for training shall be between 7:00 a.m. and 7:00 p.m. unless specifically permitted otherwise.
- B. The Contractor is responsible for insuring that the instructors teaching these training courses are not only familiar with technical information, but able to utilize proper methods of instruction, training aids, audiovisuals, etc., to insure effective presentations.
- C. The Contractor is responsible for providing all training aids, audiovisual equipment and visual aids for the conduct of these courses.
- D. All training materials are to become the property of the Authority at the conclusion of training.
- E. Submission and Approval of Training Plans shall be in accordance with the General Requirements.
- F. Submission and Approval of Training Plans: Submit to the Construction Manager, at least 30 days prior to scheduled delivery of equipment, a detailed outline of the proposed training

program for the operation personnel. Include such information as the duration of the program, material and literature to be utilized, topics to be covered, and any material and equipment required to be provided by WMATA. WMATA will provide rail vehicles and rail vehicle components required for the training program.

- G. Include each piece of equipment's operation and maintenance manual as a basic text for instruction. Organize the program to permit WMATA to develop, within its own organization, the capability to continue the education of its personnel in the proper operation and repair of the equipment. Assume no prior knowledge, on behalf of the WMATA personnel, of the equipment.
- H. Levels of Training: Training shall be provided as specified in the individual Equipment Specification Sections and pursuant to the requirements set forth herein.
 1. Level I: Include 8 hours of "hands-on" training to familiarize the operating personnel with equipment operation, performance, features, safety features and requirement, and detailed instruction in operation and light maintenance of equipment. Class size shall be limited as indicated in subparagraph 1.05 I.
 2. Level II: Include a minimum of 18 hours of "hands-on" training to familiarize the plant and equipment personnel on parts and component replacement and repair, including anticipated major repairs. Class size shall be limited as indicated in subparagraph 1.05 I.
 3. Level III: Include a minimum of 18 hours of initial "hands-on" training to familiarize personnel on the programming requirements of the equipment, with 8 hours of follow-up training 3 months later, or earlier if requested. Class size shall be limited as indicated in subparagraph 1.05 I.

I. Number of Personnel To Be Trained And Class Size.

Level Of Training	Approximate Number of Individuals	Maximum Class Size	Minimum Number of Classes
Level I		8	
Level II		4	
Level III		4	

1.06 GENERAL DESIGN AND FABRICATION REQUIREMENTS:

- A. Equipment shall be designed , fabricated, installed and adjusted to secure the best commercially available results with respect to smooth, quiet, convenient and efficient operation, durability, economy of maintenance and operation, and the highest standards of safety.
- B. It is not the intent of these Specifications of detail the design and fabrication of the several parts of the equipment, but the type, material, design, workmanship and fabrication of each and every part shall be fully adequate for the service required, durable, properly coordinated with all other parts, in accordance with the best commercial standards and of the highest commercial efficiency. The components of electric circuits shall be of ample and proper size, design and material to avoid injurious heating and arcing, and all other objectionable effects which may reduce the efficiency of operation and economy of maintenance and upkeep below the best commercially available results. Minimum requirements are given herein for the certain parts of equipment. Equivalent requirements approved by the Engineer shall apply to such parts as are of special design, construction or material and to which the specified requirements are not directly applicable. These minimum requirements as a whole shall also be considered as

establishing proportionate general minimum standards for all parts of the equipment.

- C. The Engineer may permit variations from the requirements of these Specifications to permit the use of the manufacturer's standard equipment, provided such standard equipment is in every way adequate for the intended use and meets the full intent of these Specifications. All such variations proposed by the Contractor shall be called to the attention of the Engineer in writing and shall be made only if approved in writing.
- D. Certain design limitation, tests, etc., are herein specified as a partial check on the adequacy of design, fabrication, and materials. These requirements do not cover all features necessary to insure satisfactory and approved operation of the equipment. Conformity with these requirements shall, in no way, supersede the general requirements as to satisfactory and efficient operation of the equipment.

1.07 NOISE AND VIBRATION ISOLATION:

- A. Noise and vibration isolation pads shall be provided where required and shall be approved type equipped with necessary bearing plates and bolts. They shall be specifically designed for the weights, speeds and vibration characteristics of the equipment supported. The pads shall provide proper distribution of weight to avoid distortion of the bed plates.
- B. Bolts and other fastenings in the connection with these pads shall also be effectively isolated.

1.08 SHOP PAINTING:

- A. Equipment shall be given one shop prime coat of approved rust-inhibitive paint containing at least 25 to 30 percent rust-inhibitive pigments and manufacturer's standard finish coat system. Shop drawings shall indicate brand and type of paint.

1.09 ELECTRICAL REQUIREMENTS

- A. Power supply for equipment shall be 480 volts, 3-phase, 60 hertz unless otherwise specified.
- B. Provide transformer for equipment as required to step down the specified supply voltage to provide lower voltage for controls and accessories and to provide voltage compatible with equipment as required.
- C. Wiring shall be provided for complete installation of all equipment and accessories and shall be adequate for proper operation of equipment. Provide disconnect switch for each equipment item requiring electric power. Disconnect switch shall meet the requirements of the respective equipment item manufacturer and the requirements of Division 16. Permanently label each disconnect switch to identify corresponding equipment item: labeling method shall be subject to approval of the Construction Manager. Electrical Trade will bring power wiring to line side of disconnect switch. Make connection to secondary side of disconnect switch and provide all wiring and conduit from this point, including wiring to controllers and starters. Provide 480 volt and 208 volt equipment. All disconnect switches shall be fused with 200,000 amp limiter fuses. Provide 120 volt equipment with electric thermal overload disconnecting means sized as required for each equipment item. Wire and cable for light, power and signal circuits shall conform to those specified in the National Electrical Code. In no case shall maximum current exceed that specified by National Electrical Code for type of conductor used. Provide conduit where required; all wiring and conduit shall be in accordance with the requirements of Division 16.

- D. Motors:
1. Motors shall be high efficiency makes, each bearing the UL label and constructed to standard of NEMA, IEEE, ANSI, and AFBMA.
 2. Motors shall be suitable for operation on the electrical service indicated.
 3. Horsepower ratings and sizes shall be selected at 40° C ambient temperature for service as specified in Section 16225 - Motors. Provide motors with epoxy encapsulated insulation for severe usage in a corrosive atmosphere.
 4. Motors rated one horsepower or greater shall have a full-load power factor of 85 percent or higher. Motors rated 50 horsepower and over shall be designed for reduced voltage starting.
- E. Drives:
1. Guards shall be provided for each coupling and belt drive in conformance with applicable codes.
 2. Belt drives shall have adjustable motor drive pulleys, and pulleys shall be replaced by the Contractor if required to properly operate the equipment provided.
 3. Provide sliding motor bases where adjustable motor drive pulleys are provided.

1.10 GASKETS AND FASTENERS:

- A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.
- B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded, or have their threads, heads or slots damaged.
- C. Furnish all bolts, studs, nuts and other fasteners for make-up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

1.11 EQUIPMENT:

- A. Equipment, machinery and materials shall be as specified in the various Sections of Divisions 11 and 14.
- B. Equipment shall be factory-finished with manufacturer's standard primer and finish coats of paint.
- C. Starters, controllers, disconnect switches and start-stop stations shall be provided for all equipment. Correct sizing of starters and disconnect switches shall be the responsibility of the Contractor.
 1. Electrical enclosures shall be NEMA 12 for indoor units and NEMA 4 for outdoor units unless otherwise shown.
 2. Starters shall be complete with two sets of auxiliary contacts; one set normally open; one set normally closed.
 3. For motors 25 HP or greater provide auto-transformer type reduced voltage starters.
- D. Control devices necessary for proper operation shall be provided and shall be located to permit efficient operation of the equipment, and where possible shall be grouped in a factory fabricated NEMA approved control panel complying with requirements specified in Division 16.
- E. Switches, lights and control functions shall be identified with legend plates. The plates shall be constructed of polyvinyl-chloride material of laminated multiple constructions, and rout engraved

with appropriate legends. The size of letters, colors and legend shall be submitted for approval. The legend plats shall be mounted on the equipment in an approved manner. No decals will be accepted.

- F. Piped services for equipment are specified as work of Division 15 - Mechanical and are terminated near the piece of equipment in a shut-off means. As part of the work of this Section, extend these piped services to the equipment and make the associated connections.
- G. Provide piping, fittings, valves, connections, etc., of a type and size as recommended by the equipment manufacturer that will properly interface with the piped services provided under Division 15 - Mechanical.
- H. All piping, valves, fittings, conduits and wiring required for the equipment installation shall be in accordance with the applicable portions of Divisions 15 and 16.

1.12 INSTALLATION REQUIREMENTS:

- A. Furnish common and skilled labor, tools, rigging equipment, scaffolding, shims, dowels, and other materials necessary to make complete installation of equipment specified and shown.
- B. Receive, unload, check and store equipment in suitable facilities. All equipment should be kept clean, dry, and free from damage and be marked and tagged with equipment item numbers.
- C. Examine equipment for concealed damage and report any damage.
- D. Be responsible for safety and protection from loss or damage of equipment received until work is complete.
- E. Pay demurrage charges and claims for damage resulting from unloading operations.
- F. Reassemble equipment items which were dismantled for shipment or moving. Assemble items which are delivered knocked down, or disassembled.
- G. Coordinate the installation of equipment with other trades.
- H. Protect equipment during storage and prior to start-up, which shall include covering of openings, protection against rust and other damage, etc. Equipment may be stored outdoors only with approval of the Engineer.
- I. Furnish and install grout, shim material and miscellaneous steel necessary for brackets, anchors, or supports required in installation of equipment.
- J. Accomplish field machining that might be required to fit equipment together or to install equipment.
- K. Lubricate apparatus before start-up.
- L. Field check for clearance and interferences before fabrication or installation and relocate material and equipment furnished as required to eliminate interferences.
- M. Details listed in these specifications are given for a better understanding of the work required by the Contractor, and do not place a limitation on the amount of work to be done nor do they relieve the Contractor of additional work that may be required for a complete installation.

- N. Perform mechanical and electrical work required to install the equipment in accordance with the requirements of the jurisdictional authorities and the current codes and standards for practice employed by these trades.

1.13 HOLES, OPENINGS AND INSERTS:

- A. Provide holes and openings in floors, wall, ceilings and roofs as required.
- B. Core drill holes in existing work using dustless method. Grout in holes in concrete walls, floor and roof slabs after installation of equipment, and leave them in a completely neat and sealed condition.
- C. Install concrete inserts and flashings as required.

1.14 SETTING AND ALIGNING EQUIPMENT:

- A. Equipment shall be set and aligned in accordance with manufacturers's recommendations, approved shop drawings and applicable standards of trade practice.
- B. Equipment shall be set true and level. Demonstrate adequate leveling of installed equipment.
- C. Re-tighten bolted connections after installation.

1.15 CLEANING AND PROTECTION:

- A. Clean fabricated assemblies and equipment items thoroughly before and after operating and testing.
- B. Protect equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

1.16 CONCRETE FOUNDATIONS:

- A. Concrete and reinforcement shall be in accordance with Sections 03300 and 03200.
- B. Provide anchor bolts as required for equipment to be mounted. Anchor bolts shall be in accordance with Section 05500.
- C. Provide grouting as necessary to stabilize equipment bases to concrete foundations.
- D. Provide hard rubber shims as recommended by the equipment manufacturer for leveling of equipment.

1.17 EQUIPMENT TEST AND CHECK-OUT:

- A. Before Final Acceptance, the Contractor-furnished equipment shall be tested in the presence of the Engineer to his satisfaction and demonstrated to be correctly connected and installed. Submit a testing schedule to the Engineer for approval prior to the start of the equipment test and check-out.

- B. Testing and check-out procedures of the manufacturer shall be carried out completely.
- C. The Authority will provide railcars and railcar components to be used during the testing procedures as required by the Contractor.
- D. Equipment tests shall not only be performed to demonstrate that the equipment has been properly installed and connected and operates properly but also to demonstrate that the equipment performs the work for which it is intended.
- E. Contractor is responsible, at his expense, to conduct any and all tests necessary to demonstrate that the equipment performs as specified and submitted. Tested equipment found to be defective or inoperable to any extent shall be reported to the Engineer immediately.
- F. Any operating difficulty or defective item shall be repaired or replaced and put into proper operation by the Contractor immediately, at no additional expense to the Authority.
- G. Protect equipment and surrounding areas from damage resulting from testing operations. Clean-up spills or leakage from testing.
- H. The Contractor shall bear all expenses of all tests, including the furnishing of all necessary instruments, lubricant, hydraulic fluids, supplies, data recorders, and operating personnel. Provide and bear all expenses for fuel/power required to operate the equipment during the tests.
- I. At the sole discretion of the Engineer, the Contractor will be required to repeat any test at no additional cost to the Authority.

1.18 MOTORS AND DRIVES:

- A. Motors and drives shall be checked carefully for correct rotation and alignment before placing equipment into operation.
- B. Couplings shall be disconnected and realigned before placing into service or testing.
- C. Belt drives shall be adjusted and worn belts replaced in sets. Speed adjustment shall be subject to approval of the Engineer.

1.19 INSPECTION:

- A. Work will be inspected by the Engineer periodically during the course for construction.
- B. Provide for inspections by all others having jurisdiction over the work performed under the various Sections of Divisions 11 and 14, and Section 01060, during the progress of the work.
- C. At time of final inspection, furnish certificate or certificates of final approval by all others having jurisdiction as applicable.

1.20 FIELD PAINTING:

- A. Unless otherwise specified in other Sections of these Specifications, all lubricants, cleaning compounds, and similar operating materials will be furnished by the Authority during instruction of the Authority's personnel.

- B. After all equipment and systems have been installed, connected and tested, proceed with the simultaneous start-up and initial operation of the entire facility as well as the instruction of Authority's personnel in the operation and maintenance of equipment. The Contractor shall provide sufficient personnel to adequately complement personnel made available by the Authority.
- C. During this period, provide qualified representatives of equipment manufacturers for instruction of the Authority's personnel in operation and maintenance of the equipment.
- D. The Authority will provide railcars and railcar components required for the instruction of the Authority's personnel in the operation of the equipment.

PART 2 - PRODUCTS

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PART3 - EXECUTION

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END OF SECTION

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APPENDIX A

MAJOR SHOP EQUIPMENT LISTING

NOTE: The Brand Name products specified are intended for descriptive purposes only. They represent similar equipment that is currently installed in other WMATA facilities. Design-Builders are permitted to propose products equal to those stated. All major equipment proposed will be evaluated for availability, reliability, and maintainability as stated under Section 00204.D as well as for compliance with the applicable Specification Sections shown below.

	Equipment	Schedule A Greenbelt	Schedule B Shady Grove	Schedule D Brentwood	Brand Name	Model No.	Spec Section
1	Car Hoist System - Married Pair with Car Body Posts	-	2	-	Whiting	Custom	14100
2	Car Hoist System - Married Pair with Spinning Posts	-	2	6	Whiting	Custom	14100
3	Truck Repair Hoist System - Single Truck with Spinning Posts	8	2	-	Whiting	Custom	14520
4	Motorized Turntables	15	9	2	Whiting	Custom	11300
5	Vertical Milling Center	1	-	-	Haas	VF-4	11100
6	Combination Double End Mount/Demount Press - 600T	1	-	-	Simmons-Farrel	-	11200
7	Bridge Crane -15 Ton	3	-	-	-	-	14401

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SECTION 11100
VERTICAL MILLING CENTER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract apply to this section.
- B. Related Sections include Section 11001, Equipment General Requirement.

1.02 SUMMARY:

- A. This section includes the Vertical Machining center.

1.03 TRAINING:

- A. Contractor is responsible for training as outlined in Section 01820, Demonstration and Training and Section 11001, Equipment General Requirements.
- B. Number of Personnel To Be Trained And Class Size.

Level Of Training	Approximate Number	Maximum Class Size	Minimum Number of Classes
Level I	40	8	6
Level II	8	4	2
Level III	8	4	2

- C. Levels of Training:
 - 1. Level I: Familiarizing Training
 - 2. Level II: Training for P&E Personnel
 - 3. Level III: Programming Training

PART 2 - PRODUCTS:

2.01 PRODUCT DATA:

- A. Description: the vertical machining center shall be 50" x 20" x 25" (1,270 x 508 x 635 mm) xyz travels and shall consist of cast-iron components, and have a 40-taper cartridge spindle driven by a 20 hp vector Dual-Drive motor, produces either 75 ft-lb of

torque at 1,200 rpm, or 250 ft-lb at 450 rpm with the optional 2-speed gearbox—and shall run up to 7,500 rpm in 1.2 seconds for finishing aluminum.

- B. Options and Accessories for a Vertical Milling Center machine tool shall be coordinated with the owner.

TRAVELS	S.A.E.	Metric
Maximum X Axis	50 "	1270 mm
Maximum Y Axis	20 "	508 mm
Maximum Z Axis	25 "	635 mm
Spindle nose to table (min)	4 "	102 mm
Spindle nose to table (max)	29 "	737 mm
STANDARD TABLE	S.A.E.	Metric
Length	52 "	1321 mm
Width	18 "	457 mm
Max Weight on Table	3500 lb	1588 kg
T-slot Width	.625 "	15.875 mm
T-slot Center Distance	3.15 "	80 mm
Number of T slots	5	5
SPINDLE	S.A.E.	Metric
Taper Size	#40 Taper "	#40 Taper
Spindle Max Speed	7500 rpm	7500 rpm
Drive System	Direct Speed Belt Drive	Direct Speed Belt Drive
Max Torque Standard	75 ft-lb @ 1400 rpm	102 Nm @ 1400 rpm
with Optional Gearbox	250 ft-lb @ 450 rpm	339 Nm @ 450 rpm
Spindle Motor Max. Rating	20 hp	14.9 kw
Bearing Lubrication	Air/Oil injection	Air/Oil injection
Cooling	Liquid Cooled	Liquid Cooled
AXIS MOTORS	S.A.E.	Metric
Max Thrust Rating X	2550 lb	11343 N
Max Thrust Rating Y	2550 lb	11343 N
Max Thrust Rating Z	4200 lb	18683 N
FEEDRATES	S.A.E.	Metric
Rapids on X Axis	1000 in/min	25.4 m/min
Rapids on Y Axis	1000 in/min	25.4 m/min
Rapids on Z Axis	1000 in/min	25.4 m/min
Max Cutting	650 in/min	16.5 m/min

TOOL CHANGER	S.A.E.	Metric
Capacity Standard	20	20
Tool Type / Taper	CT or BT/40	CT or BT/40
Max Tool Diameter Std (full)	3.5 "	89 mm
Maximum Tool Weight	12 lb	5.4 kg
Changer Type Standard (Optional)	Carousel (SMTC)	Carousel (SMTC)
Tool-to-Tool (avg)	4.2 sec	4.2 sec
Chip-to-Chip (avg)	4.5 sec	4.5 sec
ACCURACY (SINGLE AXIS)	S.A.E.	Metric
Positioning (\pm)	.0002 "	0.0051 mm
Repeatability (\pm)	.0001 "	0.0025 mm
GENERAL	S.A.E.	Metric
Door Opening Width	48.5 "	1232 mm
Machine Weight	13300 lb	6033 kg
Air Required	4 CFM @ 100 psi	113 lpm @ 6.9 bar
Power Required	14 kVA; 200-250 VAC, 3-phase; 50-60 Hz	14 kVA; 200-250 VAC, 3-phase; 50-60 Hz

PART 3 - EXECUTION

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SECTION 11160
LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This Section includes the following:
 - 1. Dock bumpers.
 - 2. Dock levelers.
 - 3. Truck levelers.
 - 4. Truck restraints.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Division 3 Section "Cast-in-Place Concrete" for concrete work for recessed loading dock equipment.
- B. Division 5 Section "Metal Fabrications" for curb angles at edges of recessed pits and loading dock platform edge channels.
- C. Division 8 Sections for overhead doors electrically interlocked to dock levelers.
- D. Division 15 Section "Plumbing Specialties" for pit drains for loading dock equipment permanently installed in pits.
- E. Division 16 Section "Interior Lighting" for dock lighting fixtures.
- F. Division 16 Sections for electrical wiring and connections for loading dock equipment.

1.03 DEFINITIONS

- A. Operating Range: Maximum amount of travel above and below the loading dock level.
- B. Working Range: Recommended amount of travel above and below the loading dock level for which loading and unloading operations can take place.

1.04 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, rated capacities, operating characteristics, furnished specialties, accessories, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For Installer.
- D. Product Test Reports: Based on evaluation of tests performed by manufacturer and supervised and verified by a qualified independent professional engineer, indicate

compliance of dock levelers with requirements of MH 30.1 for determining rated capacity, which is based on comprehensive testing within the last two years of current products.

1. Submittal Form: According to MH 30.1, Appendix A.
- E. Maintenance Data: For loading dock equipment to include in maintenance manuals.
- F. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- B. Source Limitations: Obtain each type of loading dock equipment through one source from a single manufacturer.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish recessed pit dimensions, slopes of driveways, and heights of loading docks, and proceed with fabricating loading dock equipment without field measurements. Coordinate loading dock construction to ensure that actual dimensions correspond to established dimensions.

1.08 COORDINATION

- A. Coordinate installation of anchorages for loading dock equipment. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Recessed Loading Dock Equipment: Coordinate size and location of pits to ensure proper clearances and operation of equipment.
1. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
 2. Asphalt paving requirements are specified in Division 2 Section "Hot-Mix Asphalt Paving."
- C. Electrical Requirements: Coordinate wiring requirements and current characteristics of loading dock equipment with building electrical system. See Division 16 Sections.

1.09 WARRANTY

- A. Special Warranty for Dock Levelers: Manufacturer's standard form in which manufacturer agrees to repair or replace dock-leveler components that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including cracked or broken structural support members and load-bearing welds.
 - b. Deck plate failures including cracked plate or permanent deformation in excess of 1/4 inch (6 mm) between deck supports.
 - c. Hydraulic system failures including failure of hydraulic seals and cylinders.
 - d. Faulty operation of operators, control system, or hardware.
 2. Warranty Period for Structural Assembly: 10 years from date of Substantial Completion.
 3. Warranty Period for Hydraulic System: Five years from date of Substantial Completion.
 4. Warranty shall be for unlimited usage of the leveler for the specified rated capacity over the term of the warranty.

1.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of loading dock equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
1. Perform maintenance, including emergency callback service, during normal working hours.
 2. Include 24-hour-per-day, 7-day-per-week emergency callback service.
- B. Continuing Maintenance Service: Provide a continuing maintenance proposal from Installer to Owner, in the form of a standard yearly maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM 36/A 36M.
- B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55 (380).

- C. Steel Tubing: ASTM A 500, cold formed.
- D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- E. Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried.
- F. Pressure-Treated Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried, and pressure treated with waterborne preservatives to comply with AWPA C2.

2.03 DOCK BUMPERS

- A. Manufacturers:
 1. American Floor Products Company, Inc.
 2. Beacon Industries, Inc.
 3. Chalfant Dock Equipment.
 4. Durable Corporation.
 5. Ellis Industries, Inc.
 6. Flexon, Inc.
 7. Hugger Dock Equipment Company.
 8. Kelley Company, Inc.; a United Dominion Company.
 9. Maman Products, Inc.
 10. Pawling Corporation.
 11. Pioneer Loading Dock Equipment.
 12. R. C. Musson Rubber Co.
 13. Rite-Hite Corporation.
 14. Serco; a United Dominion Company.
 15. Super Seal Mfg. Ltd.
 16. Superior Bumper Products Inc.
 17. Tennessee Mat Company, Inc.
 18. Vestil Manufacturing.
- B. Laminated-Tread Bumpers: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- (19-mm-) diameter, steel supporting rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles.
- C. Molded-Rubber Bumpers: Fabricated from molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Type A Shore durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240; of size and configuration indicated. Fabricate units with not less than two predrilled anchor holes.
- D. Extruded-Rubber Bumpers: Fabricated from ASTM D 2000, extruded synthetic rubber with Type A Shore durometer hardness of 75, plus or minus 5, when tested according to ASTM D 2240; of size and configuration indicated. Furnish units with predrilled anchor holes and concealed, flat, steel mounting bar.
- E. Steel-Face, Laminated-Tread Bumpers: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires and with 3/8-inch (9.5-mm) steel face plate of same size as rubber surface. Laminate plies under pressure on not less than two 3/4-inch (- 19-mm-) diameter, steel supporting rods that are welded at one end to 1/4-inch- (6-mm-) thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate

angles with predrilled anchor holes and sized to provide not less than 1 inch (25 mm) of tread plies extending beyond the face of closure angles. Weld face plate to two steel support brackets, which shall extend back to and engage 3/4-inch- (19-mm-) diameter support rods in elongated holes, allowing steel face to float on impact.

- F. Anchorage Devices: Hot-dip galvanized steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated.

2.04 RECESSED DOCK LEVELERS

- A. General: Recessed, hinged-lip-type dock levelers designed for permanent installation in concrete pits preformed in the edge of loading platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.
 - 1. Manufacturers:
 - a. Beacon Industries, Inc.
 - b. Blue Giant Equipment Corporation; Subsidiary of TBM Holdings, Inc.
 - c. Chalfant Dock Equipment.
 - d. DLM, Inc.
 - e. Ellis Industries, Inc.
 - f. Flexon, Inc.
 - g. Kelley Company, Inc.; a United Dominion Company.
 - h. McGuire, W. B. Co., Inc.; Division of Overhead Door Corporation.
 - i. Pentalift Equipment Corporation.
 - j. Pioneer Loading Dock Equipment.
 - k. POWERAMP; Division of Systems, Inc.
 - l. Rite-Hite Corporation.
 - m. Rol-Lift Corporation; Subsidiary of TBM Holdings, Inc.
 - n. Serco; a United Dominion Company.
 - o. Vestil Manufacturing.
- B. Quality Standard: MH 30.1, "Safety, Performance and Testing of Dock Leveling Devices."
- C. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform in the following manner:
 - 1. Vertical Travel: Provide operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact.
 - 2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
 - 3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to 4 inches (100 mm) over width of ramp.
 - 4. Lip Operation: Manufacturer's standard mechanism that automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck, and automatically retracts lip when truck departs.
 - 5. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs.
- D. Mechanical Operating System: Spring-operated raising and walk-down lowering of unloaded ramp. Equip units with an upward-biased-spring counterbalancing mechanism

controlled by a hold-down device. Ramp raises to top limit of operating range by operating recessed control handle in ramp to disengage hold-down device. Ramp lowers below platform level with lip retracted by operating auxiliary, recessed control handle to release support legs.

1. Free-Fall Protection: Manufacturer's standard protection system to limit free fall of loaded ramps with front edge supported by truck bed.
- E. Hydraulic Operating System: Electric-powered hydraulic raising and hydraulic lowering of ramp, controlled from a remotely located push-button station. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than 3 inches (76 mm.)
1. Remote-Control Station: Single-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 12 box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
 2. Remote-Control Station with Emergency Stop: Multibutton control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, Type 12 box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. All ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.
 - a. Dual-Panel Control Station: Remote-control station for operating side-by-side dock levelers.
 - b. Master Panel: Control panel with integral fused disconnecting means for operating dock leveler, dock door, and truck restraints.
 3. Independent Lip Operation: Electric-powered hydraulic raising and hydraulic lowering of lip, controlled independently of raising and lowering of ramp.
- F. Electric Operating System: Electric raising of ramp and automatic extending of lip, controlled from a remotely located push-button station. Equip leveler with a packaged unit including a unitized electric motor and shaft assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers.
1. Remote-Control Station: Single-button station of the constant-pressure type, enclosed in shielded NEMA ICS 6, Type 4 box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
 2. Remote-Control Station with Emergency Stop: Multibutton control station with an UP button of the constant-pressure type and an emergency STOP button of the momentary-contact type, enclosed in NEMA ICS 6, Type 12 box. Ramp raises by depressing and holding UP button; ramp lowers at a controlled rate by releasing UP button. All ramp movement stops, regardless of position of ramp or lip, by depressing STOP button. Normal operation resumes by engaging a manual reset button or by pulling out STOP button.
- G. Air-Bag Operating System: Electric, high-volume, low-pressure lifting of ramp, controlled from a remotely located push-button station. Equip leveler with a packaged unit including a PVC-coated polyester lifting bag and two-stage, single-speed electric fan of proper size, type, and operation for capacity of leveler indicated. Include dock-leveler supports controlled by release chain for lowering ramp below platform level without extending lip.
1. Remote-Control Station: Single-button station of the constant-pressure type, enclosed in shielded NEMA ICS 6, Type 4 box. Ramp raises by depressing and

holding button; ramp lowers at a controlled rate by releasing button.

- H. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.
1. Clean-Pit Frame: Designed to support leveler at sides of pit, with no side-to-side supports at front of pit floor.
 2. Hinged Lip: Full width, piano-type hinge with heavy-wall hinge tube and greased fittings, with gussets on lip and ramp for support.
 3. Toe Guards: Equip open sides of rising ramp over range indicated with metal toe guards mounted flush with ramp edges and projecting below ramp.
 - a. Finish: Factory finish dock levelers after assembly and testing. Paint toe guards yellow to comply with ANSI Z535.1.
 4. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.
 5. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.
 6. Integral Dock Bumpers: Fabricated from 4-inch- (100-mm-) thick, heavy molded-rubber compound reinforced with nylon, rayon, or polyester cord; with Type A Shore durometer hardness of 80, plus or minus 5, when tested according to ASTM D 2240. Provide two dock bumpers for each recessed dock leveler, attached to face of loading dock with expansion bolts.
- I. Accessories:
1. Curb Angles: 3-by-3-by-1/4-inch (76-by-76-by-6-mm) galvanized steel curb angles for edge of recessed leveler pit, with 1/2-inch- (13-mm-) diameter by 6-inch- (152-mm-) long concrete anchors welded to angle at 6 inches (152 mm) o.c.
 2. Self-Forming Pan: Manufacturer's standard prefabricated, self-forming steel form system for poured-in-place construction of concrete pit.
 3. Night Locks: Manufacturer's standard means to prevent extending lip and lowering ramp when overhead doors are locked.
 4. Side and rear weatherseals.
 5. Foam insulation under dock-leveler platform.
 6. Abrasive skid-resistant surface.
 7. Interlock: Leveler will not operate while overhead door is in closed position and truck restraint is not engaged.

2.05 TRUCK RESTRAINTS

- A. General: Manufacturer's standard device designed to engage truck's rear-impact guard and hold truck at loading dock. Restraint shall consist of an iron or steel restraining arm that raises until contacting rear-impact guard. Arm shall move vertically, automatically adjusting to varying height of truck due to loading and unloading operations.
1. Manufacturers
 - a. Beacon Industries, Inc.
 - b. Blue Giant Equipment Corporation; Subsidiary of TBM Holdings, Inc.
 - c. Chalfant Dock Equipment.
 - d. DLM, Inc.
 - e. Ellis Industries, Inc.
 - f. Flexon, Inc.
 - g. Kelley Company, Inc.; a United Dominion Company.
 - h. McGuire, W. B. Co., Inc.; Division of Overhead Door Corporation.

- i. Pentalift Equipment Corporation.
 - j. POWERAMP; Division of Systems, Inc.
 - k. Rite-Hite Corporation.
 - l. Serco; a United Dominion Company.
- B. Restraining Capacity: Capable of restraining total gross load indicated without permanent deflection or distortion.
 - C. Operating Range: Capable of restraining rear-impact guards within a range from 11 to 30 inches (279 to 762 mm) vertically above driveway, and from 0 to 12 inches (0 to 305 mm) horizontally in front of dock bumpers.
 - D. Power Operating System: Manufacturer's standard electromechanical or hydraulic unit.
 - 1. Remote-Control Station: Single-button station of the constant-pressure type, weatherproof, enclosed in NEMA ICS 6, Type 12 box. Restraint is engaged by depressing and holding button; restraint is released by releasing button.
 - 2. Interlock: Leveler will not operate while truck restraint is not engaged.
 - E. Mechanical Operating System: Restraint operates by use of a lifting rod or hook to raise engagement device.
 - F. Rear-Impact-Guard Sensor: Sensor detects presence of rear-impact guard and automatically returns to stored position if rear-impact guard is not engaged.
 - G. Caution Signs: Exterior, surface mounted; with black text on yellow background, and with sign copy as follows. Provide one sign at each truck-restraint location.
 - 1. Sign Copy in Forward and Reverse Text: "CAUTION, MOVE ON GREEN ONLY."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of loading dock equipment.
- B. Examine roughing-in for electrical systems for loading dock equipment to verify actual locations of connections before equipment installation.
- C. Examine walls and floors of pits for suitable conditions where recessed loading dock equipment is to be installed. Pits shall be plumb and square and properly sloped for drainage from back to front of loading dock.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation.
- B. Set curb angles in concrete edges of dock-leveler recessed pits with tops flush with loading platform. Fit exposed connections together to form hairline joints.

- C. Set curb angles in concrete edges of truck-leveler recessed pits with tops flush with driveway. Fit exposed connections together to form hairline joints.
- D. Place self-forming pan system for recessed dock levelers in proper relation to loading platform before pouring concrete.
- E. Clean recessed pits of debris.

3.03 INSTALLATION

- A. General: Install loading dock equipment, including motors, pumps, control stations, wiring, safety devices, and accessories as required for a complete installation.
 - 1. Rough-in electrical connections according to requirements specified in Division 16.
- B. Dock Bumpers: Attach dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.
 - 1. Welded Attachment: Plug-weld anchor holes in contact with steel inserts and fillet weld at other locations.
 - 2. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.
 - 3. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.
- C. Recessed Dock Levelers: Attach dock levelers securely to loading dock platform, flush with adjacent loading dock surfaces and square to recessed pit.
- D. Truck Restraints: Attach truck restraints in a manner that complies with requirements for arrangement and height required for device to engage vehicle rear-impact guard.
 - 1. Wall-Mounted Units: Weld truck restraints to steel curb angle, edge channel, or mounting plate embedded in loading dock edge.
 - 2. Wall-Mounted Units: Anchor truck restraints to loading dock face with expansion anchors and bolts.
 - 3. Driveway-Mounted Units: Anchor truck restraints to driveway with expansion anchors and bolts.
 - 4. Pit-Mounted Units: Anchor truck restraints to concrete pit with expansion anchors and bolts.

3.04 ADJUSTING AND CLEANING

- A. Adjust loading dock equipment for proper, safe, efficient operation.
- B. Test dock levelers for vertical travel within operating range indicated.
- C. Restore marred, abraded surfaces to their original condition.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain loading dock equipment. Refer to Division 1 Section "Closeout Procedures or Demonstration and Training."

3.06 LOADING DOCK EQUIPMENT SCHEDULE

- A. Laminated-Tread Dock Bumper:
1. Thickness: 4-1/2 inches (114 mm) or 6 inches (152 mm).
 2. Horizontal Style: 6 inches (152 mm), 10 inches (254 mm) or 12 inches (305 mm) high by length indicated on Drawings.
 3. Vertical Style: 8 inches (203 mm) wide by 20 inches (508 mm), 24 inches (610 mm), 36 inches (914 mm) high or height indicated on Drawings.
- B. Molded-Rubber Dock Bumper:
1. Configuration: T shape, Inverted-L shape, Square, or rectangular. Thickness: 2 inches (50 mm), 3 inches (75 mm), 4 inches (100 mm), or 6 inches (150 mm).
- C. Extruded-Rubber Dock Bumper: Flat or ribbed, with 2-inch (50-mm) nominal thickness and 9-inch (229-mm) height, or 4-1/2-inch- (114-mm-) wide base and 4-inch (100-mm) depth with half-oval shape that compresses and returns to original shape.
- D. Steel-Faced, Laminated-Tread Dock Bumper:
1. Thickness: 4-1/2 inches (114 mm) or 6 inches (152 mm).
 2. Horizontal Style: 6 inches (152 mm), 10 inches (254 mm), or 12 inches (305 mm) high by length indicated on Drawings.
 3. Vertical Style: 8 inches (203 mm) wide by 20 inches (508 mm), 24 inches (610 mm), 36 inches (914 mm), or height indicated on Drawings.
- E. Recessed Dock Leveler:
1. Operation: Mechanical operating system.
 2. Operation: Hydraulic operating system with weatherproof, single-button or multibutton remote-control station.
 3. Operation: Electric-actuator operating system with weatherproof, single-button, or multibutton remote-control station.
 4. Operation: Air-bag operating system with weatherproof, single-button remote-control station.
 5. Rated Capacity: As determined by client.
 6. Platform Size: As indicated on Drawings.
 7. Vertical Travel: Minimum working range of 12 inches (305 mm) or 18 inches (457 mm) above and 12 inches (305 mm) or 14 inches (356 mm) below adjoining platform.
 8. Length of Lip Extension: 16 inches (406 mm), 18 inches (457 mm), or 20 inches (508 mm).
 9. Compensation Capacity: Automatic vertical, lateral, or vertical and lateral.
 10. Platform: 3/16-inch- (5-mm-), 1/4-inch- (6-mm-), or 3/8-inch- (9.5-mm-) thick, nonskid steel plate.
 11. Hinged Lip: 1/2-inch- (13-mm-), 5/8-inch- (16-mm-), 3/4-inch- (19-mm-), or 1-inch- (25-mm-) thick, nonskid steel plate.
 12. Frame: Manufacturer's standard type.
 13. Toe-Guard Range: Entire upper working or operating range.
 14. Accessories:
 - a. Night locks.
 - b. Side and rear weatherseals.
 - c. Foam-insulated deck.
 - d. Interlock to overhead door.
 - e. Interlock to truck restraint.
 15. Finish: Painted in manufacturer's standard color.

- F. Truck Restraint:
1. Power Operating System: Activated by single-button station, or activated by weatherproof, single-button station.
 2. Manual operating system.
 3. Restraining Capacity: as determined by client.
 4. Communication System: Caution signs and manual signal lights or automatic signal lights.
 5. Mounting: Wall, driveway or pit.
 6. Accessories: Interlock to dock leveler or Key switch.
 - a. Interlock to dock leveler.
 - b. Key switch.
 7. Finish: Painted in manufacturer's standard color.

END OF SECTION

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SECTION 11200

COMBINATION DOUBLE END MOUNT/DEMOUNT PRESS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract apply to this section.
- B. Related Sections include Section 11001, Equipment General Requirement.

1.02 SUMMARY:

- A. This section includes a combination double end mount/demount press

1.03 TRAINING:

- A. Contractor is responsible for training as outlined in Section 01820, Demonstration and Training and Section 11001, Equipment General Requirements.
- B. Number of Personnel To Be Trained And Class Size.

Level Of Training	Approximate Number of Individuals	Maximum Class Size	Minimum Number of Classes
Level I	40	8	6
Level II	8	4	2
Level III	8	4	2

- C. Levels of Training:
 - 1. Level I: Familiarizing Training
 - 2. Level II: Training for P&E Personnel
 - 3. Level III: Programming Training

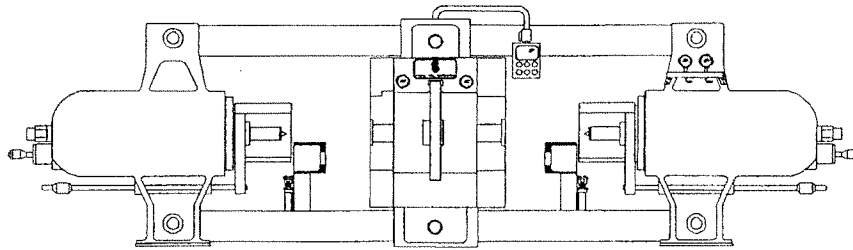
PART 2 - PRODUCTS

2.01 PRODUCT DATA

- A. This specification describes a 600 Ton Universal Combination Mount/Demount Press. Proper tooling options must be selected suitable to handle transit wheel sets with inboard bearings, AAR standard freight wheel sets, and AAR standard locomotive wheel sets. The press shall be well suited to low and medium production shops, and must handle a wide variety of work pieces or handle complex work pieces efficiently such as transit wheel sets or locomotive wheel sets.
- B. The press shall consists of two opposing horizontal double acting hydraulic press rams,

a stationary abutment, and hydraulically operated tools located between the main cylinders and the stationary abutment.

- C. Upper and lower tension bars shall tie the two main cylinders and the center abutment together. The upper and lower tension bars shall be offset to allow overhead wheel set handling.
- D. A self-contained hydraulic power unit supplying all of the press requirements shall be located on the right hand end and to the rear of the press
- E. As illustrated below



2.02 FUNCTIONS

- A. The press must be able to perform the following processes:
 - 1. Low Tonnage Wheel Demounting
 - 2. High Tonnage Wheel Demounting
 - 3. Bearing Demounting
 - 4. Gearbox Demounting
 - 5. Gear Demounting
 - 6. Gear Mounting
 - 7. Gearbox Mounting
 - 8. Variable Tonnage Bearing Mounting
 - 9. Wheel Mounting
- B. The Press must be able to perform all functions listed above on the various series of rail cars possessed by WMATA. Different series of rail cars have differing gearbox mounting arrangements on the axles and the Press shall be able to support all arrangements. The Design Builder must demonstrate that the equipment supplied is capable of servicing all WMATA rail car types.

2.03 DESIGN DATA

A. Technical Design Data

Maximum pressing force	600 T(US)	5339 KN
Main ram diameter	18"	457 mm
Main ram working stroke	36"	914 mm
Max. opening between ram faces (w/o tools)	148"	3760 mm
Max. opening between ram faces (w/ std. tools)	116"	2945 mm
Tension bar cross-section	4 x 12"	100 x 300 mm
Vertical distance between tension bars	60"	1524 mm
Horizontal offset	9"	228 mm
Centerline Press to Floor (approx.) (standard pit design)	30"	762 mm
Operating Pressure	4500 PSI	300 bar
Ram rapid approach (per minute)	120"	3048 mm
Ram rapid retract (per minute)	140"	3556 mm
Press speed bearings mount 80 T	18"	457 mm
Press speed wheel mount 200 T	16.5"	419 mm
Press speed wheel demount 600 T	8.25"	209 mm
Pump motor	40 HP (30 KW)x1200 RPM Dbl Shaft	
Hydraulic fluid - ISO 32	(approx) 200 US gallons	
Overall floor space - approximate	380x186"	9652x4724 mm
Estimated Weight	56,000#	26,000 kg

B. Machine Construction

The Wheel Mount/Demount Press shall be of heavy-duty construction for long life in continuous duty service. The main rams shall be close-grained Meehanite castings, finished to a smooth ground surface. The pressing face shall be a removable steel plate. A large bronze ram bearing in the hydraulic cylinder beam shall be provided to assure accurate alignment of ram in the cylinder during press operation

2.04 MACHINE CONTROLS AND OPERATIONS

A. Main Press Assembly

1. The press consists of two main cylinders, one at each end of the press. The center abutment is located midway between the cylinders and is attached to the cylinders by tie bars.
2. Swing-in-swing-out tooling yokes shall be located between the center abutment and the cylinders and pivot on an axis located behind the lower tie bar. These yokes will be used for mounting wheels, gears and bearings.

3. The control pendant for mounting operations shall be located at the top of the center abutment. The main electrical power cabinet shall be located on the RH side of the hydraulic tank and behind it.
 4. The hydraulic tank and its controls shall be located at the RH end and back of the press.
 5. An overhead power transfer crane conveyor shall be located in front of and over the press. This crane shall have its own pendant for controlling its motion.
- B. Press Cylinder Beam
1. The press cylinder beams shall be made of ductile iron and are sleeved with brass bearings for the main ram.
 2. The main rams shall be made of cast iron and sealed with chevron packings. The main rams shall extend and retract by jack rams and shall be prevented from rotating by guide rods attached to the ram face plates.
 3. The cylinder beams shall have rectangular slots for accommodating the tie bars while round steel pins secure the tie bars to the beams. The cylinder beams shall rest on resilient pads to allow for expansion of the tie bars under high loads.
- C. Center Abutment
1. The center abutment shall be a heavy steel plate fabrication. The center abutment shall provide a structure for the three sliding abutments used in the demounting processes. Each abutment shall slide on anti-friction bearing ways for ease of movement. The right and left sliding abutments shall be powered into position while the smaller center sliding abutment is manually operated.
 2. The center abutment shall house the gearbox support table, which is powered up and down. The support table shall be removable to allow for more clearance in the center abutment opening. The center abutment shall have rectangular slots for accommodating the tie bars and shall be secured to the tension bars by round steel pins.
- D. Mounting Yokes
1. The mounting yokes shall be located between each cylinder beam and the center abutment. The yokes shall be comprised of heavy steel fabrications designed to withstand the forces of the mounting process. Each yoke shall pivot on a large shaft and shall be hydraulically actuated. Each yoke shall accept tools required for mounting of a particular size wheel set.
- E. Hydraulic Power Unit
1. The hydraulic power unit shall be a self-contained unit. It shall consist of two pumps powered by a 40 HP motor operating at 1200 RPM. The pumps and motor shall be located on a stand, which supports a 200 gallon fluid reservoir.
 2. One pump shall deliver fluid at fixed pressure while the second pump delivers at varying pressures determined by a proportional relief valve. The valve shall be controlled by the press controller, which monitors the press mode and shall automatically determine the pressure required.
 3. Return line filtration, with automatic clog indicator, shall be provided to eliminate contaminants in the fluid. A visual oil level and temperature gauge as well as automatic monitoring shall be provided.
- F. Wheel Set Transfer Crane

1. The optional transfer crane shall consist of a free-standing bridge crane with a runway of approximately 20', a span of approximately 15' and an under bridge height of approximately 9'. Option to be exercised by WMATA.
2. The transfer crane runway shall be supported in a manner that provides an open structure at the entrance of the runway that permits wheel sets and components to be moved to and from the pre-assembly area at the front of the press by any existing overhead shop crane.
3. The transfer crane bridge shall be electrically driven with two 2 1/2 ton hoists and one 1/2 ton hoist on a second bridge attached to the main bridge to facilitate gearbox handling.
4. A main pendant control station shall be provided which controls forward and backward movement of the bridge, and the simultaneous up and down movement of the 2 1/2 ton hoists. In addition, each of the two 1/2 ton hoists shall be provided with pendant stations to control their individual up and down movement.

2.05 MACHINE CONTROLS AND OPERATION

A. The Control System

The control system shall utilize a processor as the core of its hardware and used to control all discrete input and output devices, communicates with the Wheel Press Recorder, and shall provide operator interface communications.

B. Wheel Press Recorder

Computerized Wheel Press Recorder and Data Storage Unit. For wheel mounting operations, a computerized wheel press recorder and data storage unit shall be provided. This windows based unit shall offer:

1. Display and Storage Unit containing the operator's data entry station (computer and keyboard), CRT screen (video display), dedicated wheel chart printer,
2. Pressure Transducer,
3. Displacement Transducer.

The Wheel Press Recorder shall be mounted in a separate free-standing enclosure in order to assure complete freedom from vibration that may occur during wheel mounting operation. The Recorder shall be connected to the Press by a suitable mechanical linkage, hydraulic and electronic lines.

The Wheel Press Recorder shall monitor the wheel mounting force (tonnage) applied and distance, and plots the wheel fit chart on a CRT screen in accordance with the mandatory requirements established by the AAR. This graph shall also be printed on a dedicated printer thereby providing a permanent record of each wheel mounted.

A Bearing Spike Control feature shall be available to record the "spike" produced when the wheels are mounted to axles containing inboard bearings. The Wheel Press Recorder shall contain a Data Storage Unit to compile the following useful information particular to each wheel that is mounted.

1. Date and time of the wheel mount,
2. Operator identification code,

3. Mount side of the axle (left/right),
4. Maximum force (tonnage),
5. Axle serial number, type and size,
6. Wheel serial number, manufacturer, type and size,
7. Total mounts for the day (shift) and month.

This information shall be stored on floppy disk and may be further interfaced with a (owner provided) database software program to generate customized reports.

C. Operator Interface

The operator interface or display system shall use a touch screen display. The display shall be controlled by the Remote I/O. The O/I shall provide information such as ram position, tonnage, wheel set types, and components.

D. Machine Controls

Four control stations shall contain the pushbuttons, lights and switches necessary to operate the press. These control stations shall be the main control station, the demount station, the mount station, and the pendant station. Each station shall perform different operations.

E. Main Control Station

The main control station shall be located on the door of the electrical control cabinet. The pushbuttons and lights on the Main Control Station shall operate to enable system power and indicate hydraulic faults. The pushbuttons and lights shall be as described below.

1. Control ON: An illuminated green push button shall enable control power to the press output devices. The control must be on before any press operations can be performed.
2. Hydraulic Start: An illuminated green pushbutton shall turn on the hydraulic pump motor, which supplies hydraulic fluid for all press operations. This pushbutton shall only work if the control is on. The pushbutton shall light once the hydraulic pump is running.
3. Hydraulic Stop: An illuminated red pushbutton shall turn the hydraulic pump motor off. When the hydraulic motor is not running this pushbutton will light.
4. Filters Clogged: A light indicator shall be used to indicate that a clogged oil filter on the return line to the hydraulic tank. When the filter is clogged the indicator will light.
5. Oil Tank: A dual light indicator shall be used to indicate a fault in the oil tank. The "low level" light reports low oil level in the hydraulic tank. The "overtemp" light reports that too much heat in the hydraulic oil.
6. Emergency STOP: A self-latching, mushroom shaped, red pushbutton disables control power to wheel press output devices. Control power, hydraulic pump, and all machine motion will be terminated when this pushbutton is pressed. To re-establish control power the "Emergency Stop" pushbutton must be pulled out.

F. Demount Station

The demount station shall contain the pushbuttons needed to demount wheels and

bearings. The demount station shall be located on the press right cylinder beam. It shall be used during a demount process of over 200 tons and shall be located behind a sturdy metal shield with a safety glass window for operator protection. The pushbuttons on this station are described as follows:

1. Station Active Mount/Demount Switch: A two position, maintained contact switch selects the station active for operations. The "Demount" position shall be for 600 ton demounting, all other will be enabled in the "Mount" position.
2. Station Active Pilot Light: A green pilot light that illuminates when the demount station is active.
3. Demount to left pushbutton: A white, momentary contact, reports that the press is ready to start a demount of the left wheel at 600 ton maximum force.
4. Demount to right pushbutton: A white, momentary contact, reports that the press is ready to start a demount of the right wheel at 600 ton maximum force.
5. Emergency Stop: A self-latching, mushroom shaped, red pushbutton disables control power to wheel press output devices. Control power, hydraulic pump, and all machine motion will be terminated when this pushbutton is pressed. To reestablish control power the "Emergency Stop" pushbutton must be pulled out.

G. Mounting Station

The mounting station shall contain the necessary controls for all mounting and 200 ton demounting. The mounting station pendant shall be located at the top, middle of the press. The descriptions for this station is described below.

1. Mount Left (Right) Wheel: A momentary green-lighted pushbuttons shall allow mounting the left and right wheels of a chucked wheel set. Illumination of one of these buttons indicates that the yokes and abutments are position so that the left or right wheel can be mounted. Once lit, pressing the button extends the correct ram for the wheel you are setting up to mount.
2. Mount Left (Right) Bearing: A momentary green-lighted pushbuttons shall allow mounting the left and right bearings of a chucked wheel set. Illumination of one of these buttons indicates that the yokes and abutments are position so that the left or right bearing can be mounted. Once lit, pressing the button extends the correct ram for the bearing you are setting up to mount.
3. Demount to Left or Right: A momentary blue-lighted pushbuttons operate in the same manner as the Mount Left (Right) Wheel pushbuttons. The exception is that the yokes and abutments must be positioned to demount using only the 200-ton demount selections.
4. Left or Right Abutment In/Out: A two position, maintained contact switches determine the positioning of the abutments used to demount wheels and bearings. Switched to the "in" position, the respective abutment shall be moved towards the front of the press (to be used for demounting). Switched to the out position, the respective abutment shall be retracted to the back of the press. Interlocks not allowing abutment movement shall be displayed on the Operator Interface Screen.
5. Table Up/Down: A two position, maintained contact switch positions the gearbox support table. When switched to "up", the table shall be moved up to the end of the cylinder stroke. In the "down" position, the table is fully retracted to the down position.

6. Brg. / Wheel / 200T / 600T: A four position, maintained, selector switch shall allow the operator to select the operations to be performed by the press. This switch controls the system pressure applied on the rams when mounting or demounting. Maximum System Pressure is set to a specified amount when this switch is positioned. When mounting bearings, the switch shall be set to "brg". When this switch is set to bearing the remote I/O also looks at the "bearing pressure" potentiometer. When mounting wheels the switch shall be set to "wheel". When demounting at 200 ton the switch shall be set at "200T", and when demounting at 600 tons the switch should be set at "600T".
7. Bearing Pressure Potentiometer: A potentiometer controls the system pressure from 25 tons to 75 tons when the above switch is set to "brg". These settings are commonly used to vary the pressure when mounting bearings.
8. Axle Chuck: A white pilot light shall signify that the chuck pressure has been obtained.
9. Station Active: A green pilot light shall indicate that the mounting station is active as selected by the two-position switch located on the Demount Station.
10. Hydraulic Alarm: A red pilot light shall indicate that a hydraulic error has occurred. A similar lamp on the main control panel shall also light. A message for hydraulic fault shall be displayed on the Operator Interface Screen.
11. Recorder: An illuminated, momentary contact, green pushbutton shall tell the Wheel Press Recorder to record the following operation. When pressed, if the recorder is ready, the pushbutton shall signify that it is recording. If the button does not light within 30 seconds, an error message shall be displayed on the Operator Interface Screen.

H. Pendant Station

The pendant station shall contain pushbuttons and switches for manually positioning the yokes and rams. This pendant shall be located on a swivel arm in front of the press. Below are descriptions of the controls on the pendant station:

1. Ram Right/Left: A two-position selector switch shall allow the operator select between jogging either the left or right ram.
2. Ram Extend: A momentary contact pushbutton shall allow the operator to jog the selected ram toward the center of the press. This pushbutton is enabled whether "chuck mode" is on or off.
3. Ram Retract: A momentary contact pushbutton shall allow the operator to jog the selected ram away from the center of the press. This pushbutton shall only be enabled when the "chuck mode" is off.
4. Axle Chuck On/Off: A white lighted two position, selector switch shall allow the operator to enable or disable chuck mode. When "chuck on" is selected, the rams move toward the center of the press. The lighting of this selector switch indicates adequate chuck pressure. When "chuck off" is selected, chuck pressure shall be vented to the tank and the ram retract operations shall be enabled. To mount or demount, "axle chuck" must be "on" and lit.
5. Yoke Selector Lh Whl/Brg ; Rh Whl/Brg: A four-position selector switch shall allow the operator to select the yoke of the press to be positioned. In the "Lh Whl" position, the left wheel yoke shall be in position. In the "Lh Brg" position, the left bearing yoke shall be in positioned. In the "Rh Whl" position, the right wheel yoke shall be in position. In the "Rh Brg" position, the right bearing yoke shall be in positioned.

6. Yoke Up: A momentary contact pushbutton shall allow the operator to position the selected yoke to the "up" position. The selected yoke shall be determined by the "yoke selector" switch position. When pressed, the selected yoke shall move up until the position is reached or the pushbutton is released.
7. Yoke down: A momentary contact pushbutton shall allow the operator to position the selected yoke to the "down" position. The selected yoke is determined by the "yoke selector" switch position. When pressed, the selected yoke moves down until the position is reached or the pushbutton is released.
8. Emergency Stop: A self-latching, mushroom shaped, red pushbutton shall disable the control power to wheel press output devices. Control power, hydraulic pump, and all machine motion shall be terminated when this pushbutton is pressed. To reestablish control power the "Emergency Stop" pushbutton must be pulled out.

I. Message Display:

A display on the Remote I/O, shall be multiline display located on the control pendant. The display shall indicate the error messages and diagnostic messages generated by the control program to assist the operator

1. Error Messages: Error messages shall be shown on the display as long as the fault condition exists. Correcting the fault condition removes the message from the display.
2. Diagnostic Messages: Diagnostic messages shall be shown on the display to tell the operator why certain mounting and demounting operations cannot be performed. The six pushbuttons on the Mounting Station labeled "Mount Right/Left Wheel", "Mount Right/Left Bearing", and "Demount to Right/Left" shall be used to tell the control what operation to perform. When the press is configured to perform one of these operations, the corresponding pushbutton shall illuminate. When the illuminated pushbutton is pressed, the appropriate ram will move to perform the operation.

If the pushbutton is pressed while not lit, the operation shall not be performed, and the display will show a message telling the operator why the operation has not been performed. Only one message shall be displayed at a time. Once one fault condition has been corrected, and the light is still not lit, pressing the button again shall provide another message to be displayed. This is continued until the light is illuminated indicating the operation can now be performed.

PART 3 - EXECUTION

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SECTION 11300

MOTORIZED TURNTABLES

PART 1 - GENERAL

RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract apply to this section.
- B. Related Sections include Section 11001, Equipment General Requirement.

1.01 DESCRIPTION:

- A. This section specifies the design, fabrication, furnishing, and installation of motorized turntables as specified herein.

1.02 QUALITY ASSURANCE:

- A. Manufacturer Requirements:
 - 1. Furnish Motorized Turntables manufactured and designed as approved by WMATA's engineering, operation and maintenance departments.
 - 2. Minimum expected half life of this equipment shall be 25 years. All equipment furnished shall be heavy duty, industrial type.
 - 3. The Engineer reserves the right to inspect materials and their sources, shop or fabricating facility. The Engineer further reserves the right to be present for any or all shop tests of components, assemblies, or systems. The Manufacturer shall notify the Engineer two (2) weeks in advance of any tests.
 - 4. Manufacturer's Compliance:
 - a. All factory wired control panels shall be tested for operation, as specified herein, and submitted to Underwriters Laboratories Inc., for inspection, approval, and labeling.
 - b. Nameplates: Nameplates shall be securely attached, by mechanical means, in a prominent location on each major item of equipment.
 - c. The turntables shall meet the Federal Transit Administration Buy America Clause for equipment installed in an existing maintenance shop.
 - 5. Qualification of Manufacturer: Manufacturer shall be reputable and regularly engaged in the design and manufacture of the type of equipment specified herein. Assembled components, purchased by the Manufacturer for this Contract, such as motors, gear boxes, electrical devices, etc., shall be the standard products of qualified manufacturers. All similar items shall be the products of a single manufacturer. Prior to approval of the Manufacturer's proposal for the Turntables, the Manufacturer shall submit to the Engineer the following information:
 - a. A list of turntables, of his manufacture, similar in usage, where the proposed equipment has been in service, including the duration of service.
 - b. Name of contact person at each installation submitted above, who is familiar with the operation and maintenance of turntables by the Manufacturer.
 - c. The manufacturer of the turntables shall be ISO-9001 certified and registered. The manufacturer must submit with the bid response proof that it has implemented, maintained a quality system that fulfills the requirements of the ISO-9001 in the form of a certificate documenting the most recent

- quality audit and report.
- d. Based on the information supplied, and discussions with the contact persons named, the Engineer will determine the acceptability of the proposed Manufacturer and equipment.
- e. Manufactures standard quality assurance program to the authority for approval.
- d. Welders employed in making structural welds shall be certified per AWS D1.1. Prior to shipment, certification must be furnished to the Contract Administrator for the actual welders who performed the work.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the requirements set forth in the Divisions 00 and 01, and with the additional requirements as specified for each.
- B. Certificates: Fourteen days prior to shipment, submit four copies of certification that equipment to be delivered is in compliance with applicable codes as follows:

AGMA	American Gear Manufactures Association
AISC	American Institute of Steel Construction
AREMA	American Railway Engineering Association (Allowable Material Stress Value for Steel Structures)
ASTM	American Society for Testing and Materials (Material Specifications - ASTM A-36)
AWS	American Welding Society
NEC	National Electric Code
NEMA	National Electrical Manufactures Association
- C. Shop Drawings: In accordance with the General Requirements, submit six (6) copies of complete shop drawings to the Authority for approval, including but not limited to:
 - 1. Equipment arrangement.
 - 2. Equipment outline dimensions.
 - 3. Assembly and subassemblies
 - 4. Wiring diagrams and schematics.
 - 5. Installation Instructions.
- D. Operations and Maintenance Manual: Submit in accordance with the requirements of the General Requirements.
- E. Contract Record Drawings: Submit in accordance with the General Requirements.

1.04 TRAINING:

- A. Contractor is responsible for training as outlined in Section 01820, Demonstration and Training and Section 11001, Equipment General Requirements.
- B. Number of Personnel To Be Trained And Class Size.

Level Of Training	Approximate Number of Individuals	Maximum Class Size	Minimum Number of Classes
Level I	40	8	6
Level II	8	4	2
Level III	8	4	2

- C. Levels of Training:
1. Level I: Familiarizing Training
 2. Level II: Training for P&E Personnel
 3. Level III: Programming Training

1.05 PRODUCT DELIVERY, STORAGE, HANDLING AND WARRANTY:

- A. Ship equipment upon notification by the Engineer.
- B. Package, handle and store to prevent damage.
- C. This equipment shall comply with the delivery, storage and handling paragraphs in the Special Provisions.
- D. This equipment shall comply with the job site conditions paragraphs detailed in the Special Provisions.
- E. This equipment shall comply with the warranty conditions detailed in the Special Provisions.

PART 2 - PRODUCTS

2.01 Manufacturer

- A. The Turntables shall be as manufactured and designed as approved by WMATA's engineering, operation and maintenance departments.

2.02 General Requirements

- A. The equipment shall conform to the design of the equipment pits and shall be placed in accordance with the general arrangement as shown on the contract drawings. The general arrangement may be modified only as required to suit the specific equipment being supplied. Layout dimensions as shown may be modified to improve operating efficiency. Any modifications required to the building design to accommodate the equipment shall be the responsibility of the contractor and shall be provided at no additional cost. Changes shall be specifically approved by the Engineer.
- B. Parts and components must be interchangeable with existing turntables at Brentwood, Alexandria, Shady Grove, West Falls Church, Branch Avenue and New Carrollton Shops.

2.03 Design Requirements

- A. The equipment shall consist of a motorized operated turntable capable of rotating a single transit car truck.
- B. Dimensions and Capacities
- | | | |
|----|---|----------|
| 1. | Table diameter | 11'-5" |
| 2. | Inside diameter of curb angle | 11'-6" |
| 3. | Standard track gauge | 4'-8 ½ " |
| 4. | Turning capacity | 7 ½ Tons |
| 5. | Rail rollover capacity | 25 Tons |
| 6. | Rotation | 1 RPM |
- C. The turntable shall have crossing rails that match-up with the shop running rails when the turntable is in its locked position at 90° increments.
- D. The turntable shall be mounted flush in the floor with rails recessed and set such that the gap between the shop rails and turntable rails shall not exceed 1/4 inch and the variation in horizontal and vertical alignment shall not exceed 1/4 inch when the turntable is fully loaded and locked. The maximum gap between the turntable surface and the shop floor shall be 1/2 inch. The rails used shall be suitable for the design loads and so configured as to provide smooth movement between shop rails and the turntable. Maximum variation in the plane of the table shall be 1/4 inch measured between any two points on the surface of the deck under any of the loads specified here in.
- E. The turntable shall be constructed so that the entire assembly may be conveniently removed from the pit as a unit, except the drive and automatic locking mechanism.
- F. The turntable shall be of one piece welded construction. It shall be center pin guided by a heavy duty pin with a bronze thrust bearing. Mounted on the periphery shall be roller bearing casters that support the table and roll on a circular pit rail anchored to the pit floor. The casters shall be load carrying members and be capable of handling the entire turntable load. The top surface of the turntable shall be 3/4 inch thick non-skid solid diamond steel plate capable of support shop vehicle traffic. The top shall be equipped with a door opening to provide access to components below. Design and position deck support beams so deck can support 300 pounds per square foot uniform load and a 6000 pound load on a 6 inch diameter circle.
- G. Turntable shall be capable of supporting a transit vehicle truck with a safety factor of not less than five (5) based on the ultimate strength of the materials for mechanical components. Structural components allowable stresses and loading shall be based on those specified in the AISC (ASD) 9th edition with the appropriate dynamic load factors applied.
- H. The turntables shall be complete with curb angles, to be supplied by the equipment manufacture and installed by the contractor. Curb angles shall be notched after installation to accept shop rails.
- I. Turntable rails shall be AISI 1045 minimum tensile 90,000 and Brinell hardness of

190.

- J. The drive unit shall be located under the turntable structure and drive the turntable through a heavy duty gear reducer.
- K. The drive motor shall consist of a totally enclosed, non-ventilated squirrel cage, reversible motor connected to a reducer. Provide an in-floor push button station through which the turntable can be controlled by momentary contact push buttons and reversing magnetic starters. The two (2) button control station shall be marked "Clockwise" and "Counterclockwise" with "On"- "Off" and "Run"- "Jog" selector switches.
- L. The automatic lock shall be located in a pit outside the turntable structure and automatically lock in each 90° degree segment of rotation to insure positive track alignment.
- M. Operation
 - 1. The turntable shall be powered by an electrical motor driving through a right angle gear reducer. A pinion on the output shaft of the gear reducer shall drive a ring gear on the underside of the turntable.
 - 2. The Turntable shall be capable of a rotation of 360° degrees in either direction.
 - 3. Automatic locking shall be provided at 90° degree positions and set to align the turntable rails with the shop rails.
- O. Controls
 - 1. An in-floor control station shall be provided, as shown on the contract drawings, to control the operation of the turntable.
 - 2. One (1) pushbutton control station shall be provided. All controls shall consist of individual pushbuttons which shall automatically stop all operations unless pressure is applied to the button. Individual buttons shall be provided to control clockwise and counterclockwise rotation of the turntable. "On"- "Off" and "Run"- "Jog" selector switches shall be provided.
- P. Electrical Requirements
 - 1. Power Supply - 460 volts, 3 phase, 60 hertz.
- Q. Motors
 - 1. The Motor shall be totally enclosed heavy duty type, equipped with sealed bearings and overload protection. Enclosures shall be steel or cast iron only, however, aluminum end bells are permitted. Provide overload protection for motor to permit operation within their rating under all design load conditions.
 - 2. Insulation shall be class "F." temperature rating and should not exceed that permitted by class "B" insulation.
 - 3. Provide each individual motor circuit with branch circuit over current protection in all three phases via safety fuses or fusetrons.

4. Noise level shall comply with NEMA and OSHA Article 1910,95 when measured in accordance with IEEE 85.

R. Motor Starters and Control

1. Motor Starters shall be incorporated into the motor control center. Provide motor starter with overload elements of the bimetal, thermal type on each phase.
2. Provide a stainless steel disconnect switch and stainless steel junction box mounted in a NEMA 4 enclosure installed at the motor location. Connect station to prevent operation of the motor when the station is in the "OFF" position, with provision for padlocking in the "OFF" position.

S. Pushbutton Station and Control Panel

1. The equipment shall be totally wired by the contractor, including the disconnect switches. Power feeders to the terminals of the disconnect switches are by the contractor. Interconnecting wire and conduit and connections shall be included under this division and shall be performed in accordance with the requirements of the electrical division.

T. Equipment Grounding

1. This shall be accomplished by means of a separate grounding conductor in each conduit, sized according to code. The grounding conductor shall have green insulation.

U. Isolation Ground and Cathodic Protection

1. The design requires that the turntables be electrically isolated from the other equipment and the building structure.
2. The running rails of the turntables shall be electrically isolated from the remaining portions of the turntable.

V. Painting

1. Turntables shall be given a primer coat of manufactures standard rust inhibiting primer to a dry film thickness of 1.5 mils. Two (2) finish coats of manufactures standard paint shall be factory applied over the primer coat. Each coat shall be a minimum of 2 mils dry film thickness. The paint shall be the manufactures standard safety yellow.
2. Surfaces shall be free of rust, scale, dirt and oil before painting. Matching touch-up paint shall be provided in the amount of one quart of each color used. Final touch-up shall be performed by the contractor.

PART 3 - EXECUTION

3.01 Fabrication

- A. Fabrication shall be in accordance with all specifications and approved shop drawings.

3.02 Installation

- A. It shall be the contractors responsibility that all information regarding the scheduling, delivery and preparations necessary for installation of the equipment to be supplied under this specification be verified with the equipment manufacture and approved by the engineer prior to commencement of the work.
- B. All shop rails shall be installed by the contractor afer equipment installation.
- C. Install equipment in accordance with approved shop drawings, to the proper lines and levels, plumb and without conflicts with other work.
- D. Use non-shrink grout to level equipment and to seal voids at perimeters of bases.
- E. Ensure that all equipment is ready for checkout and start up by the manufacture.
- F. Touch-up damaged areas of factory-finished surfaces, using paint supplied by the manufacture.

3.03 Factory and Field Tests

- A. Factory Test
 - 1. The contractor shall arrange with the equipment manufacture for the performance of functional and no load test as applicable to the item specified herein. These tests shall be performed at the factory and shall be performed prior to final painting of the equipment.
- B. Field Test
 - 1. Following installation, the contractor shall insure that the equipment manufacture performs an acceptance test. Prior to the test, the manufacture shall submit for approval by the engineer an acceptance testing program. The program shall be designed to show that the equipment meets all the conditions described by this section and that the equipment will perform as intended. The contractor shall provide all material and manpower required for the program except for a transit car truck which will be furnished and operated by the authority.

3.04 Training

The equipment manufacture shall submit for approval by the engineer, details of a program which shall be designed to adequately train personnel to correctly operate and maintain the equipment. The contractor shall be responsible for supplying all materials required for the program. Following installation, the contractor shall at the convenience of the authority, conduct a program for training the personnel. The training period shall be one (1) day.

END OF SECTION

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PROJECT MANUAL

BOOK 3

(DIVISIONS 13 -16)

METRO MATTERS

SHOPS EXPANSION PROGRAM

GREENBELT YARD CONSOLIDATED HEAVY REPAIRS,

BRENTWOOD SHOP EXPANSION and

SHADY GROVE SHOP EXPANSION

**Contract FN5008
December 3, 2004**

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- 16972 JUNCTION BOXES
- 16973 CONDUIT
- 16974 LOCKS AND KEYS
- 16975 FOUNDATIONS
- 16977 TAGGING AND MARKING
- 16978 MISCELLANEOUS TRAIN CONTROL COMPONENTS AND MATERIALS
- 16979 SURFACE TRENCH

**Washington Metropolitan Area Transit Authority
Metro Matters Shops Program**

**Contract No. FN5008
Date: December 3, 2004**

16989 YARD TESTS AND INSPECTIONS

16991 YARD SIGNAL DRAWINGS AND TRACINGS

THIS PAGE NOT USED

SECTION 13110

STRAY CURRENT AND CATHODIC PROTECTION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing and connecting stray-current and cathodic-protection equipment.
- B. Related Work Specified Elsewhere:
 - 1. Grading, excavation and backfilling: Section 02320.
 - 2. Corrosion control system testing: Section 13115.
 - 3. Grounding and bonding: Section 16060.
 - 4. Wire, cable and busways: Section 16120.
 - 5. Wire connection accessories: Section 16125.
 - 6. Raceways, boxes and cabinets: Section 16130.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. ICEA: S-61-402.
 - 3. ASTM: B418, D256, D570, D638, D693, D1248, E11.
 - 4. MS: MIL-A-18001.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings.
- B. Certification:
 - 1. Certified test reports of field quality-control testing.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Mark each item with manufacturer's name, brand designation, referenced standard, type, class and rating, as applicable.
- B. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- C. Store equipment in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Cast-Iron Anodes:

1. Size and type: As shown.
2. Chemical composition:

	Element	Percent
a.	Silicon	14.33
b.	Chromium	4.5
c.	Carbon	0.85
d.	Manganese	0.65
e.	Iron	Remainder

3. Physical properties:
 - a. Tensile strength: 15,000 psi.
 - b. Compressive strength: 100,000 psi.
 - c. Brinell hardness: 520.
 - d. Density: 7.0 grams per cubic centimeter.
 - e. Melting point: 2,300F.
 - f. Specific resistance: 72 microhms per centimeter cube at 20C.
 - g. Coefficient of expansion: 7.33×10^{-6} per degree F from 32F to 212F.
4. Lead wire: Single-conductor insulated cable, 8AWG minimum, factory-connected to anode with connection sealed with cast epoxy-resin encapsulation.
5. Anode packaged as follows:
 - a. Stove pipe: Galvanized steel, 30-gauge minimum, in accordance with the one of the following:
 - 1) Diameter: Eight inches; Length: Eight feet.
 - 2) Diameter: Five inches; Length: Six feet.
 - b. Ends of pipe crimped to end seal of 1/2-inch interior-grade plywood.
 - c. Containing compacted backfill of coke breeze of graded coal or recalcined petroleum coke, with the following additional requirements:
 - 1) Resistivity on dry basis: 60 ohms per centimeter cube, maximum.
 - 2) Chemical composition:

	Material	Percent
(a)	Fixed carbon	78.22 - 78.40
(b)	Ash	18.6 maximum
(c)	Moisture	9.50 - 14.70
(d)	Volatile matter	3.00 - 3.14
(e)	Sulphur	1.2 maximum

- 3) Gradation:
 - a) Sieve size in accordance with ASTM E11.
 - b) Requirements:

Percent Passing	Sieve Size
-----------------	------------

- [1]
- [2]
- [3]

½ inch	100
3/8 inch	85
No. 6	65

B. Magnesium Anodes:

1. Packaged anodes, type and size as shown.
2. Chemical composition for high-potential type anodes:

	Element	Percent
a.	Aluminum	0.010 maximum
b.	Manganese	0.50 - 1.30
c.	Zinc	0.050 maximum
d.	Silicon	0.050 maximum
e.	Copper	0.020 maximum
f.	Nickel	0.001 maximum
g.	Iron	0.030 maximum

	Element (Cont.)	Percent (Cont.)
h.	Other metallic elements	0.050 each or 0.300 maximum total
i.	Magnesium	Remainder

3. Lead wire: Single-conductor insulated cable, 12AWG minimum, factory-connected to anode with connection sealed with cast epoxy-resin encapsulation.
4. Anode packaged in permeable cloth sack containing compacted backfill of mixture with the following requirements:

	Material	Percent
a.	Gypsum	75
b.	Bentonite	20
c.	Sodium sulphate	5

C. Zinc Anodes: MS MIL-A-18001, bare-ribbon 5/8 by 7/8-inch section or packaged anode, type and size as shown, with the following additional requirements:

1. Lead wire: Single-conductor insulated cable, 12AWG minimum, factory-connected to the anode with connection sealed with cast epoxy-resin encapsulation.
2. Anode packaged in permeable cloth sack containing compacted backfill of mixture consisting of 50-percent hydrated gypsum and 50-percent bentonite.

- D. Reference Electrode: ASTM B418, Type II, one galvanized-steel rod, factory-connected to electrode and equipped with two bolted connectors suitable for 12AWG single-conductor insulated cable.
- E. Test Boxes:
1. Cathodic-protection test boxes: Plastic, each five inches inside diameter by 18 inches long, with cast-iron lid, collar and terminal board.
 2. Stray-current test boxes: Six inches cubical, galvanized cast-iron box with watertight cover.
- F. Wire and Cable:
1. Header cable, bond wire and cast-iron anode lead wire in accordance with the following:
 - a. Single-conductor.
 - b. Size: As shown.
 - c. Insulation: HMWPE, 600 volt, in accordance with the following:
 - 1) ASTM D1248, Type I, Class C, Grade 5.
 - 2) ICEA S-61-402.
 2. Magnesium or zinc anode lead and test wire:
 - a. Single-conductor.
 - b. Size: 12AWG unless otherwise shown.
 - c. Color: As shown; anode lead as furnished.
 - d. Insulation: TW, 600-volt, moisture-resistant thermoplastic in accordance with UL 83.
- G. Pipeline-Casing Spacers:
1. Virgin polyethylene, molded.
 2. Runner height: Sufficient to provide ½-inch clearance between pipe, couplings and hubs as well as internal casing wall.
 3. Color: Natural.
 4. In accordance with the following:

	Characteristic	Reference	Requirement
a.	Compressive strength	ASTM D693	3,200 psi
b.	Tensile strength	ASTM D638,	3,100 - 5,500 psi
c.	Impact strength	ASTM D256	1.5 - 2.0 foot-pound per inch notch
d.	Water absorption	ASTM D570	0.1 percent
e.	Temperature	-	180F (80C) maximum

5. Bolts:
 - a. Steel, cadmium-plated.
 - b. Sizes: As standard with the manufacturer.
6. Nuts:
 - a. Steel, cadmium-plated, square.

- b. Sizes: To match bolts.
- H. Pipeline-Casing End Seals:
 - 1. Type L:
 - a. Modular mechanical-type.
 - b. Consisting of interlocking synthetic-rubber links with cadmium-plated steel nuts and bolts.
 - c. Depth limitations: As shown.
 - 2. Type H:
 - a. Compression-ring seals.
 - b. Nonconductive sleeve: Fiberglass reinforced epoxy (FRE), Adyl Type D or equal, with cadmium-plated steel nuts and bolts.
 - c. Depth limitations: As shown.
- I. Insulating Gasket:
 - 1. Asbestos, all-temperature.
 - 2. Full-face.
 - 3. Thickness: 1/8 inch.
 - 4. Johns-Mansville 71 or equal.
- J. Insulating Sleeves and Washers:
 - 1. Up to 300F:
 - a. Sleeve: Mylar tube, 1/32-inch thick.
 - b. Washer: Phenolic, 1/8-inch thick.
 - 2. 300F and above:
 - a. Sleeve: Klingerit or equal, 1/32-inch thick.
 - b. Washer: Johns-Mansville 71 or equal, Teflon.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Bury anodes or electrodes of type and at location shown. Excavate and backfill holes in accordance with Section 02320, with the following additional requirements:
 - 1. Wet packaged anode thoroughly before backfilling hole.
 - 2. Use fine clay soil, free from stones and bricks, for backfilling.
- B. Install header cable of size and at location shown, in accordance with Section 16120.
- C. Install test boxes of type and at location shown.
- D. Connect anode lead wires to header cable or test boxes as shown.
- E. Isolate pipes of different metals and Authority pipes from utility-company pipes using insulated union, compression insulating couplings, or insulated flange and bolt connections. Connect each side of insulated joints to test box using conductors as shown.
- F. Where Authority pipes cross utility-company pipes, connect Authority pipes to test boxes using two 12AWG and one 4AWG conductors as shown.

- G. Bond joints in buried metallic pipe and structure in accordance with Section 16060. Connect buried metallic pipe and structure to test boxes using single-conductor insulated cable of size shown.
- H. Install conduit of type shown, in accordance with Section 16130.
- I. Install single-conductor insulated cable in accordance with Section 16120. Leave one foot of slack in test boxes.
- J. Use thermit weld sealed with cast epoxy-resin encapsulation for splices made in direct-burial cable.
- K. Use compression-type connectors in accordance with Section 16125.
- L. Install casing spacers in accordance with manufacturer's recommendation, except maximum spacer distance not to exceed 10 feet.

3.02 IDENTIFICATION:

- A. Identify wire and cable in each test box using nonmetallic fiberboard or plastic tags or pressure-sensitive labels.

3.03 FIELD QUALITY CONTROL:

- A. Provide necessary equipment and perform testing in the presence of the Authority Representative in accordance with Section 13115.

END OF SECTION

SECTION 13115

CORROSION CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies test procedures for corrosion-control systems.
- B. Related Work Specified Elsewhere:
 - 1. Wire, cable and busways: Section 16120.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
- B. Instrument Calibration:
 - 1. Calibrate test instruments within six months prior to use on this project.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Working Drawings:
 - 1. Layout of system being tested, showing location of system components, including test stations.
 - 2. Instrument hook-up for each test.
- B. Certification:
 - 1. Certified test report for each test conducted including the following:
 - a. Types, models, serial numbers, and dates of calibration of all instruments.
 - b. Data resulting from specified test procedures, in approved format.
 - 2. Certificates of inspection.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Wire and Cable: Section 16120.

PART 3 - EXECUTION

3.01 TEST EQUIPMENT:

- A. DC Voltmeter: Multi-scale, center zero, minimum sensitivity 50,000 ohm/volt, accurate to within one percent of full scale, covering the following full-scale ranges: 0-10 and 0-100 millivolts; 0-1, 0-10, 0-100 volts.

- B. DC Ammeter: Multi-scale, maximum shunt drop of 20-mV sensitivity, or millivolt meter and shunts, accurate to within one percent of full scale, covering the following full-scale ranges: 0-1, 0-10, 0-100 amperes.
- C. Resistivity Meter: Self-contained, synchronous-vibrator, battery-powered unit. Instrument readings unaffected by resistance of leads or probes.
- D. DC-Power Sources: Automotive wet-cell batteries, six or 12 volts. For circuits with high internal resistance use two or more batteries, a dc generator or cathodic-protection rectifier.
- E. Test Cable: Single-conductor cable, stranded copper, assorted sizes and lengths to suit test conditions.
- F. Steel probes for making electrical contact to buried structures in absence of test stations.
- G. Slide-Wire Resistors: 0-400 ohm, 15-ampere capacity over full-range of adjustment.
- H. Reference Half-Cell: 7/8-inch diameter by eight inches long, saturated copper-copper sulfate.

3.02 TEST PROCEDURES:

- A. Electrical Continuity:
 - 1. Test the following items for continuity:
 - a. Mechanical and bell-and-spigot pipe joints: Test after backfilling is completed. Test individual and multiple bonds.
 - b. Metallic tunnel-liner joints: Test after invert has been cast. Test longitudinal bonds individually or in sections not to exceed 150-linear feet.
 - c. Concrete reinforcement in tunnel, station, retaining wall, reinforced-concrete pipe, aerial, floating slab and building structures: Test after concrete has been cast. Test bonded joints individually or in sections not to exceed 150 feet for tunnel and station structures, not to exceed 500-linear feet for other structures.
 - d. Underpinning, soldier and structural piles: Test prior to backfilling or use leads in structure after backfilling. Test bonded piles individually or in longitudinal sections not exceeding 600-linear feet.
 - 2. Test Procedure:
 - a. Single bond: Connect instruments across bond to be tested as shown. Use separate set of wires and contact points to structures for voltage and current circuits. Beginning with highest scales on voltmeter and ammeter, close switch and observe meter readings. Reduce meter ranges until lowest possible scale is reached. Adjust current level to less than five amperes. Read ON values of voltage and current, break circuit and immediately read OFF values. Record ON and OFF readings on data sheet and determine incremental change for current and voltage. Obtain minimum of three readings to ensure accuracy. Determine and record bond resistance for each reading. Resistance of bond not to exceed calculated theoretical resistance by more than 10 percent.
 - b. Multiple bonds in parallel: Where two structures are bonded by multiple bonds in parallel, test as specified for single bond. Record resistance readings obtained. Actual resistance not to exceed 10 percent of calculated theoretical resistance of bonds.

- c. Multiple bonds in series: Connect instruments as shown. Determine and record resistance between points A and B, including bonds in series as specified for single-bond test. Total resistance measured between points A and B not to exceed 10 percent of theoretical resistance of sum of bonds plus theoretical resistance of structure between points A and B.
 - d. Multiple bonds in parallel on reinforcing steel: Connect instruments as shown. Determine and record resistance between points A and B, including bonds in parallel as specified for single-bond test.
- B. Insulating Joints:
- 1. Test the following for zero-percentage leakage through insulation.
 - a. Insulated flanges and unions: Test buried flanges and fittings after backfilling is completed. Test exposed flanges and fittings after installation is completed. Test each flange or union individually, using existing test wires.
 - b. Casing and sleeve insulation: Test prior to backfilling. Test each casing or sleeve individually.
 - 2. Test Procedures:
 - a. Set up instrumentation as shown. If pipe length is too short for proper test-connection spacing, use maximum possible spacing for L-value. With switches open, read and record value of E_0 . Close switch in I1 circuit. Read and record current, I1, and voltage, E1. Calculate calibration factor (K) for millivolt shunt using equation shown.
 - b. With switches open, read and record value of E0. Close switch in I2 circuit. Read and record current, I2, and voltage, E2. Determine difference between E0 and E2.
 - c. Calculate and record percentage of leakage by equation shown.
- C. Cathodic-Protection Systems Using Cast-Iron Anode:
- 1. Test the following:
 - a. Hydraulic-elevator well casing: Test casing having cathodic-protection system after pit invert has been constructed. Test each system individually using test stations in elevator pit.
 - b. Buried chilled-water, steam and condensate piping: Test after backfilling is complete. Test each system individually, using existing test stations along pipeline.
 - 2. Procedures: Perform tests in the following order:
 - a. Electrical-continuity and insulating-joint tests as specified.
 - b. Anode tests:
 - 1) Structure-to-anode resistance:
 - a) Connect instruments as shown.
 - b) With switch open, record voltage reading 1 on E.
 - c) Close switch and record voltage and current readings.
 - d) Reduce current level to less than five amperes by adjusting power source. Record voltage and current readings.
 - e) Open switch and immediately record voltage as current-off value for potential.
 - f) Using different values of current and voltage, determine and record resistance using formula shown. Obtain a minimum of three sets of readings to ensure accuracy.
 - g) Take necessary corrective measures to ensure that resistance is not less than 0.3 ohms.
 - 2) Anode-to-earth resistance:

- a) Procedure:
 - (1) Place copper-copper sulfate reference half-cell at least 50 feet away from anode location and connect voltmeter to read anode-to-earth voltage as shown.
 - (2) Perform test as specified for structure-to-anode resistance.
- b) Acceptance criteria: Actual anode-to-earth resistance not to exceed 20 percent of design soil resistance.
- c) Design resistance: As specified in Exhibit 13115-1.
- d) Soil resistivity:
 - (1) If anode-to-earth resistance exceeds 20 percent of design resistance, obtain average soil resistivity in anode-location area.
 - (2) Make measurements by four-pin method as shown.
 - (3) Make measurements using suitable resistivity instrument or by battery, voltmeter and ammeter.
 - (4) Place pins at least 1.5-times pin spacing horizontally from underground metallic structures.

D. Cathodic-Protection Systems Using Magnesium Anode:

- 1. Test galvanic-anode cathodic-protection system for the following structures and utilities:
 - a. Buried potable-water, chilled-water and fire piping; sewage-ejector piping; and sewage-pump piping using test stations.
 - b. Piling: Test structures having cathodic-protection systems. Test each structure individually. Test electrical continuity between piles.
- 2. Procedures: Perform tests in the following order:
 - a. Electrical-continuity and insulating-joint tests as specified.
 - b. Anode tests:
 - 1) Structure-to-anode resistance: Perform test as specified for cathodic-protection systems using cast-iron anode.
 - 2) Anode-to-earth resistance test and soil resistivity: Perform tests as specified for cathodic-protection systems using cast-iron anode.

E. Wire and Cable: Install in accordance with Section 16120.

F. Coal-Tar Epoxy Coating:

- 1. Subject final coating to spark test for capability of maintaining dielectric integrity at 5,000 volts minimum.
- 2. Visually inspect coating prior to installation; repair damaged areas in accordance with field-correction recommendations of the coating manufacturer.
- 3. Backfilling prior to approval of coating is prohibited.

Exhibit 13115-1

G. Design Resistance:

Structure	Soil Resistance	Anodes	Anode-to-Earth Resistance

--	--	--	--

Exhibit 13115-1 (Cont.)

H. Evaluation:

1. When anode-to-earth resistance exceeds 20 percent of design value, use data from soil-resistivity test to recalculate design resistance.
2. If actual anode-to-earth resistance exceeds recalculated design resistance, install additional anodes as directed.

I. Recalculation: Resistance is calculated by use of the following formulae:

1. Single horizontal anode:

$$a. \quad R_{H(N=1)} = \frac{0.00521e}{L} \left\{ 2.3 \log \frac{4L^2 + 4L(S^2 + L^2)^{0.5}}{dS} + \frac{S}{L} - \frac{(S^2 + L^2)^{0.5}}{L} - 1 \right\}$$

b. Where:

$R_{H(N=1)}$ = Resistance to earth of the horizontal-ground anode (ohms).

e = Effective soil resistivity (ohm-cm).

L = Horizontal-anode length (feet).

d = Anode diameter (feet).

S = Twice anode depth (feet).

2. Single vertical anode:

$$a. \quad R_{V(N=1)} = \frac{eK}{L}$$

b. Where:

$R_{V(N=1)}$ = Resistance of single vertical anode-to-earth (ohms).

e = Effective soil resistivity (ohm-cm).

L = Length of anode (feet).

K = Shape function (anode length/ anode diameter) from Table 1.

Exhibit 13115-1 (Cont.)

c. Table 1: The Shape Function:

L/d	K	L/d	K
1	.0056	16	.0201
2	.0092	18	.0207
3	.0113	20	.0213
4	.0128	25	.0224
5	.0140	30	.0234
6	.0150	35	.0242
7	.0158	40	.0249
8	.0165	45	.0255
9	.0171	50	.0261
10	.0177	55	.0266
12	.0186	60	.0270
14	.0194	-	-

3. Multiple vertical anodes in parallel:

a.
$$R_{V(N,S)} = \frac{R_{V(N=1)}}{N} + \frac{eP}{S}$$

b. Where:

$R_{V(N,S)}$ = Resistance-to-earth of vertical anodes in parallel (ohms).

$R_{V(N=1)}$ = Resistance-to-earth of single anode (ohms).

e = Effective soil resistivity (ohm-cm).

N = Number of vertical anodes in parallel.

S = Spacing between anodes (feet).

P = Parallel factor from Table 2.

Exhibit 13115-1 (Cont.)

c. Table 2: Parallel Factor:

n	P	n	P
2	.00261	14	.00168
3	.00289	16	.00155
4	.00283	18	.00145
5	.00268	20	.00135
6	.00252	22	.00128
7	.00237	24	.00121
8	.00224	26	.00114
9	.00212	28	.00109
10	.00201	30	.00101
12	.00182	-	-

4. Resistance-to-earth of the horizontal ground bed:

a. $R_{H(N,S)} = \frac{R_{V(N,S)}}{R_{V(N=1)}/N} \times \frac{R_{H(N=1)}}{N}$

b. Where:

$R_{H(N,S)}$ = Resistance-to-earth of the horizontal ground bed (ohms).

$R_{V(N,S)}$ = Resistance-to-earth of N anodes, at spacing S, installed vertically (ohms).

$R_{V(N=1)}$ = Resistance-to-earth of single vertical anode (ohms).

$R_{H(N=1)}$ = Resistance-to-earth of single horizontal anode (ohms)

N = Number of anodes.

END OF SECTION

THIS PAGE NOT USED

SECTION 13905

FIRE PROTECTION, SUPPRESSION AND ALARM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing dry standpipe, wet standpipe, sprinkler, exterior fire protection and clean agent fire-suppression systems.
- B. Related Work Specified Elsewhere:
 - 1. Water distribution system: Section 02515.
 - 2. Storm and sanitary system: Section 02535
 - 3. Firestopping: Section 07841.
 - 4. Field painting: Section 09920.
 - 5. Corrosion control system: Section 13115.
 - 6. Identification of mechanical equipment and piping: Section 15075.
 - 7. Piping system: Section 15205.
 - 8. Control equipment: Section 15900.
 - 9. Grounding and bonding: Section 16060.
 - 10. Wire and cable: Section 16120.
 - 11. Raceways, boxes and cabinets: Section 16130.
- C. Description of System:
 - 1. Dry standpipe system: Consists of siamese fire-department connection, dry fire line, check valves, automatic air vents, drain valves and angle hose valves.
 - 2. Wet standpipe system: Consists of siamese fire-department connection, wet fire line, check valves, drain valves, fire water-line surveillance valve, angle hose valves and capped branch connections for sprinkler systems where shown.
 - 3. Sprinkler system, other than escalator: Consists of sprinkler lines, fire water-line surveillance valve, flow-alarm check valve, drain valve, and sprinkler heads as well as heating tracers in areas subject to freezing temperatures, supplied from site water supply or relocated fire main as is applicable.
 - 4. Exterior fire-protection system: Consists of lead-ins to wet standpipe system, valves and accessories, supplied from the city water main.
 - 5. Automatic, total-flooding clean agent suppression system: Consists of smoke detectors, agent storage containers, nozzles, clean agent suppression system control and detection panel, manual pull station, alarm bell, evacuation horn, clean agent suppression system discharge visual alarm and necessary interface boxes for signals from and to HVAC and communications. Each room or hazard area to have its own system designed to provide a concentration of 7 percent by volume.

D. Area of Operation

AREA	CLASS	DENSITY	AREA OF OPERATION
Office Area	Light Hazard	.10 gpm/sf	1500
Parts & Storeroom	Ordinary Hazard (II)	.19 gpm/sf	2000
Battery Room	Extra Hazard (I)	.30 gpm/sf	1500
Inspection Pit	Ordinary Hazard (II)	.20 gpm/sf	1500
Vehicle Maintenance, Shops & Lube	Ordinary Hazard (II)	.19 gpm/sf	1500
Building Mech./Elec. Service Areas	Ordinary Hazard (II)	.15 gpm/sf	1500

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. AWS: A5.13
 3. FM Approval Guide.
 4. NFPA: 12A, 13, 14, 15, 24, 2001.
 5. UL: 262, 312, 1479, Fire Protection Directory.
 6. ANSI/ASME: B16.1, B16.5, B16.9, B31.1.
 7. ANSI: Z535.1.
 8. NEMA: 250.
 9. FS: A-A-1992 SS-C-153, WW-P-421, WW-P-501, WW-U-516, WW-U-531.
 10. MSS: SP-58.
 11. ASTM: A36, A47, A53, A135, A183, A234, A 240, A276, B766, D1752, D2000.
- B. Qualification of Welding Personnel: Section 05120.
- C. Design Criteria:
1. NFPA 12A, 13, 14, 15 and 2001 as applicable.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Shop Drawings:
 - a. Methods of joining, welding, fastenings, and anchoring.
 - b. Materials and locations for wet standpipe, dry standpipe, sprinkler, clean agent suppression and external systems.
 - c. Pipes and piping layout, including pipe hangers and supports.
 - d. Pipe hangers and supports.
 - e. Valves.
 - f. Escutcheons.
 - g. Gauges.
 - h. Automatic air vents.
 - i. Pipe sleeves.
 - j. Mechanical couplings.

- k. Layout of sprinkler and clean agent suppression systems and detail drawings approved by Fire Marshal of jurisdiction in which work is to be performed.
 - l. Reports covering test materials.
2. Certification:
- a. Acceptance test results.
 - b. Manufacturer's certification that pipe-joint gaskets and lubricants are satisfactory for use with pipe and fittings specified and that couplings are designed and tested as specified.
3. Samples: Paint, Section 09920.
4. Operation and Maintenance Manuals.

1.04 JOB CONDITIONS:

- A. Do not perform welding when the temperature of the base metal is less than zero degree F.
- B. Do not perform welding when surfaces are wet or during periods of high winds unless operator and work are properly protected.
- C. Environmental Requirements: Paint, Section 09920.

1.05 OPERATION AND MAINTENANCE TRAINING:

- A. Upon completion of installation and in accordance with the General Requirements furnish for a period of not less than two consecutive man-days services of a manufacturer's field engineer with specialized experience in the components of the system to instruct Authority personnel in the proper operation and maintenance of the systems.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of piping and electrical equipment sub-assemblies, parts and relays.
- B. Pipe and Fittings:
 - 1. Exterior fire-protection system:
 - a. Ductile-iron pipe and fittings:
 - (1) Piping embedded or otherwise inaccessible: FS WW-P-421, Type III, Grade C, 250-pound pressure class.
 - (2) Piping from point of connection to inside of structure: FS WW-P-421, Grade C, 250-pound pressure class, flanged. Flanges: ANSI B16.1.
 - (3) Pipe coated on outside with bituminous coating and lined with cement mortar of twice standard thickness specified for pipe size used.
 - (a) Cement-mortar lining having seal coat of nontoxic, tasteless and odor-free bituminous material.
 - (4) Neoprene gaskets furnished for joints.
 - 2. Interior fire-protection system:

- a. Fire lines, embedded or otherwise inaccessible:
 - (1) Pipe: Galvanized steel, ASTM A53, Type E, Grade B, with the following additional requirements:
 - (a) Fire-protection piping: Extra-strong weight, Schedule 80.
 - (2) Fittings and flanges: Galvanized, furnished with wall thickness equal to or greater than that of adjacent pipe, with the following additional requirements:
 - (a) Fire lines: ASTM A234, Grade B, and ANSI B16.9 for dimensions and tolerances.
 - i. Flanges: ASTM A234 and ANSI B16.5 for dimensions and tolerances.
- b. Fire lines, exposed or otherwise accessible:
 - (1) Pipe:
 - (a) Galvanized steel: One of the following:
 - i. ASTM A53: One of the following:
 - 1. Type E, Grade B.
 - 2. Type F, Grade A.
 - ii. ASTM A13
 - (b) Welded or seamless.
 - (c) Standard weight, Schedule 40, with grooved ends. Use of Schedule 10 pipe is not allowed.
 - (2) Mechanical joint couplings: Keyed for joining grooved-end piping.
 - (a) Coupling housing: Malleable iron in accordance with ASTM A47, Grade 32510, galvanized, fabricated in two or more parts enclosing resilient gasket seal, with keys to fit machined grooves on pipe ends. Rated at 300-psig minimum pressure and factory-finished with manufacturer's standard paint coating.
 - (b) Coupling gasket: Chlorinated butyl, ASTM D2000, specification 3-BA-615-A14-B13, with following additional requirements:
 - i. Molded grooves.
 - ii. Pressure-responsive seal, integrity increasing with internal pressure.
 - (c) Coupling bolts and nuts: Oval-neck track-type bolts with hexagonal nuts conforming to ASTM A183 permitting single-wrench assembly, having minimum tensile strength of 110,000 psi, with cadmium-plated finish ASTM B766, Type III.
 - (3) Fittings:
 - (a) Grooved-end, fabricated of malleable-iron casting in accordance with ASTM A47, Grade 32510, galvanized; nonstandard fittings fabricated from Schedule 40 steel pipe.
 - (b) Mechanical branch outlets:
 - i. Victaulic 920 or equal.
 - ii. Victaulic Style 72 or equal.
 - (c) Threaded pipe fittings: FS WW-P-501, Type 1, Class B.
 - (d) Welding fittings made of same wall thickness as pipe.
 - i. Factory-made welding fittings.
 - ii. Mitered-joint elbows and field-made reducers are prohibited.
 - (e) Butt-welded fittings larger than 1-1/2 inches: ANSI B16.9.
 - (f) Flanges for welded piping system: ANSI B16.5, galvanized forged steel, welded-neck type, 175 pressure class for stations and 250 pressure class for tunnels.

(4) Paint, Primer, and Undercoat: Alkyd Semigloss System as specified in Section 09920, Color: OSHA Red (Safety Red) in compliance with ANSI Z535.1 for piping, White for stenciling.

c. Unions: WP 175 psig.

(1) 1-1/2 inches and smaller: Threaded, FS WW-U-531, Type B to match piping.

(2) Two inches and larger: Flanged.

(a) Two union flanges, 2-1/2 and three inches: Steel, FSA WW-U-531, or cast iron, ANSI B16.1.

(3) Four inches and larger: Forged steel, slip-on weld neck flanges, ANSI B16.5.

(4) Nonferrous piping unions: Brass, FS WW-U-516.

C. Valves:

1. Fire-line valves, outside stem and yoke (OS&Y), UL Fire Protection Directory listed or FM Approval Guide listed for 175-psig minimum, meeting requirements of listed NFPA Standards, with UL or FM symbol cast or stamped on valve body.

2. Gate valves: UL 262 or FM Approval Guide listed, 175-psig WP

3. Check valves: UL 312 or FM Approval Guide listed, 175-psig WP, flanged-end connections, swing-type, metal-to-metal, rubber-faced or equivalent, valve seat 15 degrees from perpendicular to direction of flow.

4. Sprinkler flow-alarm check valves: Designed to operate on 10 gpm or more with restriction bypass which allows restricted flow of water to pass from supply to system side of alarm-valve clapper, to decrease possibility of false alarms resulting from increase in supply water pressure or from water hammer.

a. Furnished with retarding chamber, test and drain connections and electric contact unit.

b. Cast-iron bodies with nonferrous-metal seat, rings, bearings and renewable clapper facing.

c. Contacts: Section 15900.

5. Fire water-line surveillance valve:

a. Double-disc, solid-wedge gate-type with outside stem and yoke (OS&Y) and renewable ring seats.

b. Designed for position indicator contact:

(1) Contacts open with valve fully open.

(2) Contacts close and alarm condition is initiated with two turns of hand wheel or when valve stem has moved one-fifth of distance from normal fully open position.

6. Sprinkler alarm check-valve surveillance: Contact closes on flow amounting to 10 gpm or greater.

7. Ball drip valves: 3/4 inch, threaded both ends and rated at 175-psig minimum.

8. Air and vacuum valves:

a. Automatic.

b. High-capacity; minimum flow, 3.0 cfs; pressure differential, 5.0-psig maximum.

c. Designed for maximum system working pressure; 175-psig minimum; suitable for working pressures from zero psig to maximum capacity.

9. Angle hose valves:

a. Cast bronze, male outlet, replaceable rubber disc and rising stem.

b. Rough-bronze body, polished-finish bonnet, nut and stem, complete with cap and chain.

c. Cast-iron or aluminum hand wheel, red-enameled.

d. Working pressure: 200 psig.

e. UL Fire Protection Directory listed with symbol cast or stamped on valve body.

f. American National Standard Fire Hose threads.

10. In-line cut-off valves:
 - a. Flanged gate valve, with outside stem and yoke
 - b. Comply with UL 262, UL Fire Protection Directory listed or FM Approval Guide listed with symbol cast or stamped on valve body.
 - c. Working pressure, 175 psig.
 - d. Cast-iron or aluminum hand wheel, red-enameled.

- D. Fire Department Siamese Connection:
 1. Free standing:
 - a. Paved areas: Double clapper, with sidewalk sleeve, sidewalk plate, two rocker-lug plugs and chains, polished brass, two female inlets with 2-1/2 inch American National Standard Fire Hose Threads, UL Fire Protection Directory listed or FM Approval Guide listed, working pressure of 200 psig and with cast recessed Type B Metro logo and inscription, as shown, except inside fenced Authority property.
 - b. Landscaped areas: As specified for paved areas, except no sidewalk sleeve or plate.
 - c. Paint, Primer, and Undercoat: Alkyd Semigloss System as specified in Section 09920, Color: OSHA Red (Safety Red) in compliance with ANSI Z535.1 for piping, White for stenciling.
 2. Wall-mounted: Double clapper rectangular wall plate for flush mounting, two rocker-lug plugs and chains, polished brass, two female inlets with 2-1/2 inch American National Standard Fire Hose Threads, UL Fire Protection Directory listed or FM Approval Guide listed, working pressure of 200 psig, and with cast raised Type B Metro logo and inscription as shown. Provide sill cock where necessary for drainage.

- E. Sprinkler Heads:
 1. Standard fusible-link type.
 2. Bronze finish, exposed and temperature rating of 165F in accordance with listed NFPA Standards.

- F. Sprinkler Test Connections:
 1. Drain piping, valves and fittings necessary for testing in accordance with listed NFPA Standards.

- G. Control System: Except as specified for clean agent suppression systems: Provided by other trades.

- H. Supporting Devices:
 1. Pipe hangers and supports:
 - a. Adjustable, stainless steel, clevis-type, threaded full length, with diameter consistent with pipe size and the load imposed: MSS SP-58.
 - b. Hanger rods: 3/8-inch minimum diameter, stainless steel, ASTM A276, Type 304, threaded full length, with diameter consistent with pipe size and the load imposed: MSS SP-58.
 - c. Nuts and washers: Stainless steel.
 - d. Supported from stainless steel inserts in concrete slab: MSS SP-58.
 2. Adjustable U-bolt type:
 - a. U-Bolt: Fabricated from stainless steel, MSS SP-58.
 - b. Nuts and washers: Stainless steel.
 - c. Chair: Cast iron or fabricated from stainless steel.
 3. Z-bar: Fabricated from stainless steel: ASTM A240, Type 304.
 4. Pipe anchors:
 - a. Designed to withstand a minimum of five times anchor load.
 - b. Vertical pipes anchored by means of clamps welded around pipes and secured to wall or floor construction.

5. Expansion-bolt anchors:
 - a. Consisting of bolt, expander, star lock washer and nut.
 - b. Fabricated of stainless steel, Alloy S30300 in accordance with ASTM E527, including expander and star lock washer.
 - c. Anchor assemblies: FS A-A-1992, Group II, Type 4, Class 1.
 6. Self-drilling anchors:
 - a. Self-drilling, expansion anchors with self-cutting annular broaching grooves.
 - b. Anchor and expander plug: Double-plated, FS A-A-1992, Group III, Type 1.
 7. Pipe sleeves:
 - a. Through interior masonry-unit walls: PVC, as shown, large enough to accommodate pipe but minimum two sizes larger than pipe size.
 - b. Through cast-in-place concrete interior walls and concrete ceilings: Factory-made cast iron with anchor flange and cast-iron plate collar screw-fastened to slab and pipe.
 - (1) Sleeves minimum two sizes larger than pipe; for floors and ceilings projecting four inches above finish floor.
 - c. Through exterior structural elements: Minimum two sizes larger than pipe and as shown.
 - d. Sleeves designed for pipe-movement allowance due to expansion and contraction.
 8. Escutcheon plates:
 - a. Polished brass or stainless steel, screw-fastened to wall or ceiling.
 - b. Plate collars caulked with silicone sealant or intumescent putty.
 - c. Sealant: UL-1479.
- I. Pressure Gauges: Spring pressure-type, 3-1/2 inch dial, in accordance with NFPA 14.
- J. Bonding Strap: 2AWG single-conductor cable: Section 16060.
- K. Preformed Joint Filler: ASTM D1752.
- L. Coal-Tar Epoxy: Section 02535.
 1. Thinner of type recommended by manufacturer of coating and used only when approved.
- M. Water-Flow Indicator: Vane-type water flow switch, UL Fire Protection Directory listed, FM Approval Guide listed. Electrical rating: 24 volts dc, 1.5 amperes, normally open contacts to actuate with flow of 10 gpm or more.
- N. Clean agent suppression system:
 1. Smoke detectors: Products of combustion, dual-chamber, ionization-type, operating voltage of 22 to 28 volts dc, 30 milli-amperes (ma) standby current drain at 24 volts dc and alarm current drain of 60 ma at 24 volts dc. Three amperes minimum alarm contact rating at 24 volts dc. Detector will activate alarm approximately five seconds after product of combustion particulate enters ionization chamber. Detectors equipped with indicator lamp which will remain lighted until reset. Unit listed by UL Fire Protection Directory and FM Approval Guide as signal and release device.
 2. Manual pull station: Contained in cast-metal housing for mounting on standard four-inch junction box unit to have dual-action release configuration such as discharge lever protected by lift cover, to prevent accidental discharge, and tamper-resistant screw to prevent unauthorized access to reset procedure. For operation at 24 volts dc. Listed by UL Fire Protection Directory as release device.
 3. Abort switch: A momentary, normally closed push-button switch. Time delay to restart at designated setting when abort switch is released. Switch to be accessible and labeled 'CLEAN AGENT ABORT.' Activation of the abort switch to silence discharge warning horn.

4. Clean agent suppression system control equipment:
 - a. Control panel: Multizone for operation by smoke detectors and manual pull station, singly or in combination, to activate prealarm or release of agent as required. Power source for operating extinguishing system as well as specified auxiliary functions.
 - (1) Panel enclosure: NEMA 250, Type 1 surface-mounted, dead front; indicators and control switches visible, mounted on panel behind hinged, locked glass-paneled door, complete with relays, trouble and alarm bell, silencing switch with ring-back feature, LED indicating lamps, nameplates, switches and terminals to provide relays for fire-alarm system tie-in, for HVAC systems fan shut-down, HVAC-damper closing, for test delay switch with automatic reset to permit testing fire-alarm system without activating auxiliary control functions.
 - (2) Operating circuitry: Solid-state electronics with plug-in circuit modules for detection and release circuits; 120-volt ac, 60-Hertz supply; 24 volts dc signal and release circuits including power for operating extinguishing sub-system and other functions. Power consumption 10 watts steady state, 200 watts peak.
 - (3) Functional circuitry: Provide two detection zones and two output circuits for signal and release, all Class B supervised. Detection circuits to accommodate smoke detectors and manual stations intermixed. Signal output circuit of the polarity-reversal type. Release circuit to include supervised abort switch and adjustable time delay. Provide separate relay output for each zone alarm, general alarm, trouble, pre-discharge and system-fired circuit; utilize 10-ampere contact.
 - (4) Operation: Activation of detector, circuit to light zone alarm lamp on indication panel, sound audible local alarm, activate the extinguisher system and energize auxiliary relays for remote alarm or equipment shut-down. Loss of dc power or discontinuity in detection circuits to light trouble lamp on indicator panel and actuate bell alarm; provide trouble bell silence switch with ring-back circuit to silence trouble bell alarm. Receipt of zone alarm to override trouble alarm. A single switch to reset control unit.
 - (5) Indicator lights, as follows:
 - (a) POWER ON: Green.
 - (b) TROUBLE: Yellow.
 - (c) ALARM ZONE 1: Red.
 - (d) ALARM ZONE 2: Red.
 - (e) PRE-DISCHARGE: Red.
 - (f) SYSTEM FIRED: Red.
 - b. Extinguishing system:
 - (1) Provide system designed to discharge seven-percent volume concentration of extinguishing agent with discharge not to exceed 10 seconds. The system to comply with NFPA 2001. Each extinguishing system to include the following
 - (a) Agent storage container: Container fabricated of high-strength alloy steel with burst-disc actuator valve assembly, safety plug, cable assembly, 0 - 600-psig pressure gauge, pressure switch and lifting ring. Container to conform to applicable DOT specifications; to automatically relieve between 850 psi and 100 psi in event of excessive pressure buildup. Super-pressurize filled container with dry nitrogen to 390 psig at 70F to assist rapid distribution. Container

- designed for on-site reconditioning and refilling. Actuator valve assembly to be an integral part of container.
- (b) Discharge nozzle: Provide series of one-piece, nonclogging nozzles to distribute agent in protected volume. Nozzle size selection determined by container size and geometry of volume to be protected. Nozzles connected through reducer, elbow and piping. Nozzle discharge pattern to deliver uniform agent coverage to all areas of enclosed hazard.
- (c) Actuator: Electrical device to operate on demand to provide path for relief and discharge of agent.
- (d) Mounting bracket: Designed for wall-mounting agent storage container and capable of withstanding 1,000-pound thrust for five seconds in any direction.
- (e) Agent: Liquefied compressed clean agent suppression system conforming to requirements of NFPA 2001.
- (f) Alarm bell: Motor driven, with six-inch gong, 24-volt dc operating voltage, 90 dBA sound-pressure level at one meter and OSHA Safety Red finish.
- (g) Evacuation horn: Vibrating, 24-volt dc, 0.063 amperes, 97 dBA sound-pressure level at one meter.
- (h) Discharge indication light: Flashing device with legend CLEAN AGENT DISCHARGE; 24-volt dc.
- (i) Clean agent suppression system interface box: Data-transmission system (DTS) cabinet specified in Section 16130, with the following additional requirements:
 - i. Cabinet: Hoffman A161206LP.
 - ii. Terminal strip: 16 terminals minimum.
 - iii. Exterior finish color: OSHA Safety Red.
 - iv. Identify cabinet on cover with COMMUNICATION INTERFACE in one-inch high yellow letters.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances to space provided and make serviceable.
- B. Provide support beams, concrete pads, platforms, and hangers necessary for proper installation of equipment as recommended by manufacturer.
- C. Install complete fire-protection systems as shown and as specified. During installation, protect work, equipment, and materials. Plug or cap pipe openings.
- D. Flush underground mains before connection to wet-standpipe risers at following minimum flow rates:
 - 1. Six-inch pipe: 750 gpm.
 - 2. Eight-inch: 1,000 gpm.
 - 3. 10-inch pipe: 1,500 gpm.
 - 4. 12-inch pipe: 2,000 gpm.
- E. Fasten escutcheon plates to wall or ceiling. Seal plate collars watertight with mastic.
- F. Welding Procedure:
 - 1. As specified in Section 05120, with the following additional requirements:

- a. Manual metallic arc process, except for pipe sizes four inches and smaller where oxyacetylene welding may be used.
 - (1) Use electrodes and rods of composition recommended by AWS A5.13 for pipe.
 - (2) Heat surface within three inches from point where weld will start to a temperature warm to hand before welding.
 - b. Leave joint surfaces smooth, uniform and free from fins, tears and other defects which adversely affect proper welding.
 - c. After each pass of weld on multiple-pass welding, clean weld free of slag and other deposits before applying next pass.
 - d. Peen with light blows of blunt-nosed peening hammer. Do not peen surface layers or first pass in groove welds.
 - e. For groove welds, center surface pass substantially on seam, smooth and free from depressions.
 - f. Fillet weld with minimum cutting back of outside surface of pipe.
 - (1) Leave throat of full fillet weld not less than 0.707 of thickness of pipe.
 - (2) Repair excess cutting back and undercutting of base metal in pipe adjoining the weld.
 - (3) Fill craters to full cross section.
 - g. Position pipes to be welded so that joints will be in alignment. Joints misaligned more than 20 percent of pipe wall thickness or maximum of 1/8 inch are prohibited.
 - h. Install welding pipe in accordance with ANSI B31.1.
2. Cut ends of screw-jointed pipes squarely to seat in bottom of recess of fittings. Ream after cutting so waterway is not reduced in size.
 3. Apply thread dope or compound to male thread only.
 4. Where cathodic protection is shown, apply coal-tar epoxy coating as specified in Section 02535 and test as specified in Section 13115.
- G. Buried Ductile-Iron Pipe: Install as specified in Section 02515, except use mechanical joints.
- H. Steel-Pipe Installation:
1. Maintain OSHA required head clearance.
 - a. Install horizontal piping with minimum pitch of one inch in 40 feet.
 - b. Provide drains at low points: Minimum 3/4-inch valves with hose connection.
 - c. Install vertical pipes near wall from which they are supported.
 2. Make connections to equipment without placing strain on piping and equipment.
 3. Joints for fireline piping of mechanical-type, grooved or welded couplings for lines four inches and larger and screwed or welded for lines under four inches, except that mechanical-type grooved couplings must be accessible.
 - a. Provide number of mechanical couplings necessary to allow minimum 1-1/4 inch expansion per 100 feet of main.
 - b. Use reducing tee for mechanical couplings or mechanical branch outlet at main-to-branch connections.
 - c. Make in-line cut-off valves accessible from floor or walkway level.
- I. Mechanical-Type Groove Couplings: Install couplings according to manufacturer's instructions and as follows:
1. After grooving, remove indentations, projections and roll warps as necessary. Cut pipe ends square to tolerance of plus-or-minus 0.03 inch. Provide zinc coating on exposed surface.
 2. Lightly coat pipe ends and coupling gasket with non-petroleum-based lubricant.
 3. Center gasket, install housing and ensure that keys are securely located in pipe grooves.
 4. Install bolts and nuts tightened uniformly to manufacturer's recommended limits using torque wrench, without pinching gaskets.

- 5. Provide bonding across couplings for stray-current protection.
- J. In-Line Valves: Install in-line valves by bolting fitting to valve and welding fitting to pipe.
- K. Pipe Anchors: Securely anchor piping as specified, where shown and where necessary for proper installation to force pipe expansion in proper direction.
- L. Expansion-Bolt Anchors: Drill holes and install expansion-bolt anchors in manner recommended by anchor-bolt manufacturer. Do not install less than eight inches from concrete edge.
- M. Pipe Sleeves: Fill annular space between pipe and sleeves with preformed joint filler, tightly placed to form effective seal against groundwater.
- N. Bonding: In accordance with Section 16060, and with the following additional requirements:
 - 1. Bond mechanical joints and fittings, including valves, by exothermic-welding method.
 - 2. Make welds in accordance with manufacturer's recommendations. Clean and coat with coal-tar epoxy.
 - 3. Bond pipe using bonding strap welded to each side of joint not less than six inches from joint. Allow sufficient slack in conductor for expansion of pipe.
- O. Air Vents: Install high-capacity automatic air vent(s) at opposite end(s) of dry-standpipe system from fire-department siamese connection or where shown. Pipe air-vent outlet to nearest drain or as directed.
- P. Firestopping: Section 07841.

3.02 PROTECTION OF PIPING AND EQUIPMENT:

- A. Protect pipe, openings and valves from dirt, foreign objects and damage during construction.
- B. Replace damaged piping, valves and other appurtenances, should damage occur prior to final acceptance of the work.

3.03 FIELD QUALITY CONTROL:

- A. Field Tests:
 - 1. Flush piping with water until clean and free of scale, slag, dirt, oil, grease and other foreign material.
 - 2. Perform final testing, acceptance, and certification in accordance with NFPA 13, 14, and 24, as applicable.
 - 3. Test electrical continuity of bonded joints by measuring resistance. Total resistive value of joint not to exceed calculated resistance of bond cable plus 10 percent.
- B. Water-Pressure Testing:
 - 1. In the presence of the Engineer, test piping, prior to burial or concealment, using specified procedures specified.
 - 2. In the presence of the Engineer, completely test piping system for leaks until approved.
 - 3. Notify the Engineer at least 36 hours prior to tests.
 - 4. Test piping at the following pressures:
 - a. Fire-protection piping, inaccessible: 400 psi-minimum.
 - b. Ductile-iron pipe: At lowest point in system, 150 psi or 1-1/2 times maximum working pressure, whichever is greater.

- c. Fire-protection piping, exposed and accessible: At lowest point in system, 150 psi or 1-1/2 times maximum working pressure, whichever is greater.
- C. Test Procedures:
- 1. Test fire-protection piping in accordance with NFPA.
 - 2. Fire-protection piping, inaccessible:
 - a. Avoid excessive pressure on safety devices and mechanical seals.
 - b. Fill entire system with water and vent air from system at least 24 hours before test pressure is applied.
 - c. Apply test pressure when water and average ambient temperature are approximately equal and constant.
 - d. Maintain test pressure for six hours minimum without drop after force pump has been disconnected.
 - 3. Water-test entire system with pressure at highest point of 250 psig.
 - 4. After filling system, shut off water supply and allow it to stand for two hours under test without loss or leakage.
 - 5. Coordinate with and assist local fire department in performing flow tests. After performing hydrostatic test, drain water from firelines. Perform flow test at rate of 500 gpm with pumper connected to siamese connection, starting testing with sudden full flow into empty firelines.
 - 6. Drain system immediately after hydrostatic and flow testing.
- D. Repair of Leaks:
- 1. The following are prohibited:
 - a. Repair of leaks by mechanical caulking.
 - b. Introduction of material inside piping system to stop leakage.
 - 2. Repair leaks in threaded piping by breaking joint, cutting new threads on pipe and installing new pipe fitting.
 - 3. Coat field welds and repair damages to zinc-coated surfaces as follows:
 - a. Wire brush areas to be coated to bright metal.
 - b. Apply galvanizing repair compound at rate of two ounces per square foot.
 - 4. Replace defective coupling assembly as necessary.
 - 5. Remove defective welds by chipping or gouging.
 - a. Reweld the chipped-out places.
 - b. When base metals of fillet welds are cut back or throat of welds are less than specified, repair defect by adding additional weld metal.

3.04 CLEANING:

- A. Flush firelines with water to remove sediment after completion of tests, repairs or replacements.
- B. Disinfect firelines connected to potable-water system as follows:
 - 1. Use chlorine for disinfection in form of hypochlorite solution or in form of compressed gas applied through approved chlorinator.
 - 2. Operate valves and equipment during chlorination to ensure that chlorine reaches entire system.
 - 3. Feed water and chlorination agent into system at rate providing for 50 ppm of chlorine and allow to stand 24 hours before flushing.
 - 4. Residual chlorine, at end of 24-hour retention period, not less than 10 ppm.
 - 5. Flush treated water from system completely after disinfection.
 - 6. Continue flushing until samples show that quality of water delivered is comparable to public water supply and satisfactory to public-health authority having jurisdiction.
 - 7. Do not take samples from hydrants or through unsterilized hose.

3.05 FIELD PAINTING: Section 09920.

- A. Prepare piping, apply primer, undercoat and finish coats in accordance with Section 09920.

3.06 IDENTIFICATION OF PIPING AND VALVES: Section 15075.

3.07 CLEAN AGENT SUPPRESSION SYSTEM:

A. General:

1. Redundant system shall be provided in accordance with county code requirements. Smoke detectors to be cross-zoned so that at least one detector from each loop shall react to smoke before extinguishing system will be activated. First detector actuated to sound alarm bell, illuminate indicator lamp for appropriate alarm zone and energize fan shut-down relays and close dampers of HVAC systems serving involved space. Second detector actuated to energize evacuation time-delay relay in clean agent suppression system control panel, sound evacuation time horn and illuminate SYSTEM FIRED indicator light at clean agent suppression system control panel to indicate system discharged. Time delay shall allow sufficient time for dampers to close before release of FM200 agent. All dampers connected to the protected room shall be motorized. Actuation of manual pull station shall immediately activate sound evacuation horn, energize fan shut-down and close dampers of HVAC system serving area and release FM200. Time-delay shall be provided to allow sufficient time for dampers to close

B. Trouble Operation:

1. Opens or ground in wiring to ring bell on FM200 control panel. Silencing switch to silence trouble bell during correcting of fault.

C. Remote Alarms:

1. Activation of the following to generate alarm indicators at clean agent suppression system control panel:
 - a. Alarm Zone 1.
 - b. Alarm Zone 2.
 - c. System fired.
 - d. Trouble.

D. Performance Testing:

1. Performance-test completed system except smoke detectors.
2. Provide instrumentation and test gases-test systems including detection system in accordance with jurisdictional requirements.
3. Operate mechanical and electrical systems.
4. Inspect nozzles and agent storage containers.
5. Full equivalent test of gas discharge into each zone area. Use meter to verify delivery of specified concentrations within required time and maintained for minimum of 10 minutes.
6. After completion of satisfactory testing, refill storage containers.

END OF SECTION

THIS PAGE NOT USED

SECTION 14100

TWO (2) SCREW CAR HOISTS AND BODY HOISTS DEEP PIT DESIGN

PART 1 - GENERAL

RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract apply to this section.
- B. Related Sections include Section 11001, Equipment General Requirement.

1.01 DESCRIPTION

- A. Furnish one (1) complete de-trucking system per the Base Bid of the Proposal Form. The de-trucking system will include Car Hoists, Body Hoists/Body Supports and all required power and control components complete with panel enclosures (motor control center, master control station and remote control stations), non embedded conduit and interconnecting wiring from power supply to equipment. All equipment shall comply with ASME A17.1 and ADAAG, and all state or local jurisdictional codes and requirements.
- B. Each Car Hoist and Body Hoist/Body Support shall be of the deep Pit Design. Each Car Hoist and Body Hoist/Body Support shall be supported from the pit floor, which shall be approximately 13'-6" below the shop floor.
- C. Body Supports are actually Body Hoists which have the capacity to raise a married pair of cars. We shall specify this item only as Body Supports in the following documents.

1.02 QUALITY ASSURANCE:

- A. Manufacturer Requirements:
 - 1. Furnish Car Body Hoists manufactured and designed as approved by WMATA's engineering, operation and maintenance departments.
 - 2. Minimum expected half life of this equipment shall be 25 years. All equipment furnished shall be heavy duty, industrial type.
 - 3. The Engineer reserves the right to inspect materials and their sources, workmanship, and construction methods at any time, at the Manufacturer's shop or fabricating facility. The Engineer further reserves the right to be present for any or all shop tests of components, assemblies, or systems. The Manufacturer shall notify the Engineer two (2) weeks in advance of any tests.
 - 4. Manufacturer's Compliance:
 - a. All factory wired control panels shall be tested for operation, as specified herein, and submitted to Underwriters Laboratories Inc., for inspection, approval, and labeling.
 - b. Nameplates: Nameplates shall be securely attached, by mechanical means, in a prominent location on each major item of equipment
 - 5. Qualification of Manufacturer: Manufacturer shall be reputable and regularly engaged in the design and manufacture of the type of equipment specified herein.

Assembled components, purchased by the Manufacturer for this Contract, such as motors, gear boxes, electrical devices, etc., shall be the standard products of qualified manufacturers. All similar items shall be the products of a single manufacturer. Prior to approval of the Manufacturer's proposal for the Truck Repair Hoists, the Manufacturer shall submit to the Engineer the following information:

- a. A list of truck repair hoists, of his manufacture, similar in usage, where the proposed equipment has been in service, including the duration of service.
- b. Name of contact person at each installation submitted above, who is familiar with the operation and maintenance of all hoisting equipment provided by the Manufacturer.
- c. The truck repair hoists shall meet the Federal Transit Administration Buy America Clause for equipment installed in an existing maintenance shop.
- d. The manufacturer of the truck repair hoists shall be ISO-9001 certified and registered. The manufacturer must submit with the bid response proof that it has implemented and maintain a quality system that fulfills the requirements of the ISO-9001 in the form of a certificate documenting the most recent quality audit and report.
- e. Based on the information supplied, and discussions with the contact persons named, the Engineer will determine the acceptability of the proposed Manufacturer and equipment.
- f. Furnish manufactures ISO 9001 quality assurance program to the authority for approval.

1.03 TRAINING:

A. Contractor is responsible for training as outlined in Section 01820, Demonstration and Training and Section 11001, Equipment General Requirements.

B. Number of Personnel To Be Trained And Class Size.

Level Of Training	Approximate Number of Individuals	Maximum Class Size	Minimum Number of Classes
Level I	40	8	6
Level II	8	4	2
Level III	8	4	2

C. Levels of Training:

1. Level I: Familiarizing Training
2. Level II: Training for P&E Personnel
3. Level III: Programming Training

PART 2 - PRODUCTS

2.01 GENERAL OPERATING CHARACTERISTICS

A. The de-trucking system will raise, lower, or hold the Transit Authorities vehicles. This shall be accomplished from a master control station through a selector switch which shall allow

all Car Hoists and Body Supports to act simultaneously for married-pair vehicle lifting and support. The Car Hoists and Body Supports shall be operated from the master control station by "raise-lower" pushbuttons.

- B. Each Car Hoist and associated Body Supports of the de-trucking system shall be operated individually from a remote control station through the selector switch mounted on the master control station. The master control station shall be locked out when a remote control station is activated by the selector switch. Use of the remote control station will allow individual transit vehicle trucks to be lowered to track level.
- C. De-trucking (truck removal and installation) shall be accomplished with the assistance of Body Supports. Each pair of electro/mechanical powered Body Supports shall operate simultaneously to support the transit vehicle at any position up to fully extended when the system is operated from the master control station. Sensors in the Body Supports shall stop their operation when full contact with the jack pads is made. Each Body Support will be equipped with a head, which when positioned shall support the vehicle by the jack pad.

2.02 CAR HOISTS

- A. General:
 - 1. Each Car Hoist will be operated by an electro/mechanical drive system that is automatically self-locking at any elevation. The drive system shall be completely below shop floor level and raise a superstructure with eleven-foot long (11'-0") rails from floor level to the specified elevation or any intermediate elevation. The superstructure shall be open ended without cross-members above floor level to allow free access to the truck.
- B. Performance:
 - 1. Each Car Hoist will have a minimum raising and lowering capacity of 50,000 pounds. In the fully lowered position the car hoist shall have a roll-over capacity of 50,000 pounds on a single four wheel truck with the load equally distributed on each wheel.
 - 2. In any raised position the maximum variation from horizontal for any single hoist will be 1/4 inch measured from end-to-end or center-to-center of the rails.
 - 3. The maximum variation in level between all four hoists in the de-trucking system supporting a transit vehicle through a lifting cycle will be 1 inch.
 - 4. The maximum variation in alignment among a group of hoists will be 1/8 inch in the down position and 3/4 inch in any raised position.
 - 5. Total travel of the Car Hoist will be 60 inches maximum. Lifting speed shall be 4.5 feet per minute.
 - 6. Each group of Car Hoists shall be capable of supporting the transit vehicle with a safety factor of not less than 5:1 based on the ultimate strength of the materials for Mechanical Components. Structural Components allowable stresses and loadings shall be based on those specified in the AISC (ASD) 9th edition with the appropriate dynamic load factors applied.
- C. Car Hoist Frame Base:
 - 1. The frame base is the main structural weldment which supports all other structural members and drive machinery. It shall be anchored to the foundation floor by Anchor Bolts embedded in the pit floor. The frame shall be fabricated from structural steel rectangular tubes (ASTM A500B) and structural steel plates (ASTM A36).

2. Leveling screws shall be mounted on the frame base capable of supporting the entire car hoist against the foundation floor. The screw shall be designed to provide ease and accuracy in leveling the car hoist during installation.
3. The motor mounting base plate and hoist gear case mounting base plates shall be attached to the frame base by welding. The base plates shall be machined (milled) to true flatness one to another, to provide positive motor/gear case alignment and total bearing surface between the drive machinery and base plates.
4. Two (2) structural columns will be mounted on each frame base and attached to the base by bolted connections. The columns are to provide structural stability for the upper frame assembly which in turn supports the car hoist rails. Each column shall have two (2) vertical machined surfaces to provide long wearing, accurate guidance of the upper hoist frame.
5. Hoist Motor. The hoist shall be driven by a squirrel cage motor with a brake. The motor shall be totally enclosed-non vented heavy duty and equipped with shielded sealed bearings. Motor will be NEMA "D" design, Class "H" insulation not to exceed Class "B" temperature rise for 15 minute rating. The Motor Reducer shall have a double extension shaft to couple each end to the bevel gear cases. The motor shall be mounted to the frame base with the armature shaft perpendicular to the shop service rails.
6. Couplings. The Motor Reducer shall be coupled at each end to the bevel gear cases by solid couplings.
7. Gear Cases/Lifting Screws. The bevel gear case input shaft shall be coupled to the Motor Reducer. The input shaft shall be from alloy steel on which is an integrally machined and ground steel pinion. The pinion shall mesh and drive a high tensile bevel gear. The bevel gear shall be keyed to the lifting screw at the screw's base. The lifting screw shall be a buttress thread design and be self locking (load or no load). It shall be machined from heat treated alloy steel. The Buttress Screw shall have a pitch diameter of 3 ½ inches with an inside diameter of 3 inches and an outside diameter of 4 inches. The lifting screw which extends from the gear case vertically shall rest and rotate on a spherical thrust roller bearing and be guided by an antifriction roller bearing at the bottom of the screw. The gear case shall be splash lubricated with the gear case housing fabricated from steel. The gearing used shall be rated for the horsepower of the hoist motor.
8. Hoist Nut. The hoist nut shall be machined from nonferrous material. It shall be compatible and travel (raise/lower) on the rotating buttress threads of the lifting screw. The nut shall bear against and be locked from rotation by pins in the nut adapter plate. The adapter plate shall be attached by four (4) bolts to the upper hoist frame. The nut shall be designed to provide minimum wear when subjected to maximum stress conditions.

D. Upper Hoist Frame.

1. The upper hoist frame shall be the structural member to raise and lower a Transit Car, guided by the columns of the base frame. The frame structure also provides the bridge section and rail system to carry the crossing load of a transit car or raise/lower/support a Transit Car.
2. The upper hoist frame shall be a weldment, fabricated from structural steel rectangular tubes (ASTM A500B); plates, channels, bar stock, and wide flange beams (ASTM A-36).
3. The upper frame assembly shall be designed to provide a clear unobstructed area between the hoist rails when the hoist is fully raised. Each car hoist rail shall be supported by a wide flange beam on a yoke type structure consisting of two rectangular steel tubes acting as columns, per side, supported by a common structure which remains below floor level when the hoist is fully raised. The structure shall bear against the hoist nuts and be supported by the lifting screws.

4. The car hoist rails shall be hardened to avoid damage due to end batter, and manufactured from an AISI 1045 steel bar with a minimum tensile strength of 90,000 P.S.I., and a Brinell Hardness of 190.
 5. Automatic wheel stops shall be actuated when car hoists are raised greater than two inches (2") from the full down position. The wheel stops shall be a mechanical design, not requiring an electrical interface. The stops shall be held positively clear of the flange way and railhead when the car hoists are in the lowered position. Four (4) automatic stops shall be installed on the car hoist at the ends of the running rails. Also, four (4) manual wheel stops shall be provided per car hoist.
- E. Guide System:
1. The Car Hoists shall be provided with a positive roller guide system. The system shall provide guidance and stability to the upper hoist frame during raising/lowering/static modes. The system shall be designed to transfer all eccentric or side loading, imposed on the upper hoist frame, into the frame base, leaving the lifting screws subjected to compressive loads only.
 2. Guide Roller System. McGill Camrol bearing shall be mounted to the upper hoist frame and operate with running clearance against the machined surface on the columns, of the frame base. Eight (8) bearings shall be used in the design to transfer lateral loads which are perpendicular to the service track. The bearings shall be properly spaced with four bearings opposing on each side of the upper hoist frame.
- F. Design
1. The design shall protect against damage due to the nut running past the limit switch. Each car hoist shall have an operating upper and lower limit switch which limits travel of the upper hoist frame. There shall also be an upper overtravel limit switch and a redundant lower travel limit switch. A runoff area shall be provided at the lower end of nut travel to disengage the lifting nut from the upper frame assembly upon over travel past the limit switches. All limit switches shall be actuated directly by the jack screw nuts.
 2. Fully loaded, the hoist shall not deflect more than 1/4 inch measured at the top of the running rail with 1.2 kips applied horizontally in any direction at the rail.
- G. Centralized Lubrication System:
1. When used in conjunction with the protective sleeves, it shall shorten the cleanup time and extend the period between major cleanups by minimizing contaminants which adhere to the exposed screws.
 2. The PLC controlled lubrication system shall provide lubrication to the jack nuts and screws for the shop's car lifting equipment.
 3. Lubricant shall be distributed from a centrally located 55 gallon drum through a system of pipes to control panels mounted on the equipment. A network of tubing and hoses shall feed the lubricant directly to the jack nuts in controlled portions when the equipment is in operation.
 4. Electrically controlled and programmed feeder valves and cycles switches, connected to the PLC at the motor control centers, will feed only the nuts in operation.
 5. When four car hoists are used to raise a married pair of transit cars, all eight (8) nuts and screws shall receive lubrication. When two to eight body hoists are engaged to the car(s), only the active pair(s) are lubricated. If only a single body hoist is used to straighten a tilted car body, both body hoist screws be lubricated as a pair. Since this operation occurs on an occasion timed interval, and the travel

- distances are short, the excess lubricant is negligible.
6. The pump shall be pneumatically operated through a filter-lubricator, connected to shop air. It requires approximately 50 PSI, and regulation of the lubricant supply shall be controlled at this point. Lubricant entering the system from the pump passes through an in-line strainer to ensure clean lubricant.
 7. High pressure reset indicators in the feeders shall isolate high pressure problems at the nuts. A data Panel located on the Motor Control Center (MCC) door shall indicate a lubrication fault and its pit location. A green indicator light on the car hoist lifting frame shall activate during operation to visually indicate proper operation from the shop floor level.

Note: The system is not intended to apply the initial coat of lubricant required after a periodic cleaning.

A hand applied coat will still be required. The system shall apply a sufficient quantity of lube to replace that amount lost during normal operation.

H. Maintainability:

1. Hoist Motor Reducer. The Motor Reducer shall be removable by disconnection of the mounting bolts and couplings, without disturbance to other components.
2. Bevel Gear Case/Lifting Screws. A gear case/lifting screw shall be removable from the pit by removing the center pit cover; upper frame; disconnecting motor reducer coupling and removal of gear case mounting bolts. External lifting devices will only be required for lifting pit cover and gear case/lifting screw from pit.
3. Guide Rollers. Guide rollers shall be accessible and replaceable by use of small hand tools only. No major disassembly shall be required.

I. Lifting Nut and Wear Detection System

1. Lifting nuts shall have the capability of being removed for replacement or inspection without the necessity of removing the jack screw or performing major disassembly of the unit.
2. Removal/replacement of lifting nut shall be accomplished by blocking upper hoist frame at any elevation. Remove four mounting bolts supporting nut adapter plate and two (2) upper bearing capsule bolts. Rotate nut off end of screw. Work shall be accomplished with small hand tools and blocking. External lifting devices will not be required.

J. Nut Wear Detection System:

1. The wear nut detection system shall provide for positive identification of excessive wear on the hoist nuts and the ultimate shut down of the equipment if periodic inspections are not conducted.
2. In connection with the above, an additional nut or follower nut is accommodated beneath the main hoist nut. It shall serve a dual purpose, as a load support in the event of hoist nut failure and as a partial support for the sensor arrangement.
3. Nut wear is detected by an inductive sensor at each hoist nut on the Car Hoists. The Body Supports are not provided with this feature.
4. The Data Panel connected to the PLC shall indicate a nut fault and location.
5. Nut wear proximity sensors automatically stop hoisting motion when any nut in a Car Hoist System requires replacement due to wear. The controls shall allow the lowering motion of hoists to remove cars at floor level. Once the lower limit switch on the hoist is activated, all motion is locked out. As a precaution, an additional "redundant" switch is provided and activates if the regular lower limit switch should

fail.

K. Car Hoist with Spinning Post:

1. These car hoists shall be identical both mechanically and electrically to the car hoist described within this specification.
2. Wheel spinning posts shall occupy the space between the rails on the car hoist. They shall be anchored to the floor below on the same level as the car hoist bases.
3. Wheel spinning posts shall be counter-weighted columns that can be manually pivoted from a horizontal storage position to a locked vertical position.
4. In the storage position, the spinning post shall be concealed beneath hinged portions of the floor plate.
5. An internal locking pin shall be provided to hold the spinning posts in a vertical position.
6. Aluminum adapter beams are to be provided for placement between the vertical spinning posts to hold the car at the truck jacking pad locations.

2.03 BODY HOISTS/BODY SUPPORTS

A. General:

1. The body hoist/support shall be operated by a mechanical drive system that is automatically self-locking at any elevation and requiring power to raise or lower. The drive system shall be contained completely below shop floor level and the top of the support will be flush with the floor in the lowered position. Clearance shall be provided between the raised body supports so as to allow passage of a disconnected truck. The body supports shall be utilized for load support and can be used to raise or lower a transit vehicle at their jacking pads.

B. Performance

1. Each group of body hoists/supports shall be capable of supporting the transit vehicle with a safety factor of not less than 5: 1 based on the ultimate strength of the materials for Mechanical Components. Structural Components allowable stresses and loadings shall be based on those specified in the AISC (ASD) 9th edition with the appropriate dynamic load factors applied.
2. The total travel of the body supports shall be approximately 90 inches. Lifting and lowering speed will be approximately 4.5 feet per minute.
3. The maximum variation in level between body supports supporting a transit vehicle shall be 1/2 inch with respect to the body support on the opposite side of the transit vehicle and 1 inch over all for a married pair.

C. Body Hoists/Support Frame Base:

1. The frame base is the structural weldment which supports all other structural members and drive machinery. It shall be mounted on steel beams supported by the foundation floor slab.

D. Body Hoists/Support Frame:

1. The frame shall be the structural machinery mount and housing for all screw jack machinery and column mast guidance equipment.
2. A screw shall be mounted to the support frame. The screw jack shall be designed to lift/lower the dead load consisting of the body support column mast with head assembly. A limit switch located in the body support head will shut down the hoist motor upon contact with a load, i.e., transit car jacking pad. The basic components of the Body Hoist/Support shall consist of the hoist motor, input shaft coupling,

- gear case, lifting screw and hoist nut.
3. Support Motor. The hoist/support shall be driven by a squirrel cage motor reducer with a brake. The motor reducer shall be totally enclosed, non-vented heavy duty and equipped with shielded sealed bearings. Motor will be NEMA "D" design, Class "H" insulation not to exceed Class "B" temperature rise for 15 minutes rating. The motor reducer shall have a single extension shaft to couple the reducer shaft to the screw. The motor reducer shall be horizontally mounted and bolted to the body support frame.
 4. Couplings. The motor reducer shall be coupled to the screw by a flexible coupling.
 5. Gear cases/Lifting screws. The gear case input shaft shall be coupled to the hoist motor. The input shaft shall be from alloy steel on which is an integrally machined and ground steel worm. The worm shall mesh and drive a high tensile bronze worm gear. The worm gear shall be keyed to the lifting screw at the upper base. The lifting screw shall be a Buttress Thread Design and be self locking (load or no load). It shall be machined from heat treated alloy steel. The Buttress Screw shall have a pitch diameter of 3 1/2" inches with an inside diameter of 3 1/16" and an outside diameter of 3 15/16 inches. The worm gear will rotate on antifriction roller bearings. The lifting screw which is suspended from the gear case vertically will rest and rotate on tapered thrust roller bearings. The gear case shall be lubricated with the gear case housing manufactured from a ductile iron, machined casting. The gear case shall be rated for the horsepower of the hoist motor. The gear case will be mounted inverted rotating. It will be attached to the body support frame by mounting bolts.
 6. Hoist Nut. The hoist nut shall be machined from nonferrous material. It will be compatible and travel (raise/lower) on the rotating Buttress Threads of the lifting screw. The nut shall bear against and be locked from rotation by the lifting bracket, attached to the base of the column mast. The lifting bracket shall be bolted to the column mast. The nut shall be designed to provide minimum wear when subjected to maximum stress conditions.

E. Guide System:

1. The Body Hoist/Support shall be provided with a positive guide system. The system shall provide guidance and stability of the column mast, in all directions, during raising/lowering/static modes. The system shall be designed to transfer all eccentric or side loading, imposed on the column mast into the body support frame, leaving the lifting screws subjected to compressive loads only.

F. Column Mast

1. The column mast shall be designed and located to allow a disconnected truck to pass through and between the column masts, with the masts in a raised position.
2. The head attached to the top of the column mast shall have adequate extension to reach under and provide proper bearing area to the jacking pad of the Transit car.
3. A lifting bracket shall be bolted to the base of the column mast. The lifting bracket shall serve as the attachment of the lifting screw/nut which raises/lowers/supports the column mast.
4. Column Mast Support shall be designed to endure all compressive loads of the column mast when in a lowered position. The structural support shall be located on centerline with the column mast. It's elevation shall be adjustable with shim placed between the hoist support frame and steel beams supported by the foundation floor slab. The base of the column mast shall be in bearing against the top of the support when the mast is at its lower travel and the top surface of the mast shall be level with the shop floor/pit cover. The Body Hoist/Support shall be shimmed for elevation

and bolted to its support beams.

G. Design:

1. The design shall protect against damage due to the lifting nut running past limit switches. Each Body Hoist/Support shall have operating upper and lower limit switches which limit travel of the column mast. All limit switches shall be actuated by a limit switch trip. The lifting screw shall also have a nut run off area at the lower end of the screw to disengage the nut from further lowering. At such time of over travel, the lifting screw can rotate without either raising or lowering the column mast. This condition shall not cause any damage to the lift equipment. The limit switch must them be inspected/reset before the lift system can be placed back in operation. There shall also be a load sensing switch to prevent raising or lowering of the column mast with a live load contacting the column mast head.

H. Maintainability.

1. Hoist Motor. The motor shall be removable by removing pit cover, disconnection of the mounting bolts and motor couplings, without disturbance to other components.
2. Gear cases/Lifting screws. A gear case/lifting screw shall be removable from the pit by removing pit cover; lowering column mast on cribbing (approximately twelve inches thick) placed between the bottom of the mast and the lower column mast support; removing lifting nut from end of lifting screw; disconnection of motor coupling; removal of gear case mounting bolts. External lifting devices shall only be required for lifting pit cover and gear case/lifting screw, from pit.
3. Lifting nut. Removal/replacement of lifting nuts will be accomplished by lowering column mast onto cribbing (approximately twenty four inches thick) placed between the bottom of the mast and the pit floor and rotating hoist nut off lower end of lifting screw.

2.04 PIT COVERS AND ACCESS COVERS

- A. The main pit cover and body hoist/support pit covers shall be provided. Pit edge configuration will be as shown on the drawings. Pit covers shall be 3/8" floor plate and designed to support a concentrated load of 4,000 pounds, distributed as though it were imposed by the wheel of a fork lift truck having an imprint not less than 6 inches in diameter. Pit covers shall be in place at all operating heights. Gaps between the pit covers and the floor shall not exceed 1/2 inch.

2.05 CONTROL AND POWER WIRING

A. Power Supply:

1. The motor control center, master control station and remote control stations shall be furnished complete. All non embedded conduit and interconnecting wiring shall be provided.

B. Control Arrangement:

1. A master control station shall be provided for the de-trucking system. The master control station will contain constant pressure type push button switches to operate hoists in unison for raising the transit vehicle. Selector switches, various indicator and pilot lights and push button controls as detailed in the following will be provided.

C. Master Control Station:

1. The master control station shall be a floor mounted pedestal type with the control panel surface inclined at an angle of approximately 30 degrees from horizontal.
2. The wiring enclosure will be a NEMA 12 type with a hinged cover. An engraved legend plate shall be laminated gray plastic with black lettering attached to the enclosure cover. Control devices mounted in the cover shall be shop wired, bundled and wired to a terminal strip mounted to a stand-off panel in the enclosure.
3. The master control station panel will include control devices with suitable legends as follows:
 - Car Hoists with Body Hoists Master Control Station -
 - a. "Hoist Power On/Off" Selector Switch.
 - b. "Body Hoists normal/Bypass" Selector Switch.
 - c. "Car Hoists Remote" Push Button (momentary).
 - d. "Body Hoists Remote" Push Button (momentary).
 - e. "Car Hoists Up" Push Button (momentary).
 - f. "Car Hoists Down" Push Button (momentary).
 - g. "Body Hoists Up" Push Button (momentary).
 - h. "Body Hoists Down" Push Button (momentary).
 - i. "Malfunction Light" (red).
 - Car Hoists Master Control Station -
 - a. "Hoist Power On/Off" Selector Switch.
 - b. "Car Hoists Remote" Push Button (momentary).
 - c. "Car Hoists Up" Push Button (momentary).
 - d. "Car Hoists Down" Push Button (momentary).
 - e. "Malfunction Light" (red)
4. Operational and Interlock Design Parameters:
 - a. Interlocks shall be provided to allow the lowering of a single car hoist only when the transit vehicle is supported by body supports.
 - b. Interlocks shall be provided to allow the body supports to operate only when the car weight is removed from the body supports.

D. Remote Control Stations:

1. Remote control stations shall be floor mounted "swing-up" type with the control panel surface inclined at an angle of approximately 30 degrees from horizontal.
2. The Remote Control Stations shall include control devices with suitable legends as follows:
 - Car Hoists with Body Hoists Remote Control Station -
 - a. "Hoist Power On/Off" Selector Switch.
 - b. "Car Hoist Up" Push Button (momentary).
 - c. "Car Hoist Down" Push Button (momentary).
 - d. "Body Hoist Up" Push Button (momentary).
 - e. "Body Hoist Down" Push Button (momentary).
 - Car Hoists Remote Control Stations -
 - a. "Hoist Power On/Off" Selector Switch.
 - b. "Car Hoists Up" Push Button (momentary).
 - c. "Car Hoists Down" Push Button (momentary).

3. The wiring enclosure shall be NEMA 12 with a hinged cover. An engraved legend plate shall be attached to the enclosure cover. Control devices mounted in the cover shall be shop wired bundled and wired to a terminal strip mounted to a stand-off panel in the enclosure.

E. Motor Control Center:

1. The Motor Control Center (MCC) which shall be free standing, equipped with 600 Amp horizontal and 300 AMP vertical bus bar and having a NEMA 12 hinged cover type electrical enclosure. The motor control center shall include an externally operated disconnect switch, control circuit transformer, Programmable Logic Controller (PLC) (master relay panel) and circuit breakers. A hinged shelf shall be included for setting the lap top computer on. Devices will be completely internally wired to a terminal strip with wires properly numbered to correspond to the electrical diagrams. Wiring shall be completed in a neat workmanship like manner using wiring troughs and wire bundles for cover devices.
2. NEMA type C wiring will be provided. Disconnects shall be motor circuit protectors.
3. The MCCs shall be provided with a ground buss with motor ground terminals.
4. All logic circuitry shall be handled by means of a Programmable Controller. The Programmable Controller will be microprocessor-based General Electric Fanuc 9030 and of sufficient memory size to incorporate all logic controls. The controller will retain current position memory in the event of a power failure with a EEPROM. The unit will incorporate status lights to indicate the on or off conditions of any input or output device, such as limit switches, motor starter coils, etc. to facilitate trouble shooting along with a Data Panel Model 160 detailing the fault. Two spares of the following are required for each model logic controller used: I/O rack, CPU, Input Module, and Power Supply.
 - a. A Portable (Lap Top) Computer capable of reading and displaying circuit condition will be furnished. It can be used for trouble shooting and reprogramming if needed.
5. Operational and Interlock Design Parameters:
 - a. The drop out of a single motor starter, when being used in conjunction with another starter in the operation of either the car hoist system or the body support system will cause the other starter to drop out and thereby shut the system down.
 - b. Operation of any over travel limit switch, raising or lowering, shall automatically shut down the entire hoist and body support system. A "malfunction" pilot shall indicate location of the over travel.
 - c. Electrical push button, selector switches and pilot light devices shall be the heavy duty oil tight machine tool type.
 - d. Motor Starters: Individual motor starters shall be supplied for each motor within the free standing motor control center. The starters shall be a proper size AC. reverse combination starter with motor circuit protector assembled in a NEMA 12 enclosure.

F. Warning Devices:

1. A warning bell, audible within the shop will sound when any motor in that pit is energized for lifting or lowering operation.

G. Negative Return Bonding:

1. Structure Return Current Connections: The running rails of the car hoists shall be at

the same potential as the running rails embedded in the adjacent shop floor at all times. Two (2) 500 MCM insulated flexible copper cables shall be used to connect the car hoist running rails to the adjacent embedded running rails.

H. Isolation:

1. Structure Electrical Isolation: The car hoist structure, guides, control, power and transmission equipment shall be electrically isolated from the car hoist running rails and all embedded shop track running rails at all times.

I. Grounding:

1. Electrical Equipment Grounding: No hoist or support electrical equipment will be grounded through its attachment to the hoisting equipment or hoist equipment embeds. Case grounding will be through a continuous ground wire in a nonmetallic conduit or flexible liquid tight wiring conduit with an integral copper ground wire. The grounding network shall be terminated on the motor control center ground buss.

2.07 PAINT AND FINISH

A. Painting:

1. All equipment, apparatus, piping, enclosures, structural framing and supports, conduits and related items to the equipment shall receive a shop prime coat and two finish coats of equipment enamel paint. All surfaces shall be clean of rust, scale, dirt, grease, and oil before painting.
2. Each coat shall be a minimum of 5 mils dry film thickness.
3. The motor control center and master control station enclosures shall be manufacturers standard finish.

PART 3 - EXECUTION

3.01 FABRICATION

- A. Fabrication shall be in accordance with the contract specifications. Proposal and approved shop drawings for each product specified herein,

3.02 FACTORY TEST:

- A. Functional testing shall be performed for each product specified herein. Tests will be performed per printed testing procedures and instructions.

3.03 INSPECTION:

- A. A factory representative shall be responsible for a pre-installation inspection of the work site to determine acceptable site conditions before starting to install equipment. Any unsuitable deficient site conditions pertaining to the equipment installation shall be documented at that time and corrected by the General Contractor and verified as corrected before installing the equipment.

3.04 FIELD SERVICE:

- A. A factory representative shall supervise all field installation, testing and adjusting of the car hoist and body support system. He shall perform the pre-installation inspection of the site to

determine its acceptability and conduct, the operation and maintenance training..

3.05 ERECTION:

- A. Mechanical and Electrical Installation shall be in accordance with approved shop drawings and under direct supervision of the field service representative.

3.06 FIELD ACCEPTANCE TESTING:

- A. Notify the Engineer five days prior final testing.
- B. The Authority shall furnish a coupled-pair of transit cars and one transit car truck to be used in testing the equipment.
- C. The Contractor shall furnish all test equipment and personnel to perform tests. The Authority will furnish the electrical power.
- D. Test each component through five cycles of operation before testing groups of components. Test components using transit car equipment through five cycles of operation or until approved. Perform final testing with transit car equipment only after satisfactory operation of all hoisting and related components is attained.

3.07 TRAINING:

- A. Instruction of the Authority's personnel for a maximum of 1 working day (8 hours) as to start-up, operation, shut-down and maintenance of the equipment will be provided.

3.08 OPERATION AND MAINTENANCE MANUALS:

- A. Operation and maintenance manuals will be furnished with the following sections.
 - 1. Operation
 - 2. Inspection
 - 3. Lubrication
 - 4. Adjustments
 - 5. Component Removal and Installation
 - 6. Control Operation Theory
 - 7. Electrical Control Physical Schematics
 - 8. Cable and Conduit Diagrams
 - 9. Assembly Drawings with Parts Identified for Ordering purposes
 - 10. Parts lists

END OF SECTION

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SECTION 14200

HYDRAULIC ELEVATORS

PART 1-GENERAL

1.01 DESCRIPTION

- A. Provide 3500 lb. capacity, 125 fpm speed, passenger hydraulic elevator.
- B. Furnish interior cab walls and ceiling panels, door panels, hoistway entrance frames, call buttons and hall lanterns with a satin stainless steel finish.
- C. Provide epoxy flooring coating in cab. The elevator installation and design shall conform to ADAAG and local regulatory requirements and to the manufacturer's standard written specifications.
- D. Provide manufacturer's written warranty for repair service of 12 months from date of Substantial Completion and a continuing maintenance proposal starting on date initial warranty period is concluded.
- E. Provide PVC pipe casing complying with ASME A17.1 for in-ground protective cylinder casing.
- F. Provide emergency communication system, complying with ASME A17.1 and ADAAG, that dials preprogrammed number on activation.
- G. System to provide two-way voice communication and visible signals that indicate when system has been activated and when monitoring station has responded.
- H. Provide PLC Allen Bradley SLC 503 elevator controller and Allen Bradley Panelview 550 annunciator panel.
- I. Software protocols shall be provided to simultaneously transmit fault finding annunciator data to the Authority's AEMS central computer, via an RS232 connection using an Allen Bradley DF1 protocol and Allen Bradley 1770-KF3 communication interface module. Annunciator panel shall be equipped with hardware required for downloading data to a laptop PC.
- J. Coordinate specific remote elevator reporting system requirements and other elevator operation requirements with the Authority's Representative.

1.02 SUBMITTALS

- A. Elevator manufacturer shall submit product data, shop drawings, samples, manufacturer certificates, maintenance and operations manuals for WMATA review.

1.03 TRAINING

- A. Instruct Authority's personnel in proper use, operations, and daily maintenance of elevators.
- B. Train Authority's personnel in procedures to follow in identifying sources of operation failures or malfunction.

PART 2-NOT USED

PART 3-NOT USED

END OF SECTION

SECTION 14401
OVERHEAD CRANE

PART 1 - GENERAL

RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract apply to this section.
- B. Related Sections include Section 11001, Equipment General Requirement.

1.01 DESCRIPTION:

- A. This section specifies the design, fabrication, furnishing, and installation of cranes with built-up ER hoist/trolley and subject package hoist and jib crane design.

1.02 QUALITY ASSURANCE:

- A. Manufacturer Requirements:
 - 1. Furnish electric overhead & jib cranes and hoist manufactured and designed as approved by WMATA's engineering, operation and maintenance departments.
 - 2. Minimum expected half life of this equipment shall be 25 years. All equipment furnished shall be heavy duty, industrial type.
 - 3. The Engineer reserves the right to inspect materials and their sources, workmanship, and construction methods at any time, at the Manufacturer's shop or fabricating facility. The Engineer further reserves the right to be present for any or all shop tests of components, assemblies, or systems. The Manufacturer shall notify the Engineer two (2) weeks in advance of any tests.
 - 4. Manufacturer's Compliance:
 - a. All factory wired control panels shall be tested for operation, as specified herein, and submitted to Underwriters Laboratories Inc., for inspection, approval, and labeling.
 - b. Nameplates: Nameplates shall be securely attached, by mechanical means, in a prominent location on each major item of equipment.
 - 5. Qualification of Manufacturer: Manufacturer shall be reputable and regularly engaged in the design and manufacture of the type of equipment specified herein. Assembled components, purchased by the Manufacturer for this Contract, such as motors, gear boxes, electrical devices, etc., shall be the standard products of qualified manufacturers. All similar items shall be the products of a single manufacturer. Prior to approval of the Manufacturer's proposal for the cranes, the Manufacturer shall submit to the Engineer the following information:
 - a. A list of crane & hoist, of his manufacture, similar in usage, where the proposed equipment has been in service, including the duration of service.
 - b. Name of contact person at each installation submitted above, who is familiar with the operation and maintenance of all hoisting equipment provided by the Manufacturer.
 - c. The cranes and hoists shall meet the Federal Transit Administration Buy America Clause for equipment installed in an existing maintenance shop.
 - d. The manufacturer of the cranes & hoists shall be ISO-9001 and QS-9000:98 TE Supplement certified and registered. The manufacturer must

submit with the bid response proof that it has implemented and maintains a quality system that fulfills the requirements of the ISO-9001 and the QS-9000 TE Supplement in the form of a certificate documenting registration from an ANSI-RAB accredited registrar.

- e. Based on the information supplied, and discussions with the contact persons named, the Engineer will determine the acceptability of the proposed Manufacturer and equipment.

- B. Furnish manufacturer's standard quality assurance program to the authority for approval.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the requirements set forth in the General Requirements, and with the additional requirements as specified for each.
- B. Shop Drawings: In accordance with the General Requirements, submit six (6) copies of complete shop drawings to the Authority for approval, including but not limited to:
 - 1. Crane general arrangements.
 - 2. Assembly and subassemblies
 - 3. Wiring diagrams.
 - 4. Installation Instructions / Drawings.
- C. Operations and Maintenance Manual: Submit in accordance with the requirements of the General Requirements.
- D. Operations and Maintenance Training: Submit in accordance with the requirements of the General Requirements.
- E. Contract Record Drawings: Submit in accordance with the General Requirements.

1.04 TRAINING:

- A. Contractor is responsible for training as outlined in Section 01820, Demonstration and Training and Section 11001, Equipment General Requirements.
- B. Number of Personnel To Be Trained And Class Size for Jib Cranes:

Level Of Training	Approximate Number of Individuals	Maximum Class Size	Minimum Number of Classes
Level I	24	8	3
Level II	8	4	2
Level III	0	0	0

Number of Personnel To Be Trained And Class Size for Bridge Cranes:

Level Of Training	Approximate Number of Individuals	Maximum Class Size	Minimum Number of Classes
Level I	24	8	3
Level II	4	4	1
Level III	4	4	1

C. Levels of Training:

1. Level I: Familiarizing Training
2. Level II: Training for P&E Personnel
3. Level III: Programming Training

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship equipment upon notification by the Engineer.
- B. Package, to prevent damage during shipping.

1.06 APPLICABLE CODES:

ABMA	American Bearing Manufacturers Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	The American Society of Civil Engineers
ASME	The American Society of Mechanical Engineers
ASTM	American Society for Testing & Materials
AWS	American Welding Society
CMAA	Crane Manufacturers Association of American, Inc.
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers Association
OSHA	U.S. Department of Labor, 29 CFR Part 1910 - Occupational Safety & Health Standards for General Industry

1.07 WARRANTY

- A. Furnish warranty for the work in this section in accordance with the General Conditions

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Equipment: As follows:

1. Electric Overhead Traveling Cranes with Built-Up Hoists
 2. Hoist Units
 3. Jib Cranes
- B. Equipment to include all controls, enclosures, wiring, motors, structural members, and all items customarily related to the cranes and hoists.
 - C. All bearings, gears and pinions inside of gearcase are oil splash lubricated. Lifetime lubrication on all other bearings.
 - D. Equipment-Mounted Conduit: UL-listed.
 - E. Equipment Wiring and Cable: UL-listed.
 - F. C-track style festoon mounted off of B girder. Each crane includes an Electromotive SBP style pendant station mounted on a C-track. The system is designed to minimize field connections. Festoon cable is one continuous run from the P.B. junction box to the control panel mounted on the "A" girder.
 - G. Motors: Manufacturer's standard, conforming to NEMA MG-1, suitable for the intended purpose, and with electrical characteristics compatible with the building's electrical system.
 - H. Finish: Equipment Manufacturers standard - safety yellow..
 - I. Fasteners: Standard with the manufacturer.
 - J. Bridge Cond.: C-track style festoon, mounted off of B girder with standard level supports. Tow chain between trolleys helps eliminate stress on the cables. The system is designed to minimize field connections. Festoon cable is one continuous run from the trolley junction box to the control panel mounted on the "A" girder. Encoder cable is one continuous run from the hoist motor to the control panel.
 - K. Special Tools: Furnish one set of all special tools required for inspection, adjustment, maintenance and repair. Special tools are defined as those developed to perform a task unique to the equipment furnished and which are not available from commercial sources.
 - L. Wiring: Internal factory wiring of equipment: Manufacturer's standard.

2.02 DESIGN REQUIREMENTS:

- A. General: Manufacturer shall design and fabricate the equipment and controls to conform to these specifications and the dimensions and clearances indicated on the contract drawings. Manufacturer shall verify with the Engineer, the exact working dimensions, weights, and clearances of the transit car truck and related items for which crane and hoist will be designed to service. All cranes shall be designed for CMAA class "D" service. Monorail hoists and jib cranes to H4.
- B. Equipment Capacities & Features: Each crane & hoist shall be capable of lifting the rated capacity of the crane or hoist with a safety factor of not less than 5:1 on the rope based on the ultimate strength of the rope. Structural components allowable stresses and loadings shall be based on those specified in the CMAA specification #70.

C. ER Bridge Built Up Crane

1. GIRDERS : All girders are designed per CMAA standards. Wide Flange Beams with reinforcement plates mounted on inside of girders for added strength, when required. Up to 60'-0 span and welded box section with A36 steel over 60'-0 span.
2. BRIDGE RAILS: ASCE 30# rail. Rails are center mounted, held in place with opposing rail clips welded on 3'-0" centers. Rail splices when necessary, fall over an internal diaphragm. Anti-creep bars are welded to rail ends.
3. TRUCKS : Structural tube sections with flange cartridge bearing assemblies, mounted on plates which are welded to the tube trucks. Plates are machined in-line after all welding is complete to ensure proper alignment. Drop bars, rail sweeps, and polyurethane bumpers designed per CMAA standards are included. Bridge wheels R.S.R.T., double flanged, tapered tread design. Driver axles are key fit, idler axles are press fit.
4. BRIDGE DRIVES: CMAA A-4 drive arrangements, torque arm supported gear-motors hollow-shaft mounted to the drive axle extension shafts. Minimum 1.4 Service Factor for all units. Inverter Duty Squirrel Cage motors, TEFC, 1800 RPM, with Class H insulation. Minimum 10,000 hour bearing life, Unicase gray cast Iron construction (SAE Class 30), Helical gearing in compliance with ANSI/AGMA standard 2001-B88, Gears are Carburized to a hardness of 58-62 Rockwell. Double lip oil seals on output shafts, captured keys, and each unit includes oil level sight glasses as standard.
5. DRIVE WALK: Checkered plate full-length, 4 in. min. toe board and 42 in. handrail with intermediate rail.
6. IDLER WALK : Checkered plate min. 12 ft long, 4 in. min. toe board, and 42 in. handrail with intermediate rail.
7. BUMPERS : Four (4) polyurethane-type, mounted on end trucks with safety cables.
8. COLLECTORS : Crane is shipped with three (3) tandem shoe collectors. Collector staff is designed for mounting below bridge trucks. (Insul-8 or equal). A fourth conductor can be furnished for grounding.
9. RUNWAY COND. GUARD: Crane is provided with one (1) pipe-type guard to protect runway conductors from a swinging hook.

D. BUILT-UP TROLLEY SPECIFICATIONS

1. FRAME: Built-up type, structural steel channel-type trucks, tube-type load girt, sheave nest (15-30 ton) mounted above deck for ease of maintenance and flanged cartridge wheel bearing assemblies.
2. HOIST GEARCASE: Model #20ER, cast iron, horizontally mounted, horizontally split, triple reduction with helical gearing on 1st 2 reductions; spur gearing for final reduction (4340 material). Ball bearings exceed CMAA Class D B-10 life. Gearcase has oil level dip stick, and gearing inspection cover. Gearcase without mechanical load brake.
3. HOIST BRAKE: AC shoe-type, self adjusting, solenoid actuated rated to 125% motor torque. Primary braking is via flux vector control with dynamic braking resistors.
4. DRUM: 12-3/8" diameter, schedule 160 seamless steel pipe.
5. REEVING: 4 parts double reeved. All reeving has two parts off drum for true vertical lift. Running sheaves are 12" P.D. (Ball bearings). Equalizer sheave is 8" P.D. (Bushing when used).
6. ROPE: 1/2" EIPS-IWRC 6 x 37 construction, 2 dead wraps on drum.
7. BLOCK: Semi-enclosed, close guarded, steel construction, with Crosby single barbed hook, mounted on a thrust bearing provided full 360 degree rotation. Sheaves

- are 12" P.D. with ball bearings. Heavy duty hook latch provided as standard.
8. WHEELS: 4 wheels - 8 inch Forged Steel - Rim Toughened. Wheels are straight tread.
 9. TROLLEY DRIVE: Mounted at one end, torque arm supported gearmotor hollow shaft mounted to the drive axle extension shaft. Minimum 1.4 service factor for all units. Inverter duty squirrel cage motors, TEFC, 1800 RPM, with Class 'H' insulation. Minimum 10,000 hour bearing life, unicase gray cast iron construction (SAE Class 30), helical-bevel gearing in compliance with ANSI/AGMA standard 2001-B88. Gears are carburized to a hardness of 58-62 Rockwell. Double lip oil seals on output shaft. Captured keys and unit includes oil level sign glass as standard.
 10. BUMPERS: Four (4) spring type, mounted on bridge.
 11. TOW ARM: Towing arm with junction box and terminal strips provided on trolley.
 12. LIMIT SWITCH: Control circuit weight type paddle limit switch for upper hoist travel limit is standard. Plus upper/lower screw type included.

E. ELECTRICAL PROPOSAL SPECIFICATIONS

1. HOIST MOTOR: Vector duty, squirrel cage motors, foot mounted, single shaft, rated 60' duty, 1800 RPM, TENV with Class 'H' insulation and 1024 PPR encoder.
2. TROLLEY MOTORS: Inverter duty, squirrel cage gear motors, integral mounted, rated continuous duty, 1800 RPM, TEFC, with Class 'H' insulation, with integral mounted DC disc brake.
3. HOIST CONTROLS: Flux vector controls with heavy duty dynamic braking resistors, brake contactor, swift lift (125% of nominal full load speed @ < 10% loads) and load float capabilities.
4. TROLLEY CONTROLS: Variable frequency controls with heavy duty dynamic braking resistors, brake contactor, reverse plugging simulation.
5. MAINLINE CONTROL: Each crane is furnished with a thru door type Fused Manual Magnetic Main line Disconnect switch, 750 Kva Transformer. Each motion includes fused line protection. All controls are mounted in a single NEMA12, lighted enclosure (lights on when door opens). Panel includes 3% line reactor to filter incoming power to all drives.
6. POWER: All cranes are designed for 3 phase, 60 hz, 460v nominal incoming power.

F. SPECIAL FEATURES

1. Application: Crane is designed for indoor CMAA Class D service.
2. Controls: Crane utilizes State-of-the-Art Flux Vector Hoist controls and VFD bridge and Trolley controls.
3. Crane Lights: Lights mounted on swing up supports on footwalk(s).
4. Jacking Pads: Jacking pads mounted on end trucks to facilitate wheel changes included.
5. Bumper Extensions: Bumper extensions to crane extremes included.
6. Warning Horn: Warning horn activated by bridge motion or push button included.
7. Flashing Light: Red flashing light activated by crane power or bridge motion included.
8. Radio Control: Stepless radio control system with Belly-box transmitter. System includes total isolation radio/pendant transfer switch, and externally mounted antenna. System includes spare transmitter. System includes charger and spare rechargeable battery.

2.03 GENERAL

- A. Design Criteria: All crane parts shall equal or exceed design criteria as established by C.M.A.A. specification #70.
The crane proposal should cover equipment which complies with the manufacturer's interpretation of the mandatory requirements of the William-Steiger Occupational Safety & Health Act of 1970 (OSHA) as amended June 27, 1974.
Mounting of control panels will provide for 30" minimum clearance in front of cabinets to comply with 1978 NEC Section 610.57
Floating rails shall not be used for runways. Rails shall be held firmly in all directions.
- B. Drawings: Crane manufacturer shall submit three (3) prints of standard crane general arrangement drawings for approval. These drawings shall show all critical clearance dimensions and other data that is pertinent to design and construction.
- C. Assembly: Crane shall be assembled at Manufacturer works, marked for reassembling, and taken apart sufficiently for proper handling and shipment. The manner and extent the crane is broken down for shipment is at the sole discretion of crane manufacturer.
- D. Painting: The crane will be cleaned and painted using a rust inhibiting primer, and a finish coat of yellow Ferrite Pigment type enamel.
Nuts, bolts, washers and piping shall be painted, or cadmium or zinc plated. Electrical equipment and purchased components will be furnished with manufacturer's standard finish.
- E. Notification of Inspection: Crane manufacturer shall provide advance notice, as required by the contract, when equipment will be ready for inspection. The following notification procedure shall be provided:
When a single inspection is required (usually of the no-load running test), crane manufacturer shall establish a tentative date for this inspection and notify the customer accordingly.
Within forty-eight (48) hours of the tentative date, crane manufacturer will confirm or revise the exact date of inspection.
When numerous inspections are required (e.g. running test, paint, loading), crane manufacturer shall give prior notice per contract requirements of a designated inspection period - approximately two (2) weeks - during which crane manufacturer shall require the inspector available on forty-eight (48) hour notice. Failure of the inspector to be present on the scheduled inspection date, or make other arrangements mutually agreed upon, shall constitute a waiver of the requirement and work/or shipment will proceed. In the event that inspection has been waived, shipment shall not be rejected at the site by owner due to lack of shipping release. Such waiver shall not relieve crane manufacturer in any way from its obligation under the contract.
- F. Storage of Equipment: The equipment shall be stored indoors in a heated and dry building. The equipment should not be stored for more than thirty (30) days.

2.04 PAINTING:

- A. Painting: All equipment, apparatus, piping, enclosures, structural framing and supports, and related items to the equipment shall receive a shop prime coat and two finish coats of equipment enamel paint. All surfaces shall be clean of rust, scale, dirt, grease, and oil before painting.

- B. Each coat shall be a minimum of 2 mils dry film thickness.

2.05 FABRICATION:

- A. Fabricate in accordance with approved shop drawings.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All crane rail shall be installed by the building contractor.
- B. Install equipment in accordance with approved shop drawings.
- C. Ensure that all equipment is ready for checkout and startup by the manufacture.
- D. Touch-up damaged areas of factory-finished surfaces, using the same paint materials.

3.02 TESTING:

- A. Notify the engineer five days prior to shop no-load testing.
- B. The authority will furnish test weight to be used in load testing the equipment.
- C. The building / installation contractor shall furnish all test equipment and personnel to perform tests. The authority will furnish the electrical power.
- D. **Rated Load Testing:** Pursuant to the latest edition and interpretation of the Occupational Health and Safety Administration (OSHA) Regulation, 29 CFR § 1910.179 (k), each independent hoisting unit of a crane shall be given a rated load test not to exceed 125%, but no less than its rated load prior to putting the crane into service. The form of the rated load test is to be in accordance with requirements of the latest edition of OSHA regulation, 29 CFR § 1910.179 (k). A report of the rated load test is to be placed on file at a location accessible to the personnel assigned responsibility for the crane by the crane's owner. A rated load test is required for all new cranes.

It is the responsibility of the crane owner to ensure that a rated load test is performed and a report of said test is made and on file.

END OF SECTION

SECTION 14520

TRUCK REPAIR HOIST TWO (2) SCREW DEEP PIT DESIGN

PART 1 - GENERAL

RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract apply to this section.
- B. Related Sections include Section 11001, Equipment General Requirement.

1.01 DESCRIPTION:

- A. This section specifies the design, fabrication, furnishing, and installation of twelve (12) complete and operable two (2) screw deep pit truck repair hoists as specified herein.

1.02 QUALITY ASSURANCE:

- A. Manufacturer Requirements:
 - 1. Furnish Truck Repair Hoists manufactured and designed as approved by WMATA's engineering, operation and maintenance departments.
 - 2. Minimum expected half life of this equipment shall be 25 years. All equipment furnished shall be heavy duty, industrial type.
 - 3. The Engineer reserves the right to inspect materials and their sources, workmanship, and construction methods at any time, at the Manufacturer's shop or fabricating facility. The Engineer further reserves the right to be present for any or all shop tests of components, assemblies, or systems. The Manufacturer shall notify the Engineer two (2) weeks in advance of any tests.
 - 4. Manufacturer's Compliance:
 - a. All factory wired control panels shall be tested for operation, as specified herein, and submitted to Underwriters Laboratories Inc., for inspection, approval, and labeling.
 - b. Nameplates: Nameplates shall be securely attached, by mechanical means, in a prominent location on each major item of equipment.
 - 5. Qualification of Manufacturer: Manufacturer shall be reputable and regularly engaged in the design and manufacture of the type of equipment specified herein. Assembled components, purchased by the Manufacturer for this Contract, such as motors, gear boxes, electrical devices, etc., shall be the standard products of qualified manufacturers. All similar items shall be the products of a single manufacturer. Prior to approval of the Manufacturer's proposal for the Truck Repair Hoists, the Manufacturer shall submit to the Engineer the following information:
 - a. A list of truck repair hoists, of his manufacture, similar in usage, where the proposed equipment has been in service, including the duration of service.
 - b. Name of contact person at each installation submitted above, who is familiar with the operation and maintenance of all hoisting equipment provided by the Manufacturer.
 - c. The truck repair hoists shall meet the Federal Transit Administration Buy

- d. America Clause for equipment installed in an existing maintenance shop. The manufacturer of the truck repair hoists shall be ISO-9001 certified and registered. The manufacturer must submit with the bid response proof that it has implemented and maintain a quality system that fulfills the requirements of the ISO-9001 in the form of a certificate documenting the most recent quality audit and report.
- e. Based on the information supplied, and discussions with the contact persons named, the Engineer will determine the acceptability of the proposed Manufacturer and equipment.

C. Furnish manufactures standard quality assurance program to the authority for approval.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the requirements set forth in the General Requirements, and with the additional requirements as specified for each.
- B. Certificates: Fourteen days prior to shipment, submit four copies of certification that equipment to be delivered is in compliance with applicable codes as follows:

AGMA	American Gear Manufactures Association
AISC	American Institute of Steel Construction
AREA	American Railway Engineering Association (Allowable Material Stress Value for Steel Structures)
ASTM	American Society for Testing and Materials (Material Specifications - ASTM A-36)
AWS	American Welding Society
NEC	National Electric Code
NEMA	National Electrical Manufactures Association

- C. Shop Drawings: In accordance with the General Requirements, submit six (6) copies of complete shop drawings to the Authority for approval, including but not limited to:
 - 1. Equipment arrangement.
 - 2. Equipment outline dimensions.
 - 3. Assembly and subassemblies
 - 4. Wiring diagrams and schematics.
 - 5. Installation Instructions.
- D. Operations and Maintenance Manual: Submit in accordance with the requirements of the General Requirements.
- E. Operations and Maintenance Training: Submit in accordance with the requirements of the General Requirements.
- F. Contract Record Drawings: Submit in accordance with the General Requirements.

1.04 TRAINING:

- A. Contractor is responsible for training as outlined in Section 01820, Demonstration and Training and Section 11001, Equipment General Requirements.
- B. Number of Personnel To Be Trained And Class Size.

Level Of Training	Approximate Number of Individuals	Maximum Class Size	Minimum Number of Classes
Level I	40	8	6
Level II	8	4	2
Level III	8	4	2

- C. Levels of Training:
1. Level I: Familiarizing Training
 2. Level II: Training for P&E Personnel
 3. Level III: Programming Training

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship equipment upon notification by the Engineer.
- B. Package, handle and store to prevent damage.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Equipment: As follows:
 1. Truck Repair Hoists
 2. Motor Starter Panels
 3. Master Control Stations
 - a. In-floor Mounted Control Housings
- B. Equipment to include all controls, enclosures, wiring, motors, and structural members, and all items related to the truck repair hoists and in-floor mounted control housings.
- C. Automatic lubrication system to assure proper lubrication of the jack nuts and hoisting screws. Lubrication fittings shall be provided to service all other moving parts which are not sealed lubricated assemblies.
- D. All in-floor hoist equipment to be covered by checkered steel deck plate, permitting uninterrupted travel over the floor when equipment is in the down position.
- E. Piping and Tubing: Materials, sizes and fittings suited to the pressure and use for which they are intended.
- F. Equipment-Mounted Conduit: UL-listed.
- G. Equipment Wiring and Cable: UL-listed.
- H. Master Control Stations: Push button stations designed to permit single-station operation. Provide stations with all apparatus and controls. Housings for in-floor mounted Control Stations shall be provided by the manufacturer.

- I. Motors: Manufacturer's standard, conforming to NEMA MGI, suitable for the intended purpose, and with electrical characteristics compatible with the building's electrical system.
- J. Finish: Equipment Manufacturers standard - safety yellow..
- K. Fasteners: Standard with the manufacturer.
- L. Non-Shrink Grout: EMBECO or equal.
- M. Special Tools:
 - 1. Furnish one set of all special tools required for inspection, adjustment, maintenance and repair. Special tools are defined as those developed to perform a task unique to the equipment furnished and which are not available from commercial sources.
- N. Wiring:
 - 1. Internal factory wiring of equipment: Manufacturer's standard.

2.02 DESIGN REQUIREMENTS:

- A. General: Manufacturer shall design and fabricate the equipment and controls to conform to these specifications and the dimensions and clearances indicated on the contract drawings. Manufacturer shall verify with the Engineer, the exact working dimensions, weights, and clearances of the transit car truck and related items for which this hoist will be designed to service. All equipment shall be designed for a 4'-8-1/2" track gauge.
- B. Equipment Capacities & Features
 - 1. Each truck repair hoist shall be capable of supporting a transit vehicle truck with a safety factor of not less than 5:1 based on the ultimate strength of the materials for mechanical components. Structural components allowable stresses and loadings shall be based on those specified in the AISC (ASD)9th edition with the appropriate dynamic load factors applied.
 - 2. Truck repair hoists, designed to support, lift and lower the weight of a complete transit car truck. Each hoist load-rated at 12 tons.
 - 3. Checkered steel plate decks with deck support beams designed and positioned to support 300 lbs. per square foot uniform load and 4,000 lbs. concentration load at any point. All in-floor hoist equipment openings shall be closed by steel plate decks when hoist equipment is in a full down position permitting uninterrupted travel over the floor.
 - 4. Parts and components must be interchangeable with existing truck repair hoists at Brentwood, Alexandria, Shady Grove, West Falls Church, Branch Avenue and New Carrollton Shops.
- C. Equipment Travel:
 - 1. Truck Repair Hoists: Five feet total.
- D. Operating Speed:
 - 1. Lifting and lowering speeds of hoists: 4.5 feet per minute.
- E. Safety Features:
 - 1. Visual and audible indications that a hoist is in operation.
 - 2. Each hoist assembly shall have an operating upper and lower limit switch which

limits travel of the upper hoist frame. There shall also be an upper over travel limit switch and a redundant lower travel limit switch. A runoff area shall be provided at the lower end of nut travel to disengage the lifting nut from the upper frame assembly upon over travel past the limit switches. All limit switches shall be actuated directly by the jack screw nuts.

3. Each hoist shall be equipped with automatic wheel stops to preclude truck movement at any time the hoist is not at floor level.
4. Each hoist shall be equipped with spring-set magnetic motor brake and self locking jack screws and nuts, so that the hoist may be stopped at any position between full-up and full-down and shall be in a locked attitude. Power must be applied to either raise or lower the hoists.
5. Steel plate closures shall be provided to close all floor openings not protected by equipment covers.

F. Equipment Design and Construction:

1. Truck Repair Hoists Base:
 - a. The frame base is the main structural weldment which supports all other structural members and drive machinery. It shall be anchored to the foundation floor by anchor bolts embedded in the pit floor. The frame shall be fabricated from structural steel shapes and plates.
 - b. Leveling screws shall be mounted on the frame base capable of supporting the entire truck repair hoist against the foundation floor. The screw shall be designed to provide ease and accuracy in leveling the truck repair hoist during installation.
 - c. The motor mounting base plate and hoist gear case mounting base plates shall be attached to the frame base by welding. The base plates shall be machined (milled) to true flatness one to another, to provide positive motor/gear case alignment and total bearing surface between the drive machinery and base plates.
 - d. Two (2) structural jack screw columns shall be mounted on each frame base and attached to the base by bolted connections. The columns are to provide structural stability for the upper frame assembly which in turn supports the truck repair hoist rails. Each column shall have two (2) vertical machined surfaces to provide long wearing, accurate guidance of the upper hoist frame.
 - e. Hoist Motor. The hoist shall be driven by a squirrel cage motor with a brake. The motor shall be totally enclosed-non vented heavy duty and equipped with shielded sealed bearings. Motor shall be NEMA "D" design, Class "H" insulation not to exceed Class "B" temperature rise for 15 minute rating. The Motor Reducer shall have a double extension shaft to couple each end to the bevel gear cases. The motor shall be mounted to the frame base with the armature shaft perpendicular to the shop service rails.
 - f. Couplings. The motor reducer shall be coupled at each end to the bevel gear cases by solid couplings.
 - g. Gear Cases/Lifting Screws. The zero bevel gear case input shaft shall be coupled to the motor reducer. The input shaft shall be from alloy steel on which is an integrally machined and ground steel pinion. The pinion shall mesh and drive a high tensile zero bevel gear. The bevel gear shall be keyed to the lifting screw at the screw's base. The lifting screw shall be a buttress thread design and be self locking (load or no load). It shall be machined from heat treated alloy steel. The buttress screw shall have a pitch diameter of 3 ½ inches with an inside diameter of 3 inches and an outside diameter of 4 inches. The lifting screw which extends from the gear case vertically shall

rest and rotate on a spherical thrust roller bearing and be guided by an antifriction roller bearing at the bottom of the screw. The gear case shall be splash lubricated using 80/90 gear lube with the gear case housing fabricated from steel. The gearing used shall be rated for the horsepower of the hoist motor.

- h. Hoist Nuts. The hoist nuts shall be machined from nonferrous material. They shall be compatible and travel (raise/lower) on the rotating buttress threads of the lifting screws. The nuts shall bear against and be locked from rotation by pins in the upper hoist frame nut adapter plates. The adapter plates shall be attached by four (4) bolts to the upper hoist frame. The nut shall be designed to provide minimum wear when subjected to maximum stress conditions.

2. Upper Hoist Frame.

- a. The upper hoist frame shall be the structural member to raise and lower transit car truck, guided by the columns of the base frame. The frame structure also provides the bridge section and rail system to carry the crossing load of a truck or raise/lower/support a truck.
- b. The upper hoist frame shall be a weldment, fabricated from structural steel rectangular tubes (ASTM A500B); plates, channels, bar stock, and wide flange beams (ASTM A-36).
- c. The upper frame assembly shall be designed to provide a clear unobstructed area between the hoist rails when the hoist is fully raised. Each truck repair hoist rail shall be supported by a wide flange beam on a yoke type structure consisting of two rectangular steel tubes acting as columns, per side, supported by a common structure which remains below floor level when the hoist is fully raised. The structure shall bear against the hoist nuts and be supported by the two (2) lifting screws.
- d. The truck repair hoist rails shall be hardened to avoid damage due to end batter, and manufactured from an AISI 1045 steel bar with a minimum tensile strength of 90,000 P.S.I., and a Brinell Hardness of 190.
- e. Automatic wheel stops shall be actuated when the truck repair hoist is raised greater than two inches from the full down position. The wheel stops shall be a mechanical design, not requiring an electrical interface. The stops shall be held positively clear of the flange way and railhead when the hoist is in the lowered position. Two (2) automatic stops shall be installed on the hoist at the ends of the running rails. Also two (2) manual wheel stops shall be provided per hoist.
- f. Fully loaded, the hoist shall not deflect more than 1/4 inch measured at the top of the running rail with 1.2 kips applied horizontally in any direction at the rail.

3. Guide System:

- a. The truck repair hoist shall be provided with a positive roller guide system. The system shall provide guidance and stability to the upper hoist frame during raising/lowering/static modes. The system shall be designed to transfer all eccentric or side loading, imposed on the upper hoist frame, into the frame base, leaving the lifting screws subjected to compressive loads only.
- b. Guide Roller System. McGill Camrol bearing shall be mounted to the upper hoist frame and operate with running clearance against the machined surface on the columns, of the frame base. Eight (8) bearings shall be used in the design to transfer lateral loads which are perpendicular to the service track. The bearings shall be properly spaced with four bearings opposing on

- each side of the upper hoist frame.
4. Maintainability:
 - a. Hoist Motor Reducer. The Motor Reducer shall be removable by disconnection of the mounting bolts and couplings, without disturbance to other components.
 - b. Jack Screw Column Assemblies. Gear case, lifting screw and column shall be removable from the pit by removing the center pit cover, upper frame, disconnecting motor reducer coupling and removal of gear case mounting bolts. External lifting devices shall only be required for lifting pit cover and jack screw column assemblies from pit.
 - c. Guide Rollers. Guide rollers shall be accessible and replaceable by use of small hand tools only. No major disassembly shall be required.
 5. Lifting Nut and Wear Detection System:
 - a. Lifting nuts shall have the capability of being removed for replacement or inspection without the necessity of removing the jack screw or performing major disassembly of the unit.
 - b. Removal/replacement of lifting nut shall be accomplished by blocking upper hoist frame at any elevation. Remove four mounting bolts supporting nut adapter plate and two (2) upper bearing capsule bolts. Rotate nut off end of screw. Work shall be accomplished with small hand tools and blocking. External lifting devices will not be required.
 6. Nut Wear Detection System:
 - a. The nut wear detection system shall provide for positive identification of excessive wear on the hoist nuts and the ultimate shut down of the equipment if periodic inspections are not conducted.
 - b. In connection with the above, and additional nut or follower nut is accommodated beneath the main hoist nut. It shall serve a dual purpose, as a load support in the event of hoist nut failure and as a partial support for the sensor arrangement.
 - c. Nut wear is detected by an inductive sensor at each hoist nut on the truck repair hoist.
 - d. Nut wear proximity sensors automatically stop hoisting motion when any nut on a truck repair hoist requires replacement due to wear. The controls shall allow the lowering motion of hoist to remove a truck at floor level. Once the lower limit switch on the hoist is activated, all motion is locked out. As a precaution, an additional "redundant" switch is provided and activates if the regular lower limit switch should fail.
- G. Electrical Characteristics:
1. All equipment for operation shall be 460-volt, three-phase, three-wire system and ground. Provide local transformation for 120-volt, single-phase control circuits.
 2. Motors shall be totally enclosed, heavy duty type, equipped with sealed ball bearings and overload protection. Overload protection shall be provided to operate within their rating under all design load conditions. Motors shall be capable of operating at 115% service factor.
 3. Method Of Wiring: Wiring shall be in conduit continuously grounded by means of couplings, boxes and fittings. Only new materials shall be used bearing the Underwriters Laboratories (UL) label.
 4. Motor Starters shall be provided with overload elements of the bimetal thermal type on each phase. Each motor shall have an emergency stop station wired in the control circuit and installed at the motor location. Station shall be connected so that it is impossible to operate the motor when the station is in the "Off" position.

Station will contain maintained contact devices and shall be mounted in stainless steel NEMA 4 enclosures. Station covers shall have a provision for padlocking in the "Off" position.

5. Conduit: All exposed conduit shall be rigid steel, heavywall. All buried conduit shall be of PVC construction, embedded in structural concrete, with a minimum cover of 6 inches. Embedded conduits shall be spaced on 6 inch centers. The minimum size conduit for control wires and power wires shall be 3/4 inch diameter.
6. Conductors: The minimum size shall be #12 AWG for power wiring. Minimum size for control wiring shall be #14 AWG. All splices #8 and larger shall be made with a mechanical pressure lug or connector.
7. Master Control Station: In-floor mounted control station shall be designed to permit single station operation and to preserve the intent and appearance of an unobstructed smooth floor when not in use. Floor control units shall be provided complete with all apparatus, controls, stainless steel boxes, cast iron frames with hinged cover.

H. Dimensional Data:

1. Design equipment for a 4-foot 8-1/2-inch track gauge.
2. Maintain working clearances under hoists and supporting members.
3. Furnish equipment to fit within openings and pits, including anchor mechanisms and equipment mounting devices and settings, shown on Contract Drawings.

I. Alignment Tolerances:

1. Maximum variation from horizontal for truck repair hoists: 1/4 inch end to end or center to center of rails.
2. Maximum horizontal deflection of hoists with full load plus 1200 lbs. applied horizontally in any direction at loading point:

J. Automatic Lubrication System:

1. General Description and Operation:
 - a. When used in conjunction with the protective screw covers, it shall shorten the cleanup time and extend the period between major cleanups by minimizing contaminants which adhere to the exposed screws.
 - b. Lubricant shall be distributed from a centrally located reservoir through a system of pipes to control panels mounted on the equipment. A network of tubing and hoses shall feed the lubricant directly to the jack nuts in controlled portions when the equipment is in operation.
 - c. Electrically controlled feeder valves and cycle switches will feed only the nuts while operating.
2. The pump shall be pneumatically operated through a filter-lubricator, connected to shop air. It requires approximately 50 PSI, and regulation of the lubricant supply shall be controlled at this point. Lubricant entering the system from the pump shall pass through an in-line strainer to ensure clean lubricant.
3. High pressure reset indicators in the feeders shall isolate high pressure problems at the nuts, which will shut down the affected area until the problem is corrected. A green indicator light on the Truck Repair Hoist lifting frame shall activate during operation to visually indicate proper operation from shop floor level.
THE SYSTEM IS NOT INTENDED TO APPLY THE INITIAL COAT OF LUBRICANT REQUIRED AFTER A PERIODIC CLEANING. A hand applied coat will still be required. The system shall apply a sufficient quantity of lube to replace that amount lost during normal operation.
4. Each system includes the, following material:
 - a. Grease pump, pneumatically operated, from the reservoir containing SCH-460 lubricant.

- b. Runway valve, prevents pump operation with empty drum.
 - c. Air filter-regulator-lubricator, near pump inlet side.
 - d. Lubricant strainer, in line near pump discharge.
 - e. Lubrication control panel with inlet valve, solenoid grease valve, divider valve, and electrical controls.
 - f. High pressure reset indicators on divider valves.
 - g. One (1) Lot Tubing, hoses and fittings to connect pump to control panel, and in turn to Jack Nut.
 - h. 1 Lot Electrical conduit, fittings, junction boxes and wire connecting control panels and sensors.
5. Exclusion of Foreign Material: The hoist system shall be designed to assure that foreign material cannot enter the hoist mechanism to jam any jack component or drive motor/power transmission component.

2.03 PAINTING:

- A. Painting: All equipment, apparatus, piping, enclosures, structural framing and supports, conduits and related items to the equipment shall receive a shop prime coat and two finish coats of equipment enamel paint. All surfaces shall be clean of rust, scale, dirt, grease, and oil before painting.
- B. Each coat shall be a minimum of 2 mils dry film thickness.

2.04 FABRICATION:

- A. Fabricate in accordance with approved shop drawings.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. All shop track shall be installed by the contractor after equipment installation.
- B. Install equipment in accordance with approved shop drawings, to the proper lines and levels, plumb and without conflicts with other work.
- C. Use non-shrink grout to level equipment and to seal voids at perimeters of bases.
- D. Ensure that all equipment is ready for checkout and startup by the manufacture.
- F. Touch-up damaged areas of factory-finished surfaces, using the same paint materials.

3.02 TESTING:

- A. Notify the engineer five days prior final testing.
- B. The authority will furnish a transit car truck to be used in testing the equipment.
- C. The contractor shall furnish all test equipment and personnel to perform tests. The authority will furnish the electrical power.
- D. Test each truck repair hoist through five cycles of operation. Perform final testing with a truck on the hoist only after satisfactory operation of all hoisting and related components is attained.

END OF SECTION

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SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies providing the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Mechanical demolition.
 - 9. Equipment installation requirements common to equipment sections.
 - 10. Painting and finishing.
 - 11. Concrete bases.
 - 12. Supports and anchorages.

1.02 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.03 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
- 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing

and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirement

1.04 SUBMITTALS

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: For the following:
 - a. Transition fittings.
 - b. Dielectric fittings.
 - c. Mechanical sleeve seals.
 - d. Escutcheons.
 - 2. Welding certificates.

1.05 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Section 08305.

PART 2 - PRODUCTS

2.01 PIPE, TUBE, AND FITTINGS

- A. Refer to Section 15205 - "Piping Systems" for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.03 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Plastic-to-Metal Transition Fittings: CVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.04 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.05 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

2.06 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.07 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

2.08 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 MECHANICAL DEMOLITION

- A. Refer to Division 1 Section 01730 for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
 - 1. Ductwork or Piping to Be Removed: Remove portion of ductwork or piping indicated to be removed and cap or plug remaining work with same or compatible piping material.
 - 2. Ductwork or Piping to Be Abandoned in Place: Drain piping. Cap ductwork or piping with same or compatible material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Authority.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
- C. Install piping in concealed locations, except in equipment rooms and service areas.
- D. Install exposed piping and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping free of sags and bends.

- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install escutcheons for penetrations of walls, ceilings, and floors.
- L. Sleeves are not required for core-drilled holes.
- M. Permanent sleeves are not required for holes formed by removable PE sleeves.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Section 07841 for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to the General Requirements and equipment specifications in other Division 15 Sections for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.04 PIPING CONNECTIONS

- A. Make connections according to the following:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.05 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.06 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.07 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to codes at Project.

3.08 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Section 05120 for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

- C. Field Welding: Comply with AWS D1.1.

3.09 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.10 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION

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SECTION 15070
VIBRATION ISOLATION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing vibration isolation for mechanical equipment and piping.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities
 2. ASTM: A123.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities and load deflection curves.
 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, method of field assembly, components, application and size and type of anchor plates for each field connection.
 3. Certification: Welding certificates.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
1. Vibration isolators selected to produce uniform loading and deflection even when equipment weight is not evenly distributed; steel components hot-dip galvanized after fabrication in accordance with ASTM A123.
 - a. Types of vibration isolators:
 - b. For equipment and piping:
 - 1) Floor-mounted: Spring isolators.
 - 2) Suspended: Suspension-type isolators with springs and neoprene combination.
 2. Spring isolators for floor-mounted equipment:
 - a. Free-standing, laterally stable without housing, complete with minimum 1/4-inch thick neoprene, acoustical friction pad in series with spring element.
 - b. Leveling bolts and adequate facilities for bolting to equipment and supporting structure using isolation washers.
 - c. Coil outside diameter: Not less than 0.8 of operating height of spring.
 - d. Horizontal stiffness: Not less than 0.8 of vertical stiffness.
 - e. Springs designed to have additional 50-percent capacity beyond rated load.
 - f. Springs designed so that ends remain parallel during and after spring deflection to operating height.
 - g. Vibration isolators selected for lowest operating speed of equipment.
 - h. Built-in adjustable limit stops with isolators provided for equipment of operating weight different from installed weights, to prevent rising of equipment when weight is removed and for equipment exposed to wind. Limit stops not to be in contact during normal operating conditions.
 - i. Welding of springs to load-plate assembly for vibration isolators with capacities of 6,000 pounds or less is prohibited.
 - j. Vibration isolators with capacities of 6,000 pounds or less are permitted use of cups or other positive means for restraining springs.
 3. Suspension-type isolation hangers for ceiling-suspended equipment:

- a. Combination of spring and neoprene in series.
 - b. Spring made of stable steel.
 - c. Encased in structurally stable steel bracket.
 - d. Spring diameter large enough to permit 15-degree angular misalignment of rod connecting hanger to equipment without rubbing on box
 - e. Designed to provide complete support for suspended units upon failure or rupture of isolator.
4. Inertia bases:
- a. Furnished by vibration-isolator manufacturer.
 - b. Complete with steel-reinforced concrete cast into welded structural-steel channel frame, mounting templates and brackets for vibration isolators with thickness equal to eight-percent minimum of longest base dimension.
 - c. Structural-steel work: Section 05500.
5. Concrete equipment subbases (housekeeping pads)
- a. Concrete: Sections 03100, 03200 and 03300.
 - b. Concrete subbases not less than six inches high provided for floor-mounted equipment. Subbases resting on structural floor and reinforced with steel rods interconnected with reinforcing bars of floor by means of tie bars hooked at both ends.
 - c. Clearance between subbases and inertia bases: Two inches minimum.
 - d. Subbase concrete: Class 2500, Finish No. 4.
6. Snubbers:
- a. As recommended by manufacturer of vibration isolator.
 - b. Compatible with vibration isolators provided.
- B. Isolation-Unit Types and Deflection:
1. Fans, ventilating units, evaporation units and air-conditioning units: Floor-mounted and ceiling-suspended.
- a. Spring isolators designed for a minimum of 1.5 inches deflection.
 - b. Snubbers: Where shown.
2. Pumps:
- a. Base-mounted pumps on inertia bases.
 - b. Inertia bases shaped to include base elbow supports for connected piping and at least 1-1/2 times weight of supported equipment or a minimum base thickness of eight percent of longest base dimension, whichever results in greater weight.
 - c. Springs with minimum deflection of 1.5 inches under imposed static load.
3. Chillers:
- a. Vertically restrained spring isolators designed for 1.5 inches minimum deflection. Inertia bases if recommended by chiller manufacturer.
4. Self-contained air-conditioning units:
- a. Spring-isolators designed for a minimum of one-inch deflection except through-wall units.
5. Remote air-cooled condenser or condensing units:
- a. Isolators: As specified for self-contained units.
6. Cooling towers:
- a. Steel beams mounted on vertically restrained spring isolators designed for 1.5 inches minimum deflection.
 - b. Rails: Acceptable, if performance requirements for spring isolators specified for cooling towers are met.
 - c. Height of steel beams designed to support loads and eight-percent minimum of longest span between isolators.
7. Air compressors:
- a. Temperature-control compressors: Spring isolators designed for 1.5 inches minimum deflection.
8. Piping:
- a. Ceiling-suspended piping: Combination spring and neoprene in shear element hangers as specified for ceiling-suspended equipment. Springs designed for 1.5-inch minimum deflection. First two isolation hangers of each pipe connected to equipment to have deflection equal to equipment isolation-support deflection.
 - b. Floor-mounted piping isolated by spring isolators with one-inch minimum static deflection. First two spring isolators of each pipe connected to

- equipment to have deflection equal to equipment isolation-support deflection.
9. Grout: Section 03300, premixed shrinkage-compensating grout.
 10. Isolation Curb: Rigid upper and lower steel structure with vibration isolation springs having two (2) inch deflection and vertical and horizontal restraints; with elastomeric waterproof membrane.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install vibration isolators where shown as recommended by the equipment manufacturer.
- B. Mount mechanical equipment on vibration isolators to isolate equipment from structure.
- C. Jack bases and equipment into position and wedge or block before vibration isolators are loaded.
- D. Use isolator leveling bolts for final leveling of equipment after equipment is in operation.
- E. Install springs so that ends remain parallel during and after deflection to operating height.
- F. Mount snubbers as close to vibration isolators as practicable.
- G. Grout void between pump bases and inertia-base concrete.
- H. Isolate piping connected to equipment isolated from structures as follows:
 1. Condenser-water piping in its entirety.
 2. Heating hot water and chilled-water piping: Piping connected to equipment, mounted on vibration isolators or suspended with vibration hangers, isolated for a distance of 50 feet from equipment. Piping with installed length less than 50 feet isolated in its entirety only when connected to equipment provided with vibration isolators.
 3. Compressed-air piping: Connected to compressors for a distance of 50 feet from compressor. Piping with installed length less than 50 feet isolated in its entirety.
 4. Gas Piping: Connected to burners for distance of 50 feet from equipment. Piping with installed length less than 50 feet isolated in its entirety.

END OF SECTION

THIS PAGE NOT USED

SECTION 15075

IDENTIFICATION OF MECHANICAL EQUIPMENT AND PIPING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing nameplates and tags on mechanical equipment and apparatus.
- B. Related Work Specified Elsewhere:
 - 1. Field painting: Section 09920.

1.02 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Samples:
 - a. Labels and tags in each size.
 - 2. Documentation:
 - a. Charts for valves; include valve identification number, location and purpose.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Nameplates: Laminated plastic.
- B. Tags: 18-gauge stainless steel.
- C. Identification Plates: Bronze, Authority-furnished.

PART 3 - EXECUTION

3.01 IDENTIFICATION:

- A. Equipment and Apparatus:
 - 1. Label equipment and apparatus with one-inch high white letters engraved on 1-1/2 inch high, black, laminated-plastic nameplates securely fastened to metal panels, showing function and unit number of item.
 - 2. Identify devices including transducers, controls and switches by means of 1/2-inch high white letters engraved on one-inch high, black, laminated plastic nameplates identifying manufacturer and function of equipment.
 - a. Provide same type nameplates on front cover for each pilot light and for mode-of-operation selector switches. Label positions of mode-selector switches AUTOMATIC/OFF/EMERGENCY.
 - 3. Nameplates for components located in fan-control cabinets to show symbol used on schematic diagram to represent component. Label fan-control cabinet terminals using same symbols and identification corresponding to that shown on schematic diagram.

- B. Piping:
 - 1. Stencil legends and bands on piping showing service and direction of flow as specified in Section 09920.
 - 2. Color coding of exposed piping and terminatings of piping is specified in Section 09920.
- C. Valves:
 - 1. Identify valves with 1-1/2 inch diameter, 18-gauge stainless-steel tags.
 - 2. Designate appropriate service on each tag with 1/4-inch stamped black-filled letters and valve number with 1/2-inch stamped black-filled numbers.
- D. Orifice Flange and Venturi Tube:
 - 1. Identify each orifice or venturi tube with integral tab or stainless-steel tag.
 - 2. Stamp on tag differential multiplier, orifice bore, rate of flow and equipment served.

3.02 INSTALLATION:

- A. Cement nameplates with permanent adhesive on equipment and apparatus.
- B. Affix labels to surface of control and switch boxes by means of sheet-metal rivets. Cement labels to surface with permanent adhesive when rivets cannot be used.
- C. Fasten tags securely to valves, orifice flange, venturi tube with brass jack chain, so as to permit easy reading.
- D. Mount valve charts in aluminum frames with clear Lucite front cover in locations as directed.
- E. Fire-Protection and Suppression System:
 - 1. Stencil legends on piping as shown to identify service and direction of flow.

END OF SECTION

SECTION 15080

INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing insulation for ductwork, piping and equipment.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NFPA: 90A.
 - 3. ASTM: C240, C534, C552, C1071, E84.
 - 4. FS: HH-I-558.
 - 5. MS: MIL-A-3316, MIL-B-19564, MIL-C-19565, MIL-C-20079.
 - 6. SMACNA: HVAC Duct Construction Standards – Metal and Flexible
- B. Each item listed in UL Building Materials Directory.
- C. Fire-Hazard Ratings:
 - 1. Determine fire-hazard ratings in accordance with ASTM E84.
 - a. Insulation, fastener, and jacketing materials, except flexible cellular plastic for expansion joints: Not exceeding 25 for flame spread, 50 for fuel contributed and 50 for smoke developed.
 - b. Use of flameproofing and fireproofing treatments for the purpose of achieving specified fire-hazard ratings for insulation not meeting specified requirements is prohibited.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each type indicated, including materials and thermal characteristics.
 - 2. Shop Drawings: Show details of the following:
 - a. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - b. Attachment and covering of heat tracing inside insulation.
 - c. Insulation application at pipe expansion joints for each type of insulation.
 - d. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - e. Removable insulation at piping specialties, equipment connections, and access panels.
 - f. Application of field-applied jackets.
 - g. Application at linkages of control devices.
 - h. Field application for ductwork and each equipment type.

B. PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Label each item with manufacturer's name and brand designation, referenced specification number, type, class and thermal and acoustical rating as applicable.
- B. Ship each type of insulation and accessory materials securely packaged and labeled for safe handling in shipment and to avoid damage.
- C. Store materials in secure and dry storage facility.

PART 2- PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. External Ductwork Insulation with Vapor-Barrier Facing:

- 1. Insulation:
 - a. Rigid board for exposed ductwork:
 - 1) Thickness: One inch.
 - 2) Density: Three pounds per cubic foot.
 - 3) Vapor-barrier facing: As specified, factory-applied.
 - 4) FS HH-I-558, Form A, Class 2.
 - b. Flexible duct wrap for concealed ductwork:
 - 1) Thickness: Two inches.
 - 2) Density: 1.5 pounds per cubic foot.
 - 3) Vapor-barrier facing: As specified, factory-applied.
 - 4) FS HH-I-558, Form B, Type I, Class 6.
- 2. Vapor-barrier facing: foil-reinforced kraft paper.

B. Internal Ductwork Insulation:

- 1. Optional materials:
 - a. Flexible insulation:
 - 1) Thickness: One inch.
 - 2) Density: Three pounds per cubic foot.
 - 3) Smooth coating on inside.
 - 4) ASTM C1071 and NFPA 90A.
 - b. Fibrous-glass insulation:
 - 1) Thickness: One inch.
 - 2) Density: Three pounds per cubic foot.
 - 3) Perforated, galvanized-sheet metal inner lining, lining as specified.
- 2. Minimum normal incidence sound absorption coefficients based on insulation thickness of one inch:
 - a. Cycles per
second 125 250 500 1000 2000 4000
 - b. Coefficient 0.11 0.22 0.60 0.85 0.82 0.91
- 3. Maximum increase in friction loss of air due to duct insulation: 15 percent at 2,000 feet per minute velocity.

C. Piping Insulation:

- 1. General:
 - a. Vapor-permeance resistance:
 - 1) Maximum vapor permeance: 0.5 percent by volume.
 - 2) Vapor-permeance ratings for piping insulation determined in accordance with ASTM C240.
- 2. Insulation for pump discharge lines, force sewer mains and hot/cold potable-water



pipng:

- a. Pipe, valves, flanges and fittings: Rigid premolded cellular glass: Covered with aluminum jacket 0.016 inch thick; ASTM C552. Insulation to consist of one layer, one-inch thick.
 - b. Rigid premolded insulation sleeving: Thermal-pipe and tube covering, mineral fiber, industrial- type covered with aluminum jacket 0.016-inch thick; ASTM C 552, All-service jacket.
 - c. Insulation not required on embedded or buried pipe.
 - 3. Refrigerant-piping insulation:
 - a. As specified for hot/cold potable-water piping.
 - 4. Heating hot water, chilled water, and exterior cooling water piping:
 - a. As specified for hot/cold potable-water piping.
- D. Sheet Metal Duct Lining: Galvanized sheet metal, 22 gauge, perforated with 3/32-inch holes on 3/16-inch centers, with 22-percent open area.
- E. Fabric Pipe Jacket: Prefabricated laminate containing 10-by-10 asphalt-impregnated glass fabric and aluminum foil one-mil thick, sandwiched between three layers of bituminous mastic, for use on embedded or inaccessible piping.
- F. Metal Pipe Jacket:
 - 1. Galvanized sheet steel, 24 gauge (U.S.S.) having Z-type longitudinal joint seam.
 - 2. Aluminum alloy, 0.016-inch thick, mill-finish, having Z-type longitudinal joint seam.
- G. Insulation-Hanger Shields: Aluminum alloy, minimum 0.050-inch thick, mill-finish, covering bottom 180 degrees of pipe insulation, lengths as follows:

Pipe Sizes/Inclusive	Shield Length
1/2 inch to 2 inches	6 inches
2-1/2 inches to 6 inches	9 inches
6 inches to 12 inches	12 inches

PART 3 - EXECUTION

3.01 APPLICATION OF INSULATION:

- A. General:
- 1. Do not apply insulation until all surfaces to be covered are clean, dry and free of foreign materials, such as oil, grease, rust, scale and dirt.
 - 2. Apply only clean and dry insulation.
 - 3. Install insulation in accordance with manufacturer's recommendations as a minimum requirement.
 - 4. Provide complete moisture and vapor seal wherever insulation terminates against metal hangers, anchors and other projections through insulation on cold surfaces.
 - 5. Provide continuous insulation through sleeves and openings except pipe sleeves piercing exterior walls, floors and ceilings below ground level.
 - 6. Stagger joints with respect to adjacent butt joints.
 - 7. Unless otherwise shown, insulate the following:
 - a. Air-conditioning ductwork, supply and return.

- b. Heating ductwork, ventilating ductwork and combined heating and ventilating ductwork, supply and return except ductwork within heated space.
 - c. Outside-air intake ductwork.
 - d. Exhaust-air ductwork between automatic damper on discharge side of fan and louver.
 - 8. The Contractor has the option of applying insulation internally or externally, except for the following required internal applications:
 - a. Where shown.
 - b. Insulated ductwork exposed to weather.
- B. External Ductwork Insulation:
 - 1. Install insulation continuously through openings provided for passage of ductwork and unbroken over seams, angles, hangers and other accessories.
 - 2. Do not use scrap pieces of insulation to make up full-length sections. Eliminate voids by refitting or replacing insulation,
 - 3. Rigid board for exposed ductwork:
 - a. Fasten to duct with mechanical fasteners spaced 12 inches to 18 inches on center, with minimum of two rows on each side of duct.
 - b. Secure with washers firmly embedded in insulation.
 - c. Seal joints, breaks and punctures with fire-resistant vapor-barrier coating reinforced with a three-inch wide vapor-barrier strip.
 - 4. Flexible duct wrap for concealed ductwork:
 - a. Adhere to duct with fire-resistant adhesive in sufficient quantities to prevent sagging.
 - b. Secure insulation tightly to the ducts with Type 316 stainless-steel insulation bands spaced 12 inches maximum center-to-center.
 - c. For duct widths over 30 inches, secure on underside of duct with mechanical fasteners on 18-inch centers.
 - d. Butt insulation, overlap joints with vapor-barrier facing two inches minimum; seal with fire-resistant vapor-barrier adhesive.
 - e. Seal breaks and punctures with vapor-barrier strip and coating.
- C. Internal Ductwork Insulation:
 - 1. Install insulation in accordance with manufacturer's recommendations based on velocity and duct dimensions and SMACNA HVAC Duct Construction Standards --Metal and Flexible.
 - 2. Where insulation has perforated galvanized-sheet-metal inner lining, fill space between liner and outer duct, leaving no void spaces or unlined sections.
 - 3. Do not use scrap pieces of insulation to make up full-length sections. Eliminate voids by retrofitting or replacing insulation.
 - 4. Apply adhesives, where required, in accordance with manufacturer's recommendations.
 - 5. Increase both width and height dimensions of duct by two inches from dimensions shown.
- D. Piping Insulation:
 - 1. Pump discharge lines, force sewer mains and potable-water piping:
 - a. Install insulation on pump discharge lines, force sewer mains, hot and cold potable-water piping, valves, flanges and fittings. Insulation consists of one, one-inch thick layer.
 - b. Asphalt-paper inner jacket not required.
 - 2. Refrigerant-piping insulation:
 - a. Install insulation consisting of one layer, one-inch thick.

3. Embedded or inaccessible-piping insulation:
- a. Install insulation consisting of layers or thickness specified for usage specified.
 - b. Provide inner jacket of prefabricated-fabric pipe jacket.
 - c. Coat exposed surface of fabric pipe jacket with protective plastic film and inner surface with special-release paper.
 - d. Apply jacket of galvanized steel over inner jacket.
 - e. For flanges, valves and other fittings, apply aluminum jacket with paper backing or asphalt adhesive over galvanized-steel jacket. Secure by means of straps as specified.
 - f. Over elbows provide mitered insulation covered with aluminum jacket material.

E. Application of Insulation on Pipe Saddles:

1. Cut two-inch thick piece of premolded pipe insulation of same material as used on piping, slightly larger than void formed by outer pipe circumference and pipe saddle.
2. Press insulation into void by hand pressure, so that both ends project slightly beyond each end of saddle.
3. Cut ends of insulation flush with saddle ends.
4. Use of filler, adhesive or other material to fill voids or imperfections in insulation is prohibited.

F. Expansion Joints for Piping Insulation:

1. Install expansion joints in both horizontal insulation and vertical runs of piping on centers not to exceed 50 feet.
2. Install joints one-half inch wide and fill with cushioning material in accordance with insulation manufacturer's recommendations.

G. Insulation for Anchors:

1. Insulate anchors which are secured directly to cold piping as specified for a minimum distance of eight inches from surface of pipe insulation and sufficient to prevent sweating.

END OF SECTION

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SECTION 15120

COMPRESSION TANKS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing compression tanks complete with fittings and appurtenances.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASME: Boiler and Pressure Vessel Code.
 - 3. International Plumbing Code 2003.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings:
 - a. Complete catalog information and shop drawings including piping diagrams.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Compression Tank:
 - 1. Compression tank diaphragm type.
 - 2. Black-steel, welded plate with rustproof coating on exterior, capacity as shown.
 - 3. Designed for working pressure of 125-psig minimum; meeting ASME Boiler and Pressure Vessel Code.
 - 4. Diaphragm made of butyl, replaceable.
 - 5. System connection forged steel.
 - 6. Factory precharged to 12 psig.
 - 7. Provided with charging valve and drain plug.
- B. Nameplates:
 - 1. Securely attached plate on each tank showing manufacturer's name, model number and serial number.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install equipment and appurtenances within space provided and locate for easy servicing.
- B. Provide concrete pad, bracket supports, saddles and hangers for tanks.

END OF SECTION

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SECTION 15121

COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing a fully automatic compressed air system, complete, tested, and placed in operation as specified herein. The system shall include compressors, air receiver, air dryer, compressed air piping, and all other appurtenances required for an automatic compressed air system.
- B. Related work specified elsewhere:
 - 1. Vibration Isolation: Section 15070.
 - 2. Piping System: Section 15205.
 - 3. Motors: Section 16225.

1.02 QUALITY ASSURANCE

- A. Experience: Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.
- B. Manufacturer's Representative: Provide a qualified manufacturer's representative at site to supervise work related to equipment installation and check-out.

1.03 ELECTRICAL EQUIPMENT:

- A. All electrical equipment installed less than 18 inches above the finished floor shall be housed in explosion proof enclosures and installed in accordance with NEC Electrical Code Class 1, Division 2, Requirements.

1.04 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Operation and Maintenance Manual: Submit operation and maintenance manuals in accordance with General Requirements - Operation and Maintenance Data, of these Specifications. Provide complete parts, operating, and maintenance manual covering equipment at time of installation including, but not limited to:
 - a. Description of system and components.
 - b. Schematic diagrams.
 - c. Instruction: Manufacturer's printed operating and maintenance literature.
 - d. List of original manufacturer's parts including supplier's part numbers and

cuts, recommended spare parts stocking quantity, and local parts and service source.

4. Certification:
 - a. Manufacturer's certified performance and test data.
 - b. Certified motor data for the compressor motor and the motor manufacturer's complete brochure or bulletin on the motor.
 - c. Manufacturer's certified construction and foundation drawings.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING:

2. Deliver equipment in Manufacturer's containers, appropriately packaged and/or crated for protection during domestic shipment and storage in humid, dusty conditions.
3. Indelibly label all containers, including those contained in others, on outside with item description(s) per title and Mark Number of these specifications.
4. Provide equipment and materials specified complete in one shipment for each equipment item. Split or partial shipments are not permissible.

1.06 OPERATION AND MAINTENANCE TRAINING:

- A. Upon completion of installation, in accordance with the General Requirements, furnish on-site services of the manufacturer's engineering representative with specialized experience in the system and its components to instruct Authority personnel in the proper operation and maintenance of each system.

1.07 LABELING:

- A. Securely attach in a prominent location on each major item of equipment a noncorrosive nameplate showing manufacturer's name, address, model number, serial number, and pertinent utility or operating data.

PART 2 - EQUIPMENT

2.01 COMPRESSED AIR SYSTEM

- A. General Description:
 1. Furnish and install as here-in specified, shown or scheduled on the drawings a complete compressed air system. System shall include but not be limited to the following components.
 - a. Air Compressor
 - b. Receiver
 - c. Filters
 - d. Air Dryer
 - e. Automatic Condensate Drain
 - f. Condensate Management System
 - g. Pipes, valves, fittings, gauges pressure reducing valves, etc.
- B. Air Compressor:
 1. Furnish and install a rotary screw air compressor of the capacity, arrangement, size and electrical characteristics as to satisfy the required needs.
 2. Air compressor shall be the rotary screw type, U.L. approved and be furnished with a built-in water-cooled aftercooler or cooler. Unit shall be furnished with an automatic

dual control for operating under full load and idling with time delay for limiting time. Unit shall be factory furnished with an across the line starter and shall be pre-wired for a single point electrical connection. Unit to be completely assembled and factory tested under load.

3. Furnish compressor with ES Series solid state, touch pad, microprocessor based controller includes:
 - a. Full programmability, Full text/digital display, Full electrical system diagnostics, Mode selection: Constant run, Low demand, Auto start/timed stop. Sequence up to 8 units (with identical controllers), stop.
 - b. Emergency stop button, Full Text/digital display: Hourmeter, Discharge air temperature-System pressure, Reservoir temperature, Reservoir pressure, Separator differential pressure Advisory points: Service air filter, Change separator, Change oil filter, Changeoil, Low ambient/high temperature.
 - c. Protective shutdowns: High temperature, Low oil pressure, Fan motor overload, Main motor overload, High pressure, Change separator, Power interruption protection, Electronic modulation control, Thermally controlled air cooled fan motor starting, Motor rotation jog function.
 - d. NEMA 12/IP-65 control/electrical enclosure includes: Rugged 460 volt main motor starters, Control voltage transformer.
4. Airend – Shall be of the rotary helical screw type with asymmetric rotor profile for minimal Internal leakage and maximum compressor efficiency. Rotors to be dynamically balanced and mounted on antifriction-type bearings, cylindrical roller and double row tapered thrust type. Heavy duty bearings, capable of B-10 bearing life in excess of 100,000 hours are to be used. Rotor shafts to be integral part of rotors. Seals are to be mechanical face type, made of high temperature rated carbon and hardened wear rings for maximum seal life.
5. Motor – Shall be NEMA B frame, 1800 RPM, 1.15 SF, squirrel cage, induction type with Class F insulation. Motor to be open, drip proof, 3 phase, 60 Hertz, 460 volt motor windings for reduced current starting.
6. Mounting – Motor to be D-flange mounted to the compressor to insure permanent alignment. Permanent alignment assures maximum coupling/bearing life. Drive motor to be direct, Non-geared, connected to air end by a resilient flexible coupling. Motor and compressor unit is to be mounted to rigid steel base using only all angle, elastomer vibration isolators. Vibration isolators and the permanently aligned D-flange mounting virtually eliminates vibration.
7. Inlet Air Filter– Heavy duty, dry-type inlet filter capable of removing 99% of all airborne particulate 5 micron and larger is to be used.
8. Lubrication – Shall be accomplished by inherent pressure differential and without the use of an external mechanical oil pump. A full flow 10 micron oil filter and oil after cooler assures cooling and filtering of the lubricant prior to reaching the air end. A thermostatic oil mixing valve is required to assure proper oil temperature and prevent moisture contamination due to condensation. Compressor to be filled with a synthetic lubricant rated for 8000 hours at normal operating conditions.
9. Separator System – Shall consist of a separate first stage reservoir utilizing a shotgun and baffle design to separate the oil from the air. The second stage of separation to be a replaceable wrapped separator element which will limit oil carryover to 2 PPM by weight at 100 PSIG full load operation. System to include pressure relief valve and automatic blowdown valve with muffler. Separator housing to be designed so that no piping or lines have to be disconnected to replace element.
10. Piping – The use of flexible hoses, black pipe and plastic control lines will not be acceptable. Lubrication system to include all galvanized steel fittings and steel piping. Control lines to be stainless steel. Adjustable minimum pressure valve and check valve to be installed in air discharge piping.

11. Enclosure (if required) – A sound attenuating enclosure rigidly fabricated of 14 gauge steel shall be provided.
12. Oilcooler/Aftercooler – Water cooled air/oil cooler shall be heavy duty, shell and tube type Cooler, moisture separator and automatic condensate trap are to be piped and mounted within the compressor package. Shipped loose is not acceptable.
- a. Materials:
- 1) Tubes - Copper.
 - 2) Headers - Brass.
 - 3) Shell - Brass.
 - 4) End Hubs - Brass.
 - 5) End Bonnets - Cast Iron.
 - 6) Baffles - Brass,
 - 7) Mounting Brackets - Steel.
 - 8) Gaskets - Nitrile Rubber.
 - 9) Nameplate - Aluminum Foil.

2.02 AIR RECEIVER TANK

- A. Furnish and install a vertical, ASME rated, air receiver of the size and capacity Indicated on the contract drawings.
- B. Tank shall be furnished with all inlet, outlet, and drain openings as required for a complete and operational system.
- C. Tank shall be factory furnished complete with the following accessories:
1. 150 psi max working pressure
 2. Bronze safety relief valve
 3. 0 – 200 psi, liquid filled pressure gauge with needle valve end snubber
 4. Timed electric automatic condensate drain
 5. Tank shall be fully primed and finished in manufacturer's standard finish.
- D. Automatic Condensate Drain
1. Furnish and install a fully automatic condensate drain of the size, capacity, arrangement, and electrical characteristics to satisfy the required needs.
 2. Automatic condensate drain shall be complete with valve and timer combination. Unit shall have power/valve status light, "on-off" adjustment, and 6 Ft 3-prong electrical cord with plug.
- E. Filters
1. Filter shall be mounted as indicated on contract drawings. Filters shall be finished with internal automatic drain and differential pressure gauge.
 2. Furnish one additional filter cartridge upon final acceptance of the system.
 3. Filter/housing shall be constructed to withstand 250 psig maximum working pressure. Furnish unit with wall mounting bracket for field installation.

2.03 HEATSINK CYCLING REFRIGERATED AIR DRYER

- A. Scope – This specification described a complete mechanical refrigerated drying system for the removal of moisture, oil aerosols and other contaminants from a compressed air or gas stream. This is accomplished by cooling the gas with a refrigeration unit to a temperature at which the contaminants condense and are separated from the gas stream. The dryer shall be complete in all respects, including integral component equipment, inter-connecting piping, wiring and controls.

- B. Components and Construction – Each dryer system shall be complete with the following items:
1. Precooler / Reheater exchanger.
 2. Cycling refrigerated chiller section.
 3. Refrigeration system equipped with hermetically sealed compressor and water or air-cooled condenser.
 4. Centrifugal air / moisture separator.
 5. Electronic solenoid drain to automatically discharge condensate.
 6. Microprocessor based control system to regulate and monitor system operation and control condensate removal.
- C. Precooler / Reheater – Dryer shall be equipped with a single air-to-air heat exchanger to Precool incoming compressed air and reheat outgoing compressed air. Air-to-air heat exchanger shall be of the smooth-bore tube-in-tube design to provide smooth, non-fouling exchange surfaces with minimal associated pressure drop. Exchanger shall be constructed of cooper to maximize thermal transfer efficiency. The maximum design pressure shall be 200 psig.
- D. Refrigeration System – The chiller system shall be designed to dry a set amount of compressed air. The refrigeration system shall consist of one hermetic reciprocating type compressor, refrigerant feed system, air or water cooled condenser and refrigerant to thermal mass evaporator. No hot gas by-pass valve or similar capacity modulating device shall be used in the refrigeration system. Refrigerant 22 shall be used to minimize environmental hazard. The amount of refrigerant shall be minimized, through the use of a measured charge system, to prevent liquid refrigerant floodback to the hermetic compressor.
- E. Moisture Separator – A vertical moisture separator shall be located within the chiller section. Compressed air and water condensed in the chiller section shall be delivered to the separator for the separation and subsequent removal of the water from the compressed air. Separation shall be performed at the coldest point in the system by means of centrifugal acceleration, expansion into an area of low velocity with sump area and change of air flow direction. These separation mechanisms shall provide for separation efficiency in excess of 99%.
- F. Microprocessor Controls And Instrumentation
1. The chiller section and associated refrigeration system shall be controlled and monitored by a fully integrated microprocessor.
 2. The microprocessor shall control the chiller section to prevent freeze-up and shall operate the electronic drain valve.
 3. Additionally, the microprocessor shall incorporate the following features:
 - a. Dewpoint Temperature Digital Readout
 - b. High Temperature Alarm Light
 - c. Low Temperature Alarm Light
 - d. Adjustable Exchanger Temperature
 - e. Percent Savings Digital Readout
 - f. Adjustable Drain Open Time
 - g. Adjustable Drain Close Time
 - h. Drain Test Switch
 - i. Built-in Crankcase Heater Delay
 - j. Anti-rapid-cycle timer
 - k. Fahrenheit or Centigrade Temperature Display
 - l. Remote Alarm Contacts
 4. Dryer shall include a refrigerant suction pressure gauge for refrigeration system. Microprocessor shall also incorporate field programmable dewpoint settings to allow the dryer to be more closely matched to seasonal demands. A higher dewpoint

setting shall allow refrigerant compressors to experience a lighter load thereby conserving more energy and further reducing compressor wear and tear.

G. Compustat: Shall include:

1. This microprocessor control cycles the refrigeration system to maintain the desired pressure dewpoint requirement. A digital display indicates the exchanger temperature. The control includes the following features:
 - a. Timed solenoid drain with adjustable off time from 1 to 60 minutes and adjustable open time from 1 to 60 seconds. Digital display is used to set times and (2) two indicating lights display open and closed functions. Time is set with up/down buttons.
 - b. On/off switch with light indicating power is to the unit and an additional light indicating the unit is turned on and off. A third light indicates when the refrigeration turns on and off.
 - c. A high temperature warning light and contacts for remote alarm are included. (Same contacts for high and low temperature alarm).
 - d. Includes anti-short cycle timer for compressor protection. Digital display indicates count down of time before unit can restart.

H. Coolant Recirculating System Sample Specification:

1. General: Furnish and install a coolant recirculating system designed to remove 332, 750BTU/HR of heat with 38 GPM of 50% Propylene Glycol solution cooled from 128°F to 105°F at 90°F ambient with a 3 fan drycooler. Further cooling capacity shall be available with an additional shell and tube heat exchanger which will reduce coolant temperature from 105°F to 95°F with 70°F plant water during extreme summer temperatures. Coolant recirculating system shall include as a minimum all equipment listed below. Ethylene Glycol is not permissible by WMATA.
 - a. Drycooler: Air cooled drycooler shall be arranged for vertical air flow and shall consist of a polished aluminum housing, galvanized steel supports, aluminum legs, copper coils with aluminum fins, rain slinger equipped 3/4 HP 460/3/60 volt fan motors with built-in thermal overload protection and direct driven zinc plated or aluminum cooling fans with corrosion resistant guards. Fan cycling control shall be included to cycle fans during cool ambient conditions and shall include a 24 volt control circuit with control transformer, fan contactors and temperature controls.
 - b. Pump Package: Shall be a factory packaged module, ready to set in place, including 120 gallon reservoir tank, control panel, (2) 3 HP 460/3/60 volt circulating pumps, pump suction strainers, triple duty valves, pump discharge pressure gauges, low level switch, modulating control valve, trim cooler with regulating valve and reservoir temperature indicator all piped, mounted and wired. An automatic air vent, compressor discharge temperature indicator, drycooler discharge temperature indicator and flow switch shall be furnished loose for installation if field piping. Reservoir tank shall gauge glass assembly with shut-off valves.
 - c. Controls: NEMA 12 microprocessor panel shall be furnished and include a main disconnect, magnetic starter(s) for circulating pumps, hand-off-automatic selectors, pump run lights, control voltage transformer, low coolant level light with alarm, flow failure light with alarm, alarm silence button and terminal strip for remote alarm indication.
 - d. Expansion Tank: Expansion tank for hot water heating systems. Heated water expands, and in a closed hot water system, provisions must be made for the expansion. This tank is designed to control the thermal expansion of hot water and to prevent system damage and unnecessary relief valve discharge in hydronic heating systems.

- 1) Precharged at 12 psi.
 - 2) Compatible with Glycol Systems.
 - 3) Max. Temperature 240°F.
 - 4) Max. Pressure 60 psi.
2. Tank model ET-15, Volume 2.1 gallon, Watts Regulator or approved equal.

2.04 FLEXIBLE PIPE CONNECTORS

- A. Inner Hose: Stainless steel or bronze.
- B. Exterior Sleeve: Single braided stainless steel or bronze.
- C. Pressure Rating: 125 psig WSP and 450 degrees F.
- D. Joint: Threaded 2-1/2 in. Flanges 3 in.
- E. Size: Use pipe sized units.

2.05 UNIONS

- A. Ferrous Pipe: 150 psig malleable iron threaded unions.

2.06 SPARE EQUIPMENT

- A. The Contractor shall furnish the following spare equipment for each compressor units:
 1. Two (2) oil filter elements.
 2. Four (4) air intake filter elements.
- B. Spare equipment shall be identical to that furnished with the compressors.

PART 3 - CONSTRUCTION METHODS

3.01 INSPECTION:

- A. Check location of rough-in work and utility stub-outs to assure match with equipment to be installed.
- B. Inspect delivered equipment for damage from shipping and exposure to weather. Compare delivered equipment with packing lists and specifications to assure receipt of all items.
- C. Report in writing to the engineer any damage, incorrectly fabricated, non-conforming materials or equipment, improper rough-in work or utility stub-outs, or any other condition requiring remedial or corrective action. Any remedial or corrective action shall be subject to the engineer's approval prior to the performance of such action.

3.02 INSTALLATION:

- A. Contractor shall install equipment in accordance with plans, approved shop drawing and Manufacturer's instructions:
 1. Make air cock and drain connection on horizontal casing.
 2. Install line size gate valve and check valve on compressor discharge.
 3. Install replaceable cartridge type filter/silencer of adequate capacity for each compressor.
 4. Connect condensate drains to nearest floor drain.

5. Install valved bypass around air dryer.
6. Install flexible connectors at compressor discharge.
7. Vibration Isolation.
- B. Compressor installation: Contractor shall place the compressor in position on the foundation anchor bolts. The base of the compressor shall be 1/2-inch to 3/4-inch above the top of the foundation and the compressor shall be leveled as closely as possible.
- C. Air receiver and dryer installation: The air receiver shall be anchor-bolted to the floor using 1/2-inch stainless steel anchor bolts. Upon installation, actual dewpoint of dryer shall be tested. Contractor shall be responsible for providing accurate dew meter. Dew point of dryer must fall within range of 39°F for 100°F ambient temperature, 100°F intake temperature, 100 psi, and 200 cfm for one hour.
- D. Positioning: Contractor shall place equipment in accordance with any noted special positioning requirements generally level, plumb and at right angles to adjacent work.
- E. Fitting: Where field cutting or trimming is necessary, Contractor shall perform in a neat, accurate, professional manner without damaging equipment or adjacent work.
- F. Anchorage: Contractor attach equipment securely to prevent damage resulting from inadequate fastenings. Fasteners shall be installed to avoid scratching or damaging adjacent surfaces.
- G. Upon completion of work, finish surfaces shall be free of tool marks, scratches, blemishes, and stains.
- H. Vibration Isolation:
1. Vibration isolators selected to produce uniform loading and deflection even when equipment weight is not evenly distributed; steel components hot-dip galvanized after fabrication in accordance with ASTM A123.
 2. Types of vibration isolators:
 - a. For equipment and piping:
 - 1) Floor-mounted: Spring isolators.
 3. Spring isolators for floor-mounted equipment:
 - a. Free-standing, laterally stable without housing, complete with minimum 1/4-inch thick neoprene acoustical friction pad in series with spring element.
 - b. Leveling bolts and adequate facilities for bolting to equipment and supporting structure using isolation washers.
 - c. Coil outside diameter: Not less than 0.8 of operating height of
 - d. Horizontal stiffness: Not less than 0.8 of vertical stiffness.
 - e. Springs designed so to have additional 50% capacity beyond rated load.
 - f. Springs designed so that ends remain parallel during and after spring deflection to operating height. equipment.
 - g. Vibration isolators selected for lowest operating speed of
 - h. Built-in adjustable limit stops with isolators provided for equipment of operating weight different from installed weights, to prevent rising of equipment when weight is removed and for equipment exposed to wind. Limit stops not to be in contact during normal operating conditions.
 - i. Welding of springs to load plate assembly for vibration isolators with capacities of 6,000 pounds or less is prohibited.
 - j. Vibration isolators with capacities of 6,000 pounds or less are permitted use of cups or other positive means for restraining springs.
 4. Suspension-type isolation hangers for ceiling-suspended equipment:

- a. Combination of spring and neoprene in series.
- b. Spring made of stable steel.
- c. Encased in structurally stable steel bracket.
- d. Spring diameter large enough to permit 14-degree angular misalignment of rod connecting hanger to equipment without rubbing on box.
- e. Designed to provide complete support for suspended units upon failure or rupture of isolator.

3.03 TESTING AND RESPONSIBILITY:

A. Per ASME, the Contractor shall be responsible for the procurement and installation of compatible components, and shall perform all modifications necessary for the proper operation of the equipment. The Contractor, if required by the Engineer or as otherwise required by the Specifications, shall make such tests during the installation and upon the completion thereof, as may be necessary to demonstrate the work and equipment, as installed, complies with the Contract Specifications and requirements of NYCT as provided herein. He shall provide all labor, instruments and apparatus required for such tests. If any of the work or equipment fails to meet the Contract requirements or to function properly, the defects shall be rectified by readjusting or by removing and replacing the faulty work or equipment, until under test, the requirements are met all at the Contractor's expense. The Engineer reserves the right to check the Contractor's instruments or to furnish his own instruments.

B. CLEANUP:

- A. Contractor shall touch-up damage to painted finishes.
- B. Contractor shall wipe and clean equipment of any oil, grease, and solvents, and make ready for use.
- C. Contractor shall clean area around equipment installation and remove packing or installation debris from job site.
- D. Contractor shall notify the Engineer for acceptance inspection.

END OF SECTION

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SECTION 15125

PIPING CONDUIT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing complete factory-fabricated piping conduit and control-air piping conduit.
- B. Related Work Specified Elsewhere:
 - 1. Piping systems: Section 15205.
 - 2. Insulation: Section 15080.
 - 3. Raceways, boxes and cabinets: Section 16130.
 - 4. Grading, Excavating and Backfilling: Section 02320.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ANSI/ASME: B31.1.0.
- B. Source Quality Control:
 - 1. Prior to shipment, test carrier pipes at 800 psi until found leak-free.
 - 2. Test prefabricated-conduit sections and fittings at 15-psi air at the factory to ensure compliance with specified requirements and to prove weldtight.
- C. Inspection:
 - 1. Upon delivery to job site, visually inspect each section of prefabricated conduit to determine shipping damage, thickness of coating, necessary air space, bond of coating to conduit and conformance to specified requirements. Reject material not in conformance with special requirements or which displays shipping damage beyond that permitted by these Specifications.
 - 2. Coating test: After visual examination and prior to installation, perform coating dielectric-integrity test in accordance with manufacturer's instructions for test equipment.
 - 3. Repair of voids:
 - a. If voids detected by the above methods were caused by improper handling, and are such that the areas of patches extending a minimum of two inches from the outer periphery of the void total less than 100 square inches for sections of conduit up to 20 feet in length, or less than 200 square inches for sections up to 40 feet in length, the section may be repaired. Perform repairs using specified coating; repeat testing procedure.
 - b. Remove from job site sections requiring patches larger than specified and replace with new conduit sections.
 - 4. Perform inspections in the presence of the Engineer. Provide samples of coating and coating material for laboratory analysis when directed.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Shop Drawings: Include manufacturer's technical data for conduit materials, insulation, and coatings. Detail joints and fittings. Indicate dimensions, weights, and method of field assembly.
 2. Certification:
 - a. Manufacturer's certification that installation has been made in accordance with manufacturer's recommendations and published instructions and meets specified requirements.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Prefabricated-Piping Conduit:
1. Welded-piping conduit, factory-insulated armored piping, welded as specified for steel piping in Section 15205.
 2. Outer conduit: Steel, four-gauge minimum.
 3. Insulation consisting of two one-inch layers of cellular glass as specified in Section 15080 except insulation jacket consisting of outer wrap of asphalt-impregnated, fibrous-glass reinforced, asbestos pipeline felt, spirally wound under tension.
 4. Adequate air space between outer conduit and pipe insulation permitting expansion and contraction of piping without resulting damage.
 5. Outer conduit coated on inside with unmodified catalytic polyamide or versamid-cured epoxy.
 6. Outer conduit coated on outside with epoxy reinforced with two layers of fibrous-glass cloth.
 7. Finished-coat vehicle of 65-percent epoxy resin (450 - 525 epoxide equivalent) and 35-percent resinous-nitrogen curing agent with not more than five percent of vehicle as stabilizers and flow-control agents.
 8. Conduits incorporating the following features:
 - a. Pipe-support guides.
 - b. Watersheds, welded pipe only.
 - c. Leak plates.
 - d. Anchors.
 - e. End and gland seals.
 - f. Expansion loops:
 - 1) Factory-fabricated of casing, couplings, insulation and piping identical to that specified for straight runs.
 - 2) Designed and installed to ensure complete drainage.
 - 3) Designed with allowable-stress limits in accordance with in ANSI/ASME B31.1.0, for type of pipe used.
 - g. Loop casing:
 - 1) Sized to contain pipe movement without crushing insulation or causing other damage.
 - 2) Eccentric reducers and increasers, or welding collars serving same purpose, used to allow drainage through loop.

- 3) Welding collars not lighter than conduit casing and not less than 10 gauge.

B. Control-Air Piping Conduit:

1. PVC: Section 16130.

C. Conduit Monitoring System:

1. Control unit: Provided only in cases where conduit is buried or when approved.
 - a. Wall-mounted, liquid-tight, hinged cover.
 - b. Leak warning light, allowing reset by depressing, mounted on front cover.
 - c. Pressure gauge, mounted on front cover, indicating conduit internal pressure, covering conduit internal-pressure range of five to eight psi.
 - d. Compression fittings for gas inlet and gas outlet.
 - e. Gas regulator capable of adjustment from zero psig to 20 psig.
2. Copper tubing: As specified by manufacturer of monitoring system.
3. Source of dry nitrogen gas not to exceed 100 psi.
4. Relief valves as specified by the manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Excavation and Backfill: Perform in accordance with the General Requirements, Section 02030 and manufacturer's recommendations.
- B. Installation:
 1. Install prefabricated piping conduit, including expansion loops and conduit monitoring system, in accordance with manufacturer's recommendations and under personal supervision of manufacturer's representative.
 2. Fabricate field joints to match factory fabrication and perform testing as specified.
 3. Clean and sandblast steel surfaces prior to coating.
 4. Apply coating to match factory-applied coating and perform testing as specified.

3.02 FIELD QUALITY CONTROL:

- A. Install prefabricated-piping conduit under personal supervision of manufacturer's qualified field-service representative.
- B. Field Testing:
 1. Prior to application of coating and before backfilling, test conduit sections and joints for leaks by application of 15 psig for one-hour minimum.
 2. Repair leaks in accordance with manufacturer's recommendations and retest until approved.
 3. After application of coating and prior to backfill, perform coating tests as specified on exterior surfaces including field joints.
 4. Repair coating voids to restore full dielectric integrity to system or replace conduit section and repeat testing procedures.
 5. After backfilling, test conduit system by application of 15 psig for eight hours minimum
 6. Locate and repair leaks detected by loss of gas pressure and retest until approved.

7. Ventilate air space in conduit with heated air at rate of two cfm. Continue until cool mirror located at exit port exhibits no fogging.
8. Charge to five psig and close off plugs.
9. Set monitoring system according to manufacturer's instructions for unattended surveillance.
10. Submit copy of installation and inspection report.

END OF SECTION

SECTION 15135

MISCELLANEOUS PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing pumps, complete with motor drives and controls, except drainage pumping systems, chilled-water pumps and condenser-water pumps.
- B. Related Work Specified Elsewhere:
 - 1. Piping systems: Section 15205.
 - 2. Raceways, boxes and cabinets: Section 16130.
 - 3. Wire, cable and busways: Section 16120.
 - 4. Motors: Section 16225.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. UL, NEMA 250.
- B. Source Quality Control:
 - 1. Select pumps based on capacity, total dynamic head and electrical characteristics shown.
 - 2. Test pumps at 1-1/2 times working pressure.
 - 3. Balance impeller statically, dynamically and hydraulically.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Certification.
 - 4. Operations and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIAL:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of subassemblies, parts, motors, starters and relays.

- B. Hot-Water Circulating Pump:
 - 1. Type: Centrifugal, single-stage, single-suction, in-line, hydraulically balanced and electric-motor-driven.
 - 2. Minimum capacity: As shown.
 - 3. Operating speed: 1,750 rpm.
 - 4. Designed in accordance with the following:
 - a. Standards of Hydraulic Institute.
 - b. Pump supported by piping system.
 - c. To permit complete servicing without severing pipe connection.
 - 5. Construction: Bronze, with stainless-steel or heat-treated steel shafts, with the following additional requirements:
 - a. Bearings: One of the following:
 - 1) Ball bearings, frictionless with permanent grease lubrication.
 - 2) Sleeve bearings, oil-lubricated.
 - b. Roller bearings, with oil reservoir.
 - 6. Casing: Suitable for working pressure of 125 psig.
 - 7. Seals: Mechanical, designed and guaranteed for long life in hot-water systems operating at 250F.
 - 8. Motors: As specified in Section 16225.

- C. Submersible Sump Pump:
 - 1. Type: Automatic, electric-motor-driven, centrifugal, wet-pit, close-coupled.
 - 2. To include single-phase, hermetically sealed, capacitor-start motor with built-in overload protection, upper and lower bearing factory-sealed, grease-lubricated ball-type, common shaft of stainless steel, Type 316, and sealed pump cable with neoprene cover and flexible armor. Motors to have cooling characteristics permitting continuous operation in totally submerged, partially submerged and non-submerged condition.
 - 3. Casing: Close-grain cast iron, volute-type.
 - 4. Impeller: Cast bronze, enclosed or semi-open, with vanes and back shroud, dynamically balanced.
 - 5. Intake protected with slotted cast-iron or perforated steel intake strainer with effective free area sufficient to prevent cavitation and poor efficiency.

- D. Liquid-Level Control:
 - 1. Simplex submersible, single-phase unit, one of the following:
 - a. Integral with pump, designed for direct switching of single-phase pumps, complete with ON/OFF, adjustable-level float switches.
 - b. Completely independent, designed for direct switching of single-phase pumps and consisting of control box, contactor and ON/OFF level float switches.
 - 1) Control box of heavy-duty plastic having three-prong male plug for plugging into standard three-wire grounded power-supply outlet; grounded female socket into which cable from pump motor is

- plugged and heavy-duty contactor with 90-ampere lock-rotor rating for direct switching of motor load.
- 2) Float switches for ON and OFF level switching connected to control box with extra-flexible, neoprene-jacketed electrical cable. Float switches UL-listed. Floats strapped to discharge pipe at required ON and OFF levels. Mercury switch with molybdenum contacts sealed in each double-walled float enclosure. Float enclosure of heavy-duty rigid plastic, resistant to attack by inorganic salt solutions, alkalis and mineral acids.
- 2. Duplex submersible, single-phase unit. Completely independent, designed for direct switching of two single-phase pumps and consisting of duplex control box, contactors, alternator, and ON/OFF and emergency-level float switches.
 - a. Weatherproof, UL-listed, steel control box with gasketed removable cover containing contactor with 90-ampere lock-rotor rating for each pump, electric-alternator circuit and control-circuit fuse. Pump starting alternated at ON level on successive cycles. Second pump starts at EMERGENCY level if inflow exceeds capacity of first pump or is inoperative.
 - b. Float switches for ON, OFF and EMERGENCY level switching, connected to control box with extra-flexible, neoprene-jacketed electrical cable. Float switches UL-listed. Floats strapped to discharge pipes at required ON, OFF and EMERGENCY levels. Mercury switch with molybdenum contacts sealed in each double-walled enclosure. Float enclosure of heavy-duty rigid plastic, resistant to attack by inorganic salt solutions and mineral acids.
 - c. Alternator:
 - 1) Electric, automatic.
 - 2) Designed to alternate pumps on each successive cycle of operation and to operate both pumps automatically when one pump is unable to handle flow.
 - 3) Enclosure for electrical components: NEMA 250, Type 1.
- E. Wiring:
 - 1. Control panel: Completely wired at the factory prior to shipment.
 - 2. Wiring and conduit: Sections 16130 and 16120.
- F. Nameplates:
 - 1. Securely attached to each major item of equipment as specified in Section 15075. In each case, show manufacturer's name, model number, serial number, electrical and operating characteristics.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances within space provided and make readily serviceable.
- B. Provide hangers and anchor bolts required for proper installation of equipment as recommended by manufacturer.
- C. Install in accordance with manufacturer's instructions.

3.02 FIELD QUALITY CONTROL:

- A. Ensure that connections are secure and watertight.
- B. Test system through five complete operating cycles.
- C. Ensure that pump and motor operate without noticeable vibration.

END OF SECTION

SECTION 15155
DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specified providing the following drainage piping specialties:
 - 1. Trench drains.
 - 2. Oil interceptors.

1.02 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PUR: Polyurethane plastic.
- G. PVC: Polyvinyl chloride plastic.

1.03 SUBMITTALS

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - a. Oil interceptors.
 - 2. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - a. Wiring Diagrams: Power, signal, and control wiring.
 - 3. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

1.05 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 TRENCH DRAINS

- A. Trench Drains
 1. Standard: ASME A112.6.3 for trench drains.
 2. Material: Ductile or gray iron.
 3. Flange: Anchor.
 4. Grate Material: Ductile iron or gray iron.
 5. Top Loading Classification: As required for floor loading criteria.

2.02 OIL INTERCEPTORS

- A. Oil Interceptors:
 1. Type: Factory-fabricated interceptor for separating and removing oil from wastewater.
 2. Descriptive Type or Function: Tank shall be approved for use by the local wastewater district.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface.
- C. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain in accordance with Division 2.
- D. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.
- D. Ground equipment according to Division 16 Section "Grounding and Bonding."
- E. Connect wiring according to Division 16 Section "Wire, Cable and Busways."

3.03 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Oil interceptors.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 15075.

3.04 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.05 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 15185

HYDRONIC PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies providing heating hot water, chilled-water and cooling tower water pumps, complete with motor drives.
- B. Related Work Specified Elsewhere:
 - 1. Insulation: Section 15080.
 - 2. Vibration isolation: Section 15070.
 - 3. Motors: Section 16225.
 - 4. Variable Frequency Drives: Section 16269.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NEC.
- B. Design Criteria:
 - 1. Select pumps based on capacity and total dynamic head required.
- C. Source Quality Control:
 - 1. Test pumps at 1-1/2 times working pressure.
 - 2. Balance impeller statically, dynamically and hydraulically.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Certification.
 - 4. Operations and Maintenance Manuals.

1.04 JOB CONDITIONS:

- A. Safety Requirements:
 - 1. Properly guard belts, pulleys, chains, gears and other rotating parts to prevent danger to personnel.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
1. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies, parts, motors, starters and relays.
- B. Casings:
1. Close-grained cast iron, volute-type.
 2. Horizontal or vertical split case with flanged suction and discharge, designed for optimum-velocity change and hydraulic balance.
 3. Openings tapped for suction and discharge gauges, suction chamber, discharge-volute venting and casing drainage.
 4. Sections of casings bolted and doweled to permit access to impeller without removal of piping and to provide exact positioning at assembly, after inspection or replacement of parts.
 5. Split bearing brackets bolted and doweled for perfect alignment of rotor, wearing rings and bearings.
- C. Impeller:
1. Enclosed, double suction, cast bronze, one-piece.
 2. Secured to shaft by key and locking collars for exact alignment.
 3. Exterior surfaces machined.
 4. Interior surfaces and water passages deburred and hand-finished.
- D. Casing Wearing Rings:
1. Bronze, renewable-type, locked to prevent rotation.
- E. Shafts:
1. Solid, Alloy S30300 stainless steel.
 2. Sized to provide maximum 0.002-inch deflection at face of stuffing box.
- F. Mechanical Seals:
1. Single, inside-mounted, selection based on pressure, temperature, speed and shaft diameter.
 2. Seal parts:
 - a. 150 psi with shaft diameter to three inches:
 - 1) Temperature range: 40F to 225F.
 - 2) Shaft sealing member: Buna rubber.
 - 3) Rotating sealing member: Carbon.
 - 4) Metal parts of seal: Brass.
 - 5) Stationary sealing member: Nickel-alloy iron.
 - 6) Spring: Stainless steel.
 - b. Above 150 psi: As specified for 150 psi with shaft diameter to three inches, except stationary sealing member fabricated of tungsten carbide.
- G. Glands:
1. Mechanical seal, flush-type, drilled and tapped to provide clear, filtered liquid flush to seal face with separate stainless cyclone separator.
 2. Fabricated of stainless steel, factory-mounted and piped for each seal.
- H. Bearings:
1. Grease or oil lubricated, designed for 150,000 hours average life.
 2. Bearing housings enclosed and protected from dirt and water.
- I. Coupling:

1. Flexible, nonlubricated, pin and bushing.
- J. Coupling Guard:
1. Fabricated steel-housing enclosure bolted to base plate.
- K. Bedplate:
1. Structural steel, ribbed for rigidity and with minimum five-inch diameter grout holes.
 2. Drip collection chamber provided with ½-inch IPS connection at low point of bedplate.
 3. Drilled and tapped to accommodate pump, motor and coupling guard.
- L. Motors: Section 16225 with the following additional requirements:
1. Sized for nonoverloading operation under all conditions on pump curve.
 2. Four-pole, squirrel-cage induction, dripproof and fully guarded.
- M. Flexible Connection:
1. Reinforced-rubber-type or contour-molded reinforced-Teflon-type with flanged ends at inlet and outlet of pump.
 2. Reinforcement: Monel or stainless-steel rings.
 3. Designed for 150 percent of maximum working pressure.
- N. Vibration Isolators: Section 15070.
- O. Nameplates: Section 15075.
1. Securely attached on each pump showing manufacturer's name, model number and serial number.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances within space provided and make readily serviceable.
- B. Provide foundation for proper installation of equipment.
- C. Construct subbases for equipment in accordance with Section 15070.
- D. Insulate pumps as specified in Section 15080.
- E. Make final alignment on pump and motor coupling prior to operation.
- F. Mount pumps on vibration isolators where shown.
- G. Ensure that pump and motor operate without noticeable vibration after installation.
- H. Grout base.

END OF SECTION

THIS PAGE NOT USED

SECTION 15186

WATER TREATMENT SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing complete and operable water-treatment systems for heating hot water, chilled-water and cooling tower water systems.
- B. Related Work Specified Elsewhere:
 - 1. Piping systems: Section 15205.
 - 2. Insulation: Section 15080.
 - 3. Vibration isolation: Section 15070.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NEMA: 250
- B. Design Criteria:
 - 1. Design automatic water-treatment systems to minimize corrosion and prevent fouling of components.
 - a. Chilled water: Select chemicals for control of corrosion, scale and algae that are not toxic to humans in concentrations found in operating system.
 - b. Cooling Tower water: Design a non-chemical water treatment system to minimize scale and reduce biological growth in the circulating cooling tower water system. The system shall use permanent magnetic technology and copper silver electrode assembly to reduce scale and biological growth respectively.
 - c. Heating hot water: Select chemicals for control of corrosion, scale and algae that are not toxic to humans in concentrations found in operating system.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings.
 - a. Complete catalog information and shop drawings for material and equipment including wiring and control diagram.
 - 2. Certification.
 - a. Manufacturer's certified test reports.
 - 3. Documentation:
 - a. Water analysis:
 - 1) Water-sample analysis. Submit prior to introducing chemicals into systems.
 - b. Chemical-quantity requirements:

- 1) Submit calculations showing total quantities of various chemicals required for two years operation of water-treatment systems
- 2) Base quantity of chemicals for 2,000 full-load operating hours per annum for designed tonnage and average of five cycles concentration of cooling tower water.
- c. Chemical-quality requirements:
 - 1) Submit chemical formulae and descriptions or generic names of materials used.
 - 2) Prior to acceptance, submit toxicity data of water treatment complying with applicable codes and regulations of jurisdictional authorities.
 - 3) If required by the jurisdiction, submit their approval of chemicals proposed for use
- d. MSDS approval by WMATA SAFE:
 - 1) Submit Manufacturers' Safety Data Sheets (MSDS) for approval by WMATA's Safety Office (SAFE) for use by WMATA personnel and for use in the WMATA system.

4. Operation and Maintenance Manuals.

1.04 JOB CONDITIONS:

- A. Safety Requirements:
1. Store and handle chemicals so as to prevent danger to personnel.

1.05 FIELD SERVICE:

- A. Engage services of specialist for two years from day air-conditioning system is first put into normal and continuous operation to supervise and train plant-operating personnel in correct water treatment. Specialist to be certified by water-treatment system manufacturer as qualified in operation of system provided.
- B. Specialist's services to include the following:
1. Supervision of pretreatment, startup and adjustment of automatic water-treatment systems.
 2. Minimum of six inspections, at startup and during cooling season for water analysis and to analyze and recommend changes in treatment as operating conditions vary during adjustment period.
 3. Inspections at not greater than five-week intervals and additional inspections upon request from the Authority.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship products securely packaged and labeled for safe handling in shipment and to avoid damage and distortion.
- B. Label each item with manufacturer's name, brand, reference specification, type, class and other pertinent information as applicable.
- C. Supply dry chemicals in waterproof bag or containers weighing maximum of 100 pounds.

- D. Supply liquid chemicals in thirty-gallon polyethylene-lined steel drums or five-gallon plastic pails.
- E. Ship chemicals which are not used for initial startup to Authority-designated storage facility.
- F. Store products in a secure, dry storage facility.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies, parts, motors, starters and relays.
- B. Cooling Tower Water Treatment:
 - 1. HydroPlex as manufactured by Quantum Magnetic System (QMS), Inc., Cleveland, Ohio, or equal. Equipment shall include, but not limited to the following:
 - a. Electrode:
 - 1) Copper Silver Alloy Type.
 - a) Low voltage direct current, max. 60 watts per electrode assembly.
 - b) Quick disconnect electrical connection.
 - c) Adjustable duty cycles.
 - d) Minimum 1 month before cleaning and 1 year before replacement.
 - e) A quick disconnect designed for removal without using special tools.
 - b. Solid removal:
 - 1) Cyclone type separator, capable of removing particles larger than 200 microns.
 - 2) Equipped with automatic purge valve capable of removing all solids from the system during purging cycle.
 - 3) Provide a manually adjusted throttling valve between the centrifugal device and the automatic purge valve. This valve shall be a gate valve or approved equivalent of the same pipe diameter as the automatic purge valve.
 - 4) Union fittings shall be supplied on both sides of the automatic purge valve and also and also both sides of the manual throttling valve for ease of valve removal.
 - c. Magnets for scale removal:
 - 1) An integral part of the piping system. Clamp-on type will not be acceptable.
 - 2) Effective operating life 50 years minimum.
 - d. Pump:
 - 1) Single stage, end suction, centrifugal type, capable of delivering minimum of 200 gpm at the designed pressure discharge.
 - 2) Pump and motor mounted on common steel base.
 - 3) Pump fitted with ball bearings and double mechanical shaft seal.

- 4) Pump motor: Manufacturer's standard motor suitable for intended use.
 - 5) One spare part/repair kit provided with pump.
 - e. Valves, pipe and fittings:
 - 1) Valves shall be bronze construction, solder or threaded ends type, rising stem and rated at minimum 150 psi.
 - 2) Pipe, ASTM B88 Type K, Hard drawn; Fittings, ANSI B16.22.
 - f. System cabinet:
 - 1) Size to contain electrode assembly, Cyclone separator, Magnets, Flow meter, Pressure gauges and all associated plumbing, electrical wiring and controls.
 - 2) Cabinet shall be NEMA 4 rating, suitable for indoor and outdoor installations.
 - 3) Cabinet shall be provided with openings for electrical conduit and piping.
 - 4) Provide cabinet with one-inch drain at the bottom to be piped to the nearest floor drain.
 - g. Other equipment:
 - 1) A 30-gallon surge tank of corrosion-resistant construction.
 - 2) Copper test kit as manufactured by Hach Pocket Colorimeter (Catalog No. 46700-19) or approved equal.
 - 3) Conductivity meter as manufactured by Orion Quikcheck Pocket meter (Catalog No. OR914026, Model 116) or approved equal.
- C. Chilled-Water Treatment:
- 1. Pot-type chemical feeder:
 - a. Designed and constructed for 150-psig water working pressure.
 - b. Chemical feeder: Minimum capacity, 12 gallons.
 - c. In accordance with applicable codes and regulations for unfired pressure vessels.
 - 2. Chemicals: Furnish chemicals supplied for chilled-water system treatment in accordance with the following performance standards:
 - a. Corrosion inhibition:
 - 1) Carbon steel: Less than or equal to 1.0 mil per year.
 - 2) Copper and copper alloys: Less than or equal to 0.10 mil per year; chemical mixture to contain copper-corrosion inhibitor and buffering agents to maintain system pH at 7.0 to 8.5.
 - b. Scale inhibition: Maintain system free of scale deposit.
 - c. Inhibitor to be compatible with permanent glycol-based water solutions.
 - d. Containing no chromates or acids; providing colorless solution when mixed with water.
- D. Name Plates: Securely attached to each major item of equipment showing manufacturer's name, model number and serial number.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances to space provided and make readily serviceable.
- B. Provide foundations, platforms and hangers for proper installation of equipment.

- C. Provide concrete subbases for equipment conforming to the requirements of Section 15070.
- D. Provide waste connections for water-treatment equipment as specified in Section 15205.
- E. Insulate piping and equipment in accordance with Section 15080
- F. Install condenser water treatment as per manufacturer's recommendation.

3.02 APPLICATION AND PERFORMANCE:

- A. Control chemical feed automatically in direct proportion to makeup-water flow as measured by water meter.
- B. Control bleed-off flow rate automatically by timer.
- C. Adjust composition of recirculated water chemically to control scale and corrosion without use of chromates or acids.
- D. Condenser water treatment capable of operating as high as 10 standard units.
- E. Capable of operation in the system with total dissolved solids ranging from 150mg/l to 10,000 mg/l.

3.03 FIELD QUALITY CONTROL:

- A. Chemical Tests:
 - 1. Perform chemical analysis of condensing and chilled-water system at startup of cooling tower.
 - 2. Determine chemical status of water in accordance with specified requirements.
 - 3. Upon approval of treatment, add chemicals and operate systems for 48 hours.
 - 4. Analyze solution at end of 48-hour operation and submit complete report.
 - 5. Report deficiencies in treatment to the Engineer.
 - 6. Perform total of six tests for condensing and chilled-water system during each operating year at intervals of not less than five weeks.

3.04 ADJUSTING AND CLEANING:

- A. Prior to testing equipment, flush piping systems with chemically treated water to remove scale, slag, dirt, oil, grease and foreign material.
- B. Remove and hand-clean low points and strainers.
- C. Install fine cloth around strainers during initial circulation to remove silt finer than normal strainer mesh.

3.05 CHEMICAL SUPPLY:

- A. Supply quantity of chemicals required for two years' operation, based upon 2,000 full-load operating hours per year for designed tonnage of refrigeration plant.

END OF SECTION

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SECTION 15205

PIPING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing piping, fittings, valves, drains, specialties and supporting devices.
- B. Related Work Specified Elsewhere:
 - 1. Water distribution system: Section 02515.
 - 2. Sanitary sewer: Section 02535.
 - 3. Firestopping: Section 07841.
 - 4. Field painting: Section 09920
 - 5. Stray current and cathodic protection: Section 13110
 - 6. Corrosion control testing system: Section 13115.
 - 7. Fire protection, suppression and alarm: Section 13905.
 - 8. Identification of mechanical equipment and piping: Section 15075.
 - 9. Insulation: Section 15080.
 - 10. Grounding and bonding: Section 16060.

1.02 QUALITY ASSURANCE:

- A. Qualifications of Welder: Section 05120.
- B. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. The International Plumbing Code.
 - 3. The International Mechanical Code.
 - 4. ASSE Standards.
 - 5. AWWA Standards.
 - 6. ASME Code for Unfired Pressure Vessels.
 - 7. ANSI/ASME: A21.15/C115, B16.1, B16.3, B16.5, B16.9, B16.11, B16.18, B16.22, B16.39, B31.1, Z21.22.
 - 8. ANSI/AWS: A5.8, E8016, E8018.
 - 9. CISPI: HSN 85.
 - 10. FS: A-A-1192, SS-C-153C, WW-P-51F, WW-P-460D, WW-P-501, WW-U-516B, WW-U-531, WW-V-51F.
 - 11. MSS: SP-58, SP-67, SP-70, SP-80.
 - 12. PDI: WH-201.
 - 13. ASTM: A53, A74, A105, A126, A234, A276, A395, A536, B32, B61, B62, B88, B150, B280, B306, F709.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings:
 - a. Complete catalog information and shop drawings for material and equipment.
 - 2. Submittals include, but are not limited to, the following:
 - a. Pipes and piping layout, including locations of hangers and supports.

- b. Pipe hangers and supports.
 - c. Valves.
 - d. Cleanout deck plates and wall plates.
 - e. Escutcheons.
 - f. Gauges.
 - g. Expansion joints, guides and anchors.
 - h. Air eliminators.
 - i. Pipe sleeves.
 - j. Drains.
3. Certification:
- a. Certificates from manufacturers verifying the following:
 - 1) That pipe-joint gaskets and lubricants are satisfactory for use with pipe and fittings specified.
 - 2) That expansion joints are designed and tested as specified
 - b. Welding Certificates.

1.04 JOB CONDITIONS:

- A. Do not perform welding when the temperature of base metal is less than zero degree F.
- B. Do not perform welding when surfaces are wet from rain, snow, ice or during periods of high wind unless operator and work are properly protected.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies and parts.
- B. Piping:
 - 1. Cast-iron soil pipe and fittings:
 - a. Inside of or embedded within structures: ASTM A74, Class SV, uncoated.
 - b. Passing through underground structural elements or buried below or outside structures: ASTM A74, Class XH, uncoated.
 - c. Pipes, including embedded pipe crossing structural contraction joints, provided with modified bell and spigot joints with molded-neoprene elastic compression gaskets.
 - d. Gaskets: CISPI HSN 85.
 - e. Pipe and fittings manufactured with spigot ends plain and beveled.
 - f. Bells modified to receive gaskets.
 - 2. Steel pipe and fittings:
 - a. Seamless piping: ASTM A53, Types Grade B, hot-dip galvanized, Schedule40, provided for the following applications:
 - 1) Waste and drainage piping and fitting, 2-1/2 inches and smaller where embedded or otherwise inaccessible.
 - 2) Dry vents where embedded or otherwise inaccessible.
 - 3) Chilled-water and cooling tower water supply and return embedded or otherwise inaccessible.
 - 4) Heating hot water supply and return embedded or otherwise inaccessible.

- b. Fittings for chilled water, condenser water: ASTM A234 and ANSI/ASME B16.9 for dimensions and tolerances but not chemical properties.
 - c. Flanges: ASTM A105 and ANSI/ASME B16.5 for dimensions and tolerances.
 - d. Fittings and flanges furnished with properties equal to or greater than that of adjacent pipe.
3. Ductile-iron pipe and fittings:
- a. Embedded or otherwise inaccessible piping: ANSI/ASME A21.15/C115, 250-pound pressure class.
 - b. Piping for sewage-ejector discharge, drainage-pump discharge, interim pumps and for water service from point of connection to inside of structure: ANSI/ASME A21.15/C115, 250-pound pressure class, flanged.
 - 1) Flanges: ANSI/ASME B16.1.
 - c. Pipe coated on outside with bituminous coating and lined with cement mortar of twice standard thickness specified for pipe size used
 - 1) Cement-mortar lining having a seal coat of nontoxic, taste and odor-free bituminous material.
 - d. Neoprene gaskets furnished for joints.
4. Copper tubing and fittings:
- a. Copper tubing for potable water and for control air where embedded or otherwise inaccessible: ASTM B88, Type K, hard-drawn
 - b. Provide copper tubing for potable water, control air and pneumatic sewage-ejector compressed air where accessible: ASTM B88.
 - 1) Potable water and control air: Type M.
 - 2) Potable water and control air installed in conduit: Type K, annealed and lengths of piping 100 feet or less continuous without joints.
 - 3) Pneumatic sewage-ejector compressed air: Type K, hard-drawn.
 - c. Fittings for potable-water piping: ANSI/ASME B16.22.
 - 1) Fitting wall thickness after forming not less than that of adjacent piping.
 - d. Fittings for control-air piping: Wrought copper, solder joint except at apparatus connections where brass compression fittings furnished
 - e. Maximum pressure drop for high-pressure control-air mains: Five psi per 1,000 feet, with minimum 1-1/2 cubic feet per minute of 75-psi air flowing for each single station served and one cubic foot per minute for chilled-water plant.
 - 1) Minimum size for high-pressure control-air mains connecting chiller plants and underground stations: One-half inch ID, 5/8-inch OD.
 - f. Control-air piping graded to low points and each low point provided with 3/8-inch drain cock.
 - g. Solder joints: Lead-free 95.5-percent tin, 4.0-percent copper and 0.5-percent silver with non-corrosive flux; ASTM B32.
 - h. Size gas piping per NFPA 54 Fuel Gas Code.
5. Copper drainage tube (DWV) and fittings:
- a. Seamless tubing: ASTM B306, No. 122 for drainage, waste, and vent piping and fittings.
6. Copper tubing for refrigerant service:
- a. Seamless copper tubing: ASTM B280 for refrigeration service.
 - b. Fittings: Pure wrought copper, recessed solder joint, ANSI/ASME B16.18.
 - c. Solder joints: Brazing filler metal in accordance with ANSI/AWS A5.8 and the following:
 - 1) Copper to Copper - 12-percent Sil-Foss (no flux 1300F).
 - 2) Copper to Copper - 6-percent Dyna-Flow (no flux 1350F).
 - 3) Copper to Steel - 45 silver solder (white flux 1150F)

7. Condensate-drain pipes:
 - a. Hard-drawn copper: ASTM B88, Type L.
8. Unpolished stainless-steel drip pans:
 - a. Provided under water, waste or condensate-drain piping which run over transformer vaults or electric motor starters.
 - b. Each drip pan provided with one-inch drain.
9. Black-steel seamless pipe and fittings:
 - a. Exposed chilled water, cooling tower water supply and return piping: ASTM A53, Standard Weight Schedule 40.
 - b. Pipes 1-1/2 inch and smaller connected with socket-weld fittings or screwed fittings..
 - c. Pipes two inches and larger connected with welded fittings.
 - d. Pipes larger than 12 inches in diameter: Minimum 3/8-inch wall.
 - e. Threaded-pipe fittings: FS WW-P-501, Type I, Class B.
 - f. Welding fittings made of same schedule or weight classification as the pipe.
 - 1) Factory-made welding fittings.
 - 2) Mitered joint elbows and field-made reducers will not be permitted.
 - g. Butt-welded fittings larger than 1-1/2 inches: ANSI/ASME B16.9.
 - h. Socket-welding fittings: ANSI/ASME B16.11.
 - i. Flanges for welded piping system: ANSI/ASME B16.5, forged steel, welded-neck type, 150-pressure class.
 - j. Black-steel pipe and fittings for drainage in aboveground structures as specified in a., except Weight B piping furnished.
10. Unions:
 - a. 1-1/2 inch and smaller: Threaded, ASME B16.39, Type A or B to match piping.
 - b. Two inch and larger unions: ASTM A126, Class B, flanged.
 - 1) Two, 2-1/2 and three-inch union flanges: Steel, FS WW-U-531 or of cast iron, ANSI/ASME B16.1, 125-pound class.
 - c. Four inch and larger union: Forged steel, 150-pound class, slip-on weld-neck flanges, ANSI/ASME B16.5.
 - d. Nonferrous-piping unions: Brass, FS WW-U-516B.
11. Cleanouts:
 - a. For cast-iron bell-and-spigot pipe: SVCI, ferrule caulked into cast-iron fittings and extra-heavy brass tapered screw plug with recessed head.
 - b. For wrought-iron pipe: Extra-heavy brass plug in drainage fitting.
 - c. Floor cleanouts: Cleanouts turning up through architecturally finished floors made by means of a long-sweep ell or Y and adjustable ABS housing with secured, scoriated, round satin-brass cover.
 - d. Wall cleanouts: Cleanout plugs furnished with solid head tapped for 1/4-inch brass machine screw to secure coverplate. Coverplate to be polished-brass round access plate secured to plug with countersunk screw.
 - e. For threaded pipes: Bronze, FS WW-P-460D, Class A.
 - f. Furnished with adjustable recessed head in floor and where shown.
 - g. Except for test openings, cleanout plugs for pipes up to four inches to be same size as pipe.
 - h. On pipe sizes five inches and larger, cleanout plugs to be of four inches and pipe reduced to plug size with bushing

C. Valves:

1. Gate valves two inches or smaller:
 - a. MSS SP-80, Type 2, Class 150.
 - b. Bronze with threaded ends, rough bodies and finished trim.
 - c. Materials except handwheels: ASTM B61.

- d. Furnished with malleable-iron hand wheels.
- 2. Gate valves 2-1/2 inches and three inches
 - a. MSS SP-70, Type 3, Class 125, OS&Y flanged end, Type 1, Class 2, cast-iron bodies and bonnets.
 - b. Seat rings, disc, disc guide and stem furnished in bronze.
 - c. Outside stem and yoke (OS&Y), flanged-end connections and malleable-iron hand wheels.
- 3. Gate valves four inches and larger:
 - a. MSS SP-70, Type 2, Class 125, OS&Y, flanged end, cast-iron bodies and bonnets.
 - b. Seat rings, disc, disc guide and stem furnished in bronze.
 - c. Outside stem-and-yoke type and cast-iron hand wheels.
- 4. Globe, angle and check valves:
 - a. Two inches and smaller:
 - 1) WW-V-51F, Class B.
 - 2) Bronze with threaded ends, rough bodies and finished trim.
 - 3) Materials except hand wheels: ASTM B61.
 - 4) Globe and angle valves furnished with malleable-iron hand wheels.
 - 5) Check valves four inches and larger:
 - a) Swing-type valve seat, with iron or steel body and cap and flanged-end connections.
 - b) 150-pound class, renewable arm, disc assembly and seat ring with bronze trim.
 - c) Outside arm and weight for pump discharge check valves.
- 5. Valves for copper piping:
 - a. Gate valves with solder ends: MSS SP-80, Type 2, Class 150, Bronze, Type 1, Class B.
 - b. Gate valves with flanged ends: MSS SP-80, Type 2, Class 150, Bronze.
 - c. Globe, angle and check valves with solder or flanged ends: FS WW-V-51F, Bronze, Class B.
- 6. Pressure-reducing valves assembly:
 - a. Direct-acting type in which diaphragm and spring act directly on valve stem.
 - b. Constructed to ensure that delivered pressure does not vary more than one psi for each ten-psi variation in inlet pressure.
 - c. Wearing parts readily renewable.
 - d. Valves two inches and smaller designed for working pressure of 250 psi, brass construction except yoke connecting valve body to separate diaphragm chamber having brass cover and assembled with brass bolts.
 - e. Valves larger than two inches designed for minimum 125 psi, iron bodies and bronze trim.
 - f. Adjustable to any outlet pressure.
 - g. Gate valve and union on both inlet and outlet connections.
 - h. Provided with bypass one pipe-size smaller than main water line.
 - i. Stem-mounted pressure-reducing valve gauges, 3-1/2 inch dial, solid brass or stainless steel case and connections with T-handle stops.
 - j. Pressure-reducing valve strainer: Brass, removable without disconnecting piping.
 - 1) Strainers two inches and smaller: Brass, bodies designed for minimum working pressure of 250 psi.
 - 2) Strainers 2-1/2 inch and larger: Iron bodies designed for minimum working pressure of 125 psi
- 7. Pressure-temperature relief valves:
 - a. Temperature-and-pressure-actuated type, adjustable, bronze, single disc with bottom guide to ensure proper seating.

- b. Body, disc and base: Bronze, ASTM B62.
 - c. Spring and stem: Steel.
 - d. Lever: Malleable iron.
 - e. Pressure range from three psi to 250 psi rated and tested under ANSI/ASME Z21.22.
 - f. Temperature range: To 400F.
8. Automatic flow-control valve:
- a. Individually selected by manufacturer to automatically limit rate of flow to design capacity, regardless of system fluctuations
 - b. Selected to regulate flow within five percent of nameplate rating of system in which installed. Maximum operating differential between body tappings necessary for control not to exceed two psi.
 - c. Self-cleaning, cartridge-piston type with stainless-steel variable-area orifices.
 - d. Designed for minimum of 125 psi or 150 percent of system working pressure, whichever is greater.
 - e. Tamper proof with body tappings for connecting instruments for verifying flow-control performance.
 - f. Threaded or flanged connections as required for pipe fittings
 - g. Furnished with valve kit consisting of 1/8-inch by two-inch minimum size nipples, shutoff valves located outside of insulation and hose fittings for use with measuring instruments.
9. Refrigerant valves: UL listed.
10. Balancing cocks:
- a. Resilient-faced, eccentric-plug type designed for minimum of 125 psi or 150 percent of system working pressure, whichever is greater.
 - b. Six inches and under, wrench-operated; eight inches and over, operated by worm or spur gear.
11. Line Strainers:
- a. Water strainers, Y or basket-type, 1-1/2 inches and smaller: ASTM A126, Grade B, iron bodies with screwed connections.
 - b. Designed for minimum of 125 psi or 150 percent of system working pressure, whichever is greater.
 - c. Stainless-steel or Monel screens as follows:
 - 1) Perforations

Strainer size	Perforation size
3/4-inch to two-inch inclusive	1/32 inch
2-1/2 inch to six-inch inclusive	1/16 inch
Eight-inch to 12-inch inclusive	1/8 inch
Over 12 inches	5/32 inch

- 2) Free area of screen minimum three times area of strainer inlet pipe.
 - d. Strainer provided with 3/4- inch drain valve.
12. Backflow preventer:

- a. Reduced-pressure type with two check valves and automatically operated pressure-differential relief valve located between two check valves.
 - b. Relief valve and discharge port to drain intermediate chamber to level below supply-line inlet.
 - c. Moving parts and trim constructed of corrosion-resistant material.
 - d. Equipped with test cocks.
 - e. Conform to applicable section of ASSE and AWWA Standards.
13. Butterfly valves
- a. Provide extended necks or neck extenders to accommodate two inches of insulation.
 - b. Provide 10-position latch-lock handles.
 - c. Provide enclosed work screw operators, sizes eight inches and larger.
 - d. Provide chain wheels when above normal reaching area.
 - e. Provide adjustable balance-return stops for balancing service.
 - f. Meeting MSS SP-67.
 - g. Test shell at 225 psi.
 - h. Body:
 - 1) Wafer-type, cast iron, ASTM A126, Class B, or lug-type, ductile iron, ASTM A536 grade 60-40-18, or ASTM A395.
 - 2) To fit between ANSI/ASME B16.5 flanges.
 - 3) Bodies with integral flanges or full lugs drilled.
 - i. Seat:
 - 1) Provide ethylene-propylene-terpolymer (EPT) bonded to rigid ring providing noncollapsible and replaceable seat.
 - 2) Provide bubble-tight shutoff of 150 psi at temperatures between 25F and 225F.
 - 3) Provide O-ring as secondary seal between seat and stem.
 - j. Disc:
 - 1) Aluminum-bronze: ASTM B150.
 - k. Stem:
 - 1) Stainless steel: AISI Type 304, 316, 410 or 416.
 - 2) Isolate from contact with piped material.
14. Plug Valves:
- a. Bronze body with AGA stamp, with bronze plug and flat or square head.
 - b. ASME B16.38 and MSS Sp-78 cast iron for 2-1/2" and larger.

D. Portable Flow Meters:

- 1. Factory-fabricated case, carrying handle and fitted to hold meter securely to accommodate the following accessories:
 - a. Two 10-foot lengths of connecting hose with female connectors for venturi-tube pressure-tap nipples.
 - 1) Hose designed for minimum of 125 psi or 150 percent of system working pressure, whichever is greater.
 - 2) Completely assembled three-valve manifold with two block valves and vent and drain valves piped and mounted on base.
 - b. Set of curves showing flow versus pressure differential for each orifice or venturi tube.
 - c. Metal instruction plate, secured inside cover, illustrating use of meter.

E. Orifices and Venturis:

- 1. Stainless steel, square-edge type, mounted between pipe flanges with factory-made pressure taps.
- 2. Taps with shut-off valves and with quick-connection hose fittings for portable meters.

3. Orifice-throat diameter at specified flow and differential pressure in inches water gauge as follows:
 - a. Fall in 60 to 80 percent of full scale reading for square-root meters.
 - b. Twelve to 40 inches for linear-scale meters.
 4. Venturi size selected with design flow rate between 10 and 40 inches of water-pressure differential.
 - a. Permanent pressure loss: 25-percent maximum of indicated flow-rate differential pressure.
 5. Flow-metering equipment: Supplied by same manufacturer.
- F. Thermometers:
1. Dial-type, chromium-plated case, remote or direct-type bulb with accuracy of plus-or-minus one degree.
 - a. Three-inch minimum dial with white face and black digits, graduated in two-degree increments.
 2. Liquid-in-glass thermometers.
 3. Thermometer ranges suitable for service at not less than 20 degrees above controlled temperature settings.
- G. Thermometer Wells:
1. Stainless steel with portions surrounding bulbs not over 1/16-inch thick, designed to hold engraved-stem thermometer.
 2. Six inches projecting two inches into pipe with dust-excluding caps with gaskets and chains.
 3. Pipe smaller than 2-1/2 inches enlarged where wells are located.
 4. Set vertical or at angle to retain oil.
- H. Gauges:
1. ASTM F709, Class 1, 2 or 3, Style A, Type I or III with metal case.
- I. Shock Absorbers:
1. Constructed of stainless steel, precharged with nitrogen, argon or pneumatic pure glycerine and permanently sealed.
 2. Provided on cold-water supply piping to flush-valve water fixtures.
 3. Provided on hot and cold supply piping to lavatories and mop service basins.
 4. Certified to meet requirements of PDI WH-201.
- J. Expansion Joints:
1. General:
 - a. Designed for 150 psi and 200F for systems operating at 100 psi or less.
 - b. Provide expansion joint traverse with 150 percent of pipe expansion resulting from temperature variation of 80F.
 - c. Provide corrugated-bellows expansion joints for pipe expansion of 1-1/2 inches or less, minimum of 200 percent of expansion.
 - d. 1-1/2 inches and smaller, threaded ends; two inches and larger, flanged ends.
 2. Flexible ball joints:
 - a. Carbon steel, providing 360 degrees rotation plus 15 degrees minimum angular-flexing movement, furnished with asbestos-composition gaskets, steam-molded in steam-heat presses.
 3. Corrugated-bellows expansion joints:
 - a. Bellows constructed of single-ply or multiple-ply, formed, corrugated stainless steel for pipe sizes smaller than three inches.

- b. Self-equalizing type with equalizing or reinforcing rings, internal-telescoping stainless-steel or Monel sleeves, removable steel housing to protect bellows and support insulation.
 - c. Corrugated element: Seamless tubing or of single sheet of metal rolled into cylinder having one longitudinal seam for sizes up to 16 inches.
 - d. Joints 2-1/2 inches and smaller: Internal guides and limit stops.
4. Designed for a minimum life of 5,000 full-rated traverse cycles when tested at specified pressures and temperatures.

K. Supporting Devices:

- 1. Pipe hangers and supports:
 - a. Provide adjustable steel pipe hangers and supports as follows:
 - 1) Clevis and clamp, cadmium-plated or zinc-plated: MSS SP-58, Type 1 and Type 8 for steel and cast-iron piping.
 - 2) With cast-iron roller and sockets: MSS SP-58, Type 41 for chilled-water piping.
 - 3) Space not greater than six feet for pipe sizes up to and including 1-1/2 inches; 10 feet for pipe sizes two inches through six inches; 16 feet for pipe sizes eight inches and larger
 - b. Pipe hangers for copper tubing: Steel, copper-plated, clevis-type, spaced at maximum five feet for tubing sizes through 1-1/2 inches and maximum eight feet for sizes two inches and larger.
 - c. Hanger rods minimum diameter 3/8 inch, constructed of steel, cadmium-plated, threaded full-length and diameter required by pipe size and load imposed.
 - d. Hanger rod nuts and washers: Steel, cadmium-plated.
 - e. Supported from malleable-iron, hot-dip galvanized inserts in concrete slab: MSS SP-58, Type 18.
 - f. Pipe hangers and supports in tunnels and shafts: MSS-SP-58, stainless steel, ASTM A276, Type 304.
- 2. Pipe rolls, plates and stands:
 - a. Cast iron: MSS SP-58, Types 44, 45, and 46.
 - 1) Adjustable types selected for piping require grading after setting in place.
 - b. Protection saddles for support piping: MSS SP-58, Type 39, welded to pipe.
- 3. Pipe anchors:
 - a. Designed to withstand five times anchor load minimum.
 - b. Vertical pipes anchored by means of clamps welded around pipes and secured to wall or floor construction.
- 4. Pipe guides:
 - a. Factory-made cast semi-steel or heavy fabricated galvanized steel, consisting of bolted two-section outer cylinder and base with two-section guiding spiderbolted or welded tight to pipe.
 - b. Designed to clear pipe insulation and to prevent overtravel of spider and cylinder.
 - c. Guides not less than 12 inches long and spiders not less than the following:

Pipe size/ inches	Spider length/ inches
1-1/2 and smaller	2
2 to 3	2-1/2
4	3
5 and larger	3-1/2

5. Expansion bolt anchors:
 - a. Consisting of bolt, expander, star lock washer and nut.
 - b. Fabricated of stainless steel, Type 303, including expander and star lock washer.
 - c. Anchor assemblies: FS: A-A-1992, Group II, Type 4, Class 1.
6. Self-drilling anchors:
 - a. Self-drilling expansion anchors, with self-cutting annular broaching grooves.
 - b. Anchor and expander plug: FS: A-A-1992, Group III, Type 1, double-plated.
7. Pipe sleeves:
 - a. Through interior masonry-unit walls: As shown. Sleeve to be large enough to accommodate pipe and covering but not less than two sizes larger than pipe size.
 - b. Through poured-concrete interior walls, floors and ceiling: As shown.
 - 1) Sleeves minimum two sizes larger than pipe. At floors, sleeves to project four inches above finish floor.
 - c. Through exterior structural elements: Minimum two sizes larger than pipe and as shown.
 - d. Sleeves designed to allow expansion/contraction movement of pipe.
8. Escutcheon plates:
 - a. Polished brass or stainless steel, screw-fastened to wall or ceiling.
 - b. Plate collars caulked watertight with mastic.
 - c. Mastic: FS SS-C-153C, Type I.

L. Drains:

1. Area drains:
 - a. Cast iron with flashing flange and flat grate for entrance areas.
 - b. Outlets designed for connection to cast-iron soil pipe.
 - c. Drain sizes and types as shown.
 - d. Clamping devices: For securing membrane or flashing for drains installed in membrane-waterproofed floors and in floors not laid on ground.
2. Floor drains:
 - a. Cast iron with flashing flanges and bottom or side outlet as required and designed for connection to cast-iron soil pipe.
 - b. Clamping devices: For securing membranes or flashing, for drains installed in membrane-waterproofed floors and in floors not laid on ground.
 - c. Reinforced-neoprene flashing: For drains installed in floors that are not membrane-waterproofed and are not laid on ground.

- d. Flashing of reinforced sheet neoprene, secured to drain by clamping device and extending 12 inches minimum from drain to ensure watertight connection.
 - e. Area, yard and floor drains in public spaces having finished brass grates.
 - f. Floor-drain sizes and types as shown.
3. Roof drains:
- a. Cast iron having integral flange and a clamping device for securing the roof covering to make a watertight connection.
 - b. Drains for promenade roofs with removable, loose-set, round flat grate in square frame secured to non-puncturing flashing clamp collar with weep holes and for two inch or more roof fill.
 - c. Other roof drains furnished with cast-iron beehive or dome-shaped strainer.
 - d. Openings in each strainer having a combined-area minimum twice the area of drain outlet.
 - e. Each drain outlet having same size as downspout and with parts to make watertight connection to threaded pipe or cast-iron pipe as required.
 - f. Meeting requirements shown.
4. Canopy drains (Roof Drain - Type 5):
- a. Ductile iron: ASTM A536, Grade 65-45-12.
 - b. 30 square inches minimum grate free area.
 - c. Removable gratings, contoured to match opening in concrete rib and as shown.
5. Grease and Sand/Oil Interceptor:
- a. See Specification Section 15155.

M. Air Separators:

- 1. Provide in-the-pipeline air separators with tangential openings for water in and out.
- 2. Design to create low-velocity vortex for internal separation of free air from water stream.
- 3. Size according to size of connecting pipeline as shown.
- 4. Equip with two-inch blowdown connection located at bottom of separator.
- 5. Equip with 1-1/4 inch minimum compression tank connection located at top of tank.
- 6. Tank:
 - a. Size as shown and rated at 125-psi working pressure.
 - b. Construct of carbon steel and in accordance with ASME Code for Unfired Pressure Vessels and so certified and stamped.
- 7. Strainer:
 - a. Stainless steel with perforations sized for water flow.
 - b. Install in location to assist in separation of air.
 - c. Removable from bottom of separator.
 - d. Insulation: Section 15080.

N. Coal-Tar Epoxy Coating: Section 02535

PART 3 - EXECUTION

3.01 INSTALLATION

A. Welding Procedure:

- 1. Perform welding by manual metallic arc-process except for pipe sizes four inches and smaller where gas welding (oxyacetylene) may be used.
 - a. Use electrodes and rods of composition recommended for pipe by AWS.

- b. Heat surface within three inches from point where weld will start to temperature warm to the hand before welding.
 2. Weld corrosion-resistant nickel-copper alloy steel pipe by arc-process utilizing low-hydrogen electrodes of AWS E8016 or E8018 types
 3. Leave joint surfaces smooth, uniform, free from fins, tears and other defects which adversely affect proper welding.
 4. After each pass of weld on multiple-pass welding, clean weld free of slag and other deposits before applying next pass.
 5. Peen with light blows of blunt-nosed peening hammer.
 - a. Do not peen surface layers or first pass in groove welds.
 6. For groove welds, have surface pass substantially centered on the seam, smooth and free from depressions.
 7. Perform fillet-welds with minimum cutting back of outside pipe.
 - a. Leave throat of full fillet-weld not less than 0.707 of thickness of pipe.
 - b. Repair excess cutting back and undercutting of base metal in pipe adjoining weld.
 - c. Fill up craters to full cross section of weld.
 - d. Align and position accurately joints to be welded, so that pipe will not project beyond its adjoining pipe by more than 20 percent of pipe wall thickness or 1/8-inch maximum.
 - e. Install welded pipe in accordance with ANSI/ASME B31.1.
- B. Soil, Waste, Vent and Drainage-Piping Installation
1. Grade piping to 1/4 inch per foot and not less than that of main drain to which it is connected.
 2. Use reducers to change pipe sizes on vent and drain lines.
 3. Use long-sweep bends, Y-fittings, 1/8 or 1/16-bends, or combination Y and 1/8-bends to make changes in direction.
 4. Join service-weight soil pipe and fittings with service-weight gaskets and extra-heavy soil pipe and fittings with extra-heavy gaskets.
 - a. Designate and clearly identify service-weight and extra-heavy gaskets.
 - b. Use lubricant for making joints.
 - c. Make tight seal between external face of pipe and internal face of bell.
 - d. Use gaskets capable of making and maintaining tight seal with deflection not exceeding five degrees.
 - e. Assemble joints by use of tools recommended by pipe, fittings and gasket manufacturers.
 - f. Employ trained workmen experienced in installation of gasket system to install entire gasket system.
 5. Install embedded cast-iron piping at angle of 90 degrees to contraction joints with end of pipe bell coinciding precisely with centerline of contraction joint.
 6. Cut ends of screw jointed pipes squarely to seat in bottom of recess of fittings and ream after cutting so waterway is not reduced in size.
 7. Apply thread dope or compound to male thread only,
- C. Buried Ductile-Iron Pipe:
1. Install pipe with mechanical joints and neoprene gaskets and stabilize by use of thrust blocks.
 2. Thrust blocks: Section 02515.
- D. Potable-Water System Installation:
1. Connect and install service water piping, sizes as shown, to fixtures, equipment and outlets.

2. Install water meter in accordance with requirements of local water authority and provide the following valves:
 - a. Main shut-off gate valve inside service room ahead of water meter.
 - b. Drain with globe valve and hose nipple for 3/4-inch hose installed on house side of meter.
3. Pipe or tubing free from cuts, dents and other surface damage. Remove damaged pipe and replace with new pipe or tubing.
4. Cut square and ream ends of copper tubing.
5. Tubing ends to extend full depth of fitting recesses without binding.
6. Use lead-free 95.5-percent tin, four-percent copper and 0.5-percent silver solder with non-corrosive flux; ASTM B32.
7. Ream and clean ends of threaded pipes before assembling with fittings and apply approved joint compound to pipe thread only
8. Make connections to equipment and fixtures without undue strain.
9. Run horizontal piping with minimum pitch of one inch in 40 feet and arrange for drains at low points.
 - a. Install drain valves and hose nipples not smaller than 3/4 inch at low points.
10. Connect nonferrous piping to ferrous piping with dielectric couplings.
11. Install pressure-reducing valves where main water pressure exceeds 60 psi to maintain pressure of 15 psi at most remote fixture.

E. Control-Air Piping Installation:

1. Do not run piping concealed under duct insulation, inside of ducts or in direct contact with surfaces colder than normal room temperature

F. Steel-Pipe Installation:

1. Weld embedded pipe and install so that pipe will not penetrate construction joints or structural contraction joints.
2. Install horizontal piping with minimum pitch of one inch in 40 feet and arrange for drains at low points.
 - a. Install drain valves and hose nipples not smaller than 3/4 inch at low points.
3. Install high-capacity automatic air vents at high points, designed for 125 psi and suitable for operation on pressures under 125 psi.
 - a. Pipe air-vent outlet to floor drains.
4. Pipe drip pan to discharge as shown; if not shown, discharge to nearest open drain.
5. Provide flexible connections to coils, pumps and other equipment so as to eliminate undue strains in piping and equipment.
6. Install condensate-drain lines for each air-handling unit with pitch of 1/4 inch per foot in the direction of flow.
 - a. Run drain lines to nearest open drain.
 - b. Do not exceed 400 feet maximum length of pipe between anchor and expansion joint or 90-degree offset.
7. Do not support embedded pipe from reinforcing bars with metallic means.

G. Expansion-Joint Installation:

1. Field set expansion joints for position corresponding to ambient temperature at time of installation.
2. Setting based on manufacturer's calibration data furnished with expansion joints.
3. Do not use corrugated-bellows expansion joints where exposed in train tunnels.
4. Install ball joints in accordance with approved published recommendations of manufacturer.
5. Do not use shims or steel spacers.

H. Pipe Anchors:

1. Securely anchor piping where shown and where necessary for proper installation to force pipe expansion in proper direction.
- I. Expansion-Bolt Anchors:
 1. Drill holes and install expansion-bolt anchors as recommended by anchor-bolt manufacturer. Do not locate less than eight inches from concrete edge.
 - J. Pipe Sleeves:
 1. Exterior walls:
 - a. Install as shown.
 - b. For cathodically protected pipe, test in accordance with Section 13115.
 2. Interior walls:
 - a. Install as shown. Seal to maintain integrity of walls.
 - K. Plumbing-Fixture and Equipment Connections:
 1. Make connections to wall-hung water closets and urinals with adjustable flanged nipples secured to chair supports, wax rings and rubber or impregnated-felt gaskets.
 2. Face plate of carrier not more than six inches from back of finish wall.
 - L. Drains:
 1. Install floor drains with traps.
 - M. Air-Separator Installation
 1. Install air separator on suction side of chilled-water pump and as near to pump as practicable.
 2. Install dead-level in both directions and support from structure so that pipe can be removed without moving air separator.
 3. Install two-inch drain line, equipped with gate valve and union, from blowdown connection to nearest drain.
 - N. Attachments to Prestressed-Concrete Girders:
 1. Attach pipes and similar items to prestressed girders by welding to embedded plates or bolting to embedded fittings. Drilling into prestressed girders is prohibited, except as shown.
 - O. Refrigeration Copper Tubing Installation:
 1. Before heating joints, force nitrogen or carbon dioxide into the system.
 2. Sweat each copper tubing installation joint in accordance with standard accepted practice.
 - P. Bonding: In accordance with Section 16060, and with the following additional requirements:
 1. Bond mechanical joints and fittings, including valves, by exothermic-welding method.
 2. Make welds in accordance with recommendations of the manufacturer. Clean and coat with coal tar epoxy.
 3. Bond pipe using bonding strap welded to each side of joint not less than six inches from joint. Allow sufficient slack in conductor for expansion of pipe.
 - Q. Firestopping: Section 07841.
 1. Pipe penetration through fire rated partitions to be sealed with approved fireproof sealant.

3.02 PROTECTION OF PIPING AND EQUIPMENT:

- A. Protect pipe, openings, valves and fixtures from dirt, foreign objects and damage during construction.
- B. Replace damaged piping, valves, fixtures and appurtenances.
- C. Prior to testing, flush piping with chemically treated water until systems are clean and free of scale, slag, dirt, oil, grease and other foreign material.
- D. Hand-clean expansion joints and strainers.
- E. Coal-Tar Epoxy Coating for Protection of Ferrous Piping: Apply as specified in Section 02535 and test as specified in Section 13115.

3.03 FIELD QUALITY CONTROL:

- A. Water-Pressure Testing:
 - 1. Prior to burial or concealment, test affected piping in presence of the Engineer using specified procedures.
 - 2. Test entire piping systems and test until found leak-free in presence of and to satisfaction of the Engineer.
 - 3. Notify the Authority at least 36 hours in advance of making tests.
 - 4. Test piping at following pressures:
 - a. Soil, waste and vent piping: Requirements of local plumbing code but not less than equivalent to ten feet of water.
 - b. Chilled-water and condenser-water piping embedded or otherwise inaccessible: 400-psi minimum.
 - c. Ductile-iron pipe: 150 psi or 1-1/2 times maximum working pressure, whichever is greater, at lowest point in system.
 - d. Potable-water piping: 1-1/2 times operating pressure but not less than 100 psi at topmost outlet.
 - e. Chilled-water and condenser-water piping, exposed and accessible: 150 psi or 1-1/2 times maximum working pressure, whichever is greater, at lowest point in system.
- B. Test Procedures:
 - 1. Soil, waste and vent piping:
 - a. Water test to include entire system from lowest point to highest point.
 - b. After filling system, shut off water supply and allow it to stand two hours without loss or leakage.
 - c. Conduct final test by smoke test or peppermint test as prescribed by jurisdictional authority.
 - 2. Chilled-water and condenser-water piping embedded or otherwise inaccessible:
 - a. Avoid excessive pressure on safety devices and mechanical seals.
 - b. Fill entire system with water and vent air from system at least 24 hours before test pressure is applied.
 - c. Apply test pressure when water and average ambient temperatures are approximately equal and constant.
 - d. Maintain test pressure for minimum of six hours without drop after force pump has been disconnected.
 - e. Visually inspect joints while pipe is under test pressure.
 - 3. Ductile-iron pipe and black-steel piping:

- a. Use procedure specified for chilled-water and condenser-water piping embedded or otherwise inaccessible.
 - 4. Potable-water piping:
 - a. Use procedure specified for chilled-water and condenser-water piping embedded or otherwise inaccessible, except tests may be conducted in sections as long as no pipes or joints are left untested. Air Testing:
- C. Control-air piping:
 - 1. Test main air piping at minimum of 150 psi and maintain pressure for one hour without pumping.
 - 2. Test low-pressure air piping at minimum of 30 psi and maintain pressure for one hour without pumping.
 - 3. Correct leaks by remaking joints.
- D. Pressure Testing:
 - 1. Refrigerant piping: Test at 300 psi on high side and 150 psi on low side.
 - a. Maintain pressure for minimum of 12 hours.
 - b. Use electronic leak detector to check leaks, after soap-bubble test.
- E. Repair of Leaks
 - 1. Do not repair by mechanical caulking leaks in threads or welds occurring while pipeline is under test or in service.
 - 2. Introduction into piping system of material intended to stop leakage is prohibited.
 - 3. Repair leaks in threaded piping by breaking joint, cutting new threads on pipe and installing new pipe fitting.
 - 4. Remove defective welds by chipping or gas gouging from one or both sides of joint.
 - a. Reweld chipped-out places.
 - b. When base metals of fillet-weld are cut back or throat of weld is less than specified, repair defect by adding additional weld metal.

3.04 DISINFECTION:

- A. Adjust and Clean:
 - 1. Flush entire hot and cold-water piping and other piping and equipment connected downstream from the domestic-water inlet main shutoff valve with water to remove sediment after completion of tests, replacements or repairs.
 - a. Use chlorine for disinfection in form of hypochlorite solution or in form of compressed gas applied through approved chlorinator.
 - b. Operate valves and equipment during chlorination to ensure that chlorine reaches entire system.
 - c. Feed water and chlorination agent into system at rate providing for 50 ppm of chlorine and allow to stand 24 hours before flushing.
 - d. Residual chlorine at end of 24-hour retention period: Two-ppm minimum.
 - 2. Flush treated water from system completely after disinfection.
 - 3. Continue flushing until samples show that quality of water delivered is comparable with public water supply and satisfactory to jurisdictional public-health authority.
 - 4. Do not take samples from hydrants or through unsterilized hose.

3.05 FIELD PAINTING:

- A. Paint exposed soil and waste pipe lines in accordance with Section 09920.

END OF SECTION

SECTION 15410

PLUMBING FIXTURES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing plumbing fixtures, including emergency-eyewash and body-spray facilities.
- B. Related Work specified Elsewhere:
 - 1. Piping Systems: Section 15205

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. FS: WW-P-541/GEN, A-A-1154.
 - 3. ASMEA112.19.2M
 - 4. ADA.
 - 5. ANSI: Z358.1.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's data for each model indicated, including finishes, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Certification.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship products securely packaged and labeled for safe handling in shipment and to avoid damage and distortion.
- B. Mark each item permanently and legibly with manufacturer's name, brand, reference specification, type, class and other pertinent information as applicable.
- C. Store products in a secure, dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Plumbing Fixtures:
 - 1. General requirements:
 - a. Fixtures manufactured of twice-fired vitreous chinaware of best quality, nonabsorbent and burned so that whole mass is thoroughly fused and vitrified producing material white in color, which when fractured will show homogenous mass, close-grained and free from pores.
 - b. Brass fittings, faucets, traps and exposed piping, chrome-plated over nickel plate, with polished finish.
 - c. Brass pipe, chrome-plated over nickel plate and provided with heavy cast-brass escutcheons and set screw plated to match pipe at fixtures passing into floors, walls or partitions.
 - 2. Water closet:
 - a. Wall-hung, flush valve, siphon jet, vitreous china: ASMEA112.19.2M.
 - 3. Urinal:
 - a. Wall-hung, flush valve, washout-type, vitreous china: ASMEA112.19.2M
 - 4. Lavatory:
 - a. Vitreous china: FS WW-P-541/GEN.
- B. Fixture Supports:
 - 1. Supports for wall-hung water closets, urinals and lavatories: FS WW-P-541/GEN.
 - 2. Supports of metal, concealed in building construction. Fixtures rigidly supported from floor by means of one or more heavy extensions or feet built into floor.
- C. Mop Service Basin:
 - 1. One-piece precast terrazzo, approximate size 36 inches by 24 inches by six inches high.
 - 2. Terrazzo made of marble chips, cast in grey portland cement to produce minimum seven-day compressive strength of 3,000 psi.
 - a. Terrazzo surfaces ground with holes and pits grouted.
 - b. Excess grout removed and surfaces polished
 - 3. Stainless-steel bumpers furnished for exposed sides of basin.
 - 4. Drain body of chrome-plated brass, cast integral with basin and provided for inside neoprene joint connection two inches minimum depth to three-inch pipe.
 - 5. Chrome-plated service faucet with vacuum breaker, integral stops, adjustable wall brace, pail hook and 3/4-inch hose thread on spout.
- D. Vacuum Breakers:
 - 1. Chrome-plated brass sized to provide minimum air area equal to piping served and approved by local jurisdictional authorities
- E. Traps:
 - 1. Plain-pattern type having seal minimum of 2-1/2 inches and maximum four inches.
 - 2. 1-1/2 inch and two-inch traps: Heavy cast brass.
 - 3. All other size traps: Same material as specified for piping system to which they are connected.
 - 4. Fixture traps: As specified under plumbing fixtures, and insulated in accordance with ADA guidelines..

F. Emergency Eyewash Fountain and Body Spray:

1. In accordance with ANSI Z358.1.
 - a. Permanent type:
 - 1) Equipped with automatic pressure and volume-control devices to ensure safe and steady water flow under varying pressures.
 - 2) Wall-mounted, with functional parts constructed of corrosion-resistant materials and as follows:
 - a) Eyewash fountain: Twin chrome-plated brass eyewash heads, angled to direct flow of water into eyes and ocular area of face and mounted in stainless-steel bowl.
 - b) Body spray: Chrome-plated brass spray head and wall bracket. Spray head mounted on heavy-duty rubber hose.
 - 3) Operated by valves of the following types:
 - a) Eyewash fountain: Push-flag operating handle on stay-open valve.
 - b) Body spray: Quick-opening, chrome-plated, hand-squeeze level valve.
 - 4) Eyewash fountain and body spray equipped with pedal-operated and self-draining freeze proof valve.
 - 5) Water filter:
 - a) Made of FDA-approved polypropylene with disposable FDA-approved viscose-fiber filter media capable of removing particles larger than 20 microns.
 - b) Capable of withstanding rate of flow of seven gpm and working pressure of 200 psi at 100F.
 - 6) Shield: Fabricated as specified for toilet partition: Section 10155.
 - b. Portable type
 - 1) ASME rated 5-gallon stainless steel pressure tank.
 - 2) Equipped with built-in carrying handles, resilient bottom, pressure relief valve, tire filler valve and air pressure gauge.
 - 3) Furnished with twin chrome plated brass eye wash heads with automatic flow control and stay-open valve, with eight foot hose with hand held squeeze type valve and full size spray nozzle.
 - 4) Flow: 7-1/2 minutes from eye wash and 2-1/2 minutes from hose spray.
 - 5) Size: 25 inches tall and 26 inches circumference.
 - 6) Weight: 12 pounds empty and 42 pounds full.
 - 7) Chrome plate all metal parts.

G. Showers

1. Comply with the following applicable standards and other requirements specified for shower faucets:
 - a. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 - b. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 - c. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
 - d. Faucets: ASME A112.18.1.
 - e. Hand-Held Showers: ASSE 1014.
 - f. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 - g. Hose-Coupling Threads: ASME B1.20.7.
 - h. Manual-Control Antiscald Faucets: ASTM F 444.

- i. Pipe Threads: ASME B1.20.1.
- j. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- k. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
- l. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- 2. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - a. Atmospheric Vacuum Breakers: ASSE 1001.
 - b. Brass and Copper Supplies: ASME A112.18.1.
 - c. Dishwasher Air-Gap Fittings: ASSE 1021.
 - d. Manual-Operation Flushometers: ASSE 1037.
 - e. Plastic Tubular Fittings: ASTM F 409.
 - f. Brass Waste Fittings: ASME A112.18.2.
- 3. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - a. Flexible Water Connectors: ASME A112.18.6.
 - b. Floor Drains: ASME A112.6.3.
 - c. Grab Bars: ASTM F 446.
 - d. Hose-Coupling Threads: ASME B1.20.7.
 - e. Pipe Threads: ASME B1.20.1.
 - f. Plastic Shower Receptors: ANSI Z124.2.
 - g. Supply and Drain Protective Shielding Guards: ICC A117.1.
- 4. Shower Faucets:
 - a. Description: Single-handle thermostatic/pressure-balance valve for shower. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies; coordinate outlet with diverter valve.
 - (1) Body Material: Per Wamata Standards
 - (2) Finish: Per Wamata Standards
 - (3) Maximum Flow Rate: Per Wamata Standards
 - (4) Diverter Valve: Integral
 - (5) Mounting: Wall
 - (6) Operation: Compression, manual.
 - (7) Antiscald Device: Integral with mixing valve
 - (8) Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
 - (9) Supply Connections
 - (10) Backflow Protection Device for Hand-Held Shower
 - (11) Shower Head Type:
 - (12) Shower Head Material:
 - (13) Spray Pattern:
 - (14) Integral Volume Control:
 - (15) Shower-Arm Flow-Control Fitting
- 5. Shower Receptors
 - a. Description: Per WMATA Standards.
 - (1) Type: Standard, residential & Handicapped/wheelchair.
 - (2) Size: per ADA
 - (3) Color: per AHJ.
 - (4) Outlet: Drains per IPC.

H. Electric Water Cooler: FS A-A-1154, minimum capacity 4.75 gallons per hour, Type 1 or Type 2 dispenser, temperature not more than 60F at 15 minute period, bubbler-style, air cooled,

wall-hung, System T, for operation on 120-volt ac, 60-Hertz power. Dispenser not exceeding 18 inches in depth, with up-front spouts and controls; and complying with the ADA.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Protection of Fixtures:
 - 1. Protect plumbing fixtures from dirt, foreign objects and damage during construction period.
 - 2. Do not use warped or otherwise imperfect fixtures.
 - 3. Do not use installed fixtures for any purpose, except testing, prior to final acceptance by the Authority.
 - 4. Replace damaged and defective fixtures.
 - 5. Install vacuum breakers on water supply-piping connections to fixtures and equipment in accordance with requirements of jurisdictional authorities.

- B. Chair supports adjusted so that heights of fixtures above finished floor are as follows:
 - 1. Water closet: 18 inches to top of earthenware.
 - 2. Urinal: 17 inches to top surface of lowest part of lip.
 - 3. Lavatory: 31 inches to top of rim.
 - 4. Handicapped lavatory: 29-1/2 inches clear under apron.

- C. Emergency-Eyewash and Body-Spray Facilities:
 - 1. Install in locations shown and as follows:
 - a. Install water-supply line connecting facilities to water service.
 - b. Install filter on water-supply line at readily serviceable location.
 - c. Install drain line connecting facilities to drainage system as shown.
 - d. Install freeze-proof valve a minimum of 42 inches below grade.
 - e. Install portable type where shown.

- D. Electric Water Cooler:
 - 1. Install in locations shown and with top of spout 36 inches above floor.

END OF SECTION

THIS PAGE NOT USED

SECTION 15445

SEWAGE EJECTORS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing complete triplex dry pit submersible vertical electric sewage ejector.
- B. Related Work Specified Elsewhere:
 - 1. Piping Systems: Section 15205
 - 2. Control Equipment: Section 15900
 - 3. Miscellaneous Pumps: Section 15135
 - 4. Grounding and Bonding: Section 16060
 - 5. Wire, Cable and Busways: Section 16120
 - 6. Conduit, Raceway and Boxes: Section 16130
 - 7. Wiring and Control Devices: Section 16145
 - 8. Motors: Section 16225
 - 9. Motor Starters and Control Devices: Section 16425
 - 10. Circuit Breakers Panelboards and Load Centers: Section 16440

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications.
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASME code.
 - 3. ASTM: A48, E527.
 - 4. NEMA.
 - 5. P-MSHA.
 - 6. UL.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings:
 - a. Submit complete catalog information and shop drawings for material and equipment including wiring and control diagrams.
 - 2. Certification.
 - a. Manufacturer's certified test reports.
 - 3. Operation and Maintenance Manuals.
 - a. Submit for each drainage pumping system.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of piping subassemblies, parts, motors, starters and relays.

B. Dry Pit Pumping System:

1. Pumps:

- a. Triplex type, vertical dry-pit, non-clog sewage water pumps and motors as shown on pump schedule.
- b. Castings fabricated of gray cast iron with stainless steel wear rings and external nuts and bolts, conforming to ASTM A48 Class 30.
- c. Impeller: One piece, single suction, fully enclosed, vane-type, conforming to an ASTM A48 Class 30, non-clog design capable of passing minimum three-inch diameter solids statically, balanced and secured directly and straight motor shaft.
- d. Seals: Tandem double mechanical seals running in oil reservoir; lower seal composed of two separate carbon or ceramic lapped face rings. Protect lower compression spring against exposure to pumped liquid.
- e. Provide a pump which rotates on a minimum of two bearings permanently lubricated but capable of being regreased, suitable for a minimum L10 bearing life of 40,000 hours.
- f. Provide a heavy duty fabricated steel base with openings for access to the suction elbow and cleanout bolted directly to the volute. Provide a base which supports the assembled weight of the pump and driver. Furnish a cast iron elbow with 1/4-inch gauge connection, contoured hand hole clean out, and a 125-pound flat faced flange conforming to ANSI drilling.
- g. Provide a volute of one piece circular design with smooth fluid passages large enough to pass any solid that can pass through the impeller, made of close-grained cast iron conforming to ASTM A48 Class 30. The volute is to be side flagged tangential discharge, and capable of rotation in 45 increments to accommodate piping orientation. The volute is to have large cleanout openings located at the impeller centerline. Provide volute priming drain and 1/4-inch minimum gauge connections. Provide 125-pound flat faced flanges in accordance with ANSI drilling. Provide for removal of the rotating assembly without disturbing the suction or discharge piping. Hydrostatically test the casing to 1.5 times the design head or 1.25 times the shutoff head, whichever is greater.

2. Pump Motors: Section 16225, with the following additional requirements:

- a. 1,750 rpm maximum; 460-volt tolerance; plus or minus 10 percent nameplate-value voltage; non-overloading at all points of pump curve with cooling characteristics for continuous operation and with thermal-overload protection.
- b. Submersible as defined by the air-filled cast iron watertight enclosure.
- c. Shaft: Alloy S41600 stainless steel in accordance with ASTM E527; the rotor dynamically balanced to meet NEMA vibration limits; hardware stainless steel.

3. Controls: Control system components to be supplied by the pump manufacturer.

- a. Liquid-level controllers of direct acting float, mercury switch sensors for pump control and HIGH level indicators. Pump controls pint elevations and fully automatic operational sequence to reach pump as shown. HIGH level alarm indication system to be independent from pump control.
- b. Panel: Triplex pump control panel, in NEMA I, wall-mounted enclosure as shown. Provide surveillance for malfunction. Provide space for each pump motor starter.
- c. Motor starter: In accordance with Section 16425, with HAND/OFF/AUTO selector switch.
- d. Provide automatic electric alternator with triplex pump control panel.
 - 1) Solid state, plug-in type.

- 2) Independent ON, common OFF operation.
 - 3) Relay rating: Heavy-duty, 10 amperes, 250 volts.
 - e. HIGH level indication relays.
 - f. Float switches: Direct automatic float switches with Alloy S31600 stainless steel in accordance with ASTM E527, 5-1/2-inch diameter housing; mounting clamps and attached cables. Capable of detecting level changes of one inch from reset position, and suitable for mounting to one-inch stainless steel vertical pipe.
 - g. Provide local high-motor-temperature indicator light.
 - 4. Sequence of operation:
 - a. As the liquid level rises in the wet well have SE-1 energize as the lead pump float switch rises, and deenergize at the off level/lowering of the float switch.
 - b. On the next cycle, have SE-2 energize and proceed as described for SE-1.
 - c. On the following cycle, have SE-3 proceed the same as described above.
 - d. Program SE-1, SE-2 and SE-3 to alternate each cycle and program the other pumps to be first lag pump on and second lag pump on. The sequence is as follows:

1st Cycle	SE-1, SE-2, SE-3
2nd Cycle	SE-2, SE-3, SE-1
3rd Cycle	SE-3, SE-1, SE-2

 Normal operation = one pump per load only.
 - e. If the water level continues to rise after the first pump has energized and due to clog or mechanical failure, have SE-2 energize and trigger alarm at the first lag pump input; and if the water continues to rise due to second pump failure, then have SE-3 energize and activate alarm at the second lag pump input.
 - f. Program two more alarm inputs for indication functions.
 - g. Make low-level and high-level alarms independent of pump control and activated as required.
 - 5. Wiring:
 - a. Wiring and conduit: Sections 16130 and 16120. Cable racking in upper room and below floor slab.
 - b. Wiring for controls and motors by pump system equipment manufacturer.
 - c. Auto transformer, pump starter control panel wired from transfer switch, as shown.
 - d. Pump-motor cables: Suitable for submersible-pump application with P-MSHA approval demonstrated by code or legend permanently embossed on cable, 25 feet per pump, strain-relieved within pump junction chamber.
 - 6. Piping, valves and fittings: Section 15205, except check valves to be swing type with outside lever and spring or outside lever and weight; steel or iron body and cap and flanged end connection.
 - 7. Thrust restraints and anchors: Provide for exposed or buried pipe.
 - 8. Provide pump access gratings and ladders.
- C. Miscellaneous Equipment: Provide the following:
- 1. Furnish 120-volt, duplex, polarized convenience outlet inside of control panel.
 - 2. Provide 120-volt accessory controls with 15-ampere single-phase circuit breaker for each item.
 - 3. Provide ground-fault protection in each combination starter or trip breaker. Field adjustable device with range to 50-amperes and factory set at 5-amperes pickup fault current.
 - 4. Automatic transfer switch in accordance with Section 16145.
 - 5. Ground bus bar in accordance with Section 16060.
 - 6. Circuit breaker in accordance with Section 16440.

- 7. Surveillance in accordance with Section 15900.
- 8. Indication loss of power.

- D. Hand propelled carrier: Provide monorail and hand propelled carrier as shown.
- E. Sump pump: Provide sump pump as specified in Section 15135.
- F. Nameplates: Securely attach to each major item of equipment showing manufacturer's name, model number and serial number as specified in Section 15075.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install complete pumping system including provision for hoisting in accordance with manufacturer's recommendation and place into operation. Follow manufacturer's recommendation for minimum separation between sensor and maximum expected material level.
- B. Fit equipment and appurtenances within space provided and make readily serviceable.

3.02 FIELD QUALITY CONTROL:

- A. Tests and inspections:
 - 1. Pump chamber: Test shop and field joints for water tightness by pressurizing with compressed air to a minimum of five inches of water gauge and applying water and soap solution to the joints. Seal leaks and retest joints until leak free.
 - 2. Make arrangements for water needed for testing.

3.03 MANUFACTURER'S ASSISTANCE AND WARRANTY:

- A. Have the manufacturer guarantee equipment and controllers for two years of operation or 30 months from date of shipment, whichever comes first, so that the equipment is free from defects in design, workmanship or materials.
- B. In the event that a component fails to perform as specified or is proven defective in service during the guarantee period, have the manufacturer promptly replace the defective part at no additional cost to the Authority.
- C. Provide support beams, concrete pads, platforms, hangars and anchor bolts necessary for proper installation of equipment as recommended by manufacturer.

END OF SECTION

SECTION 15480

DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing domestic electric water heaters.
- B. Related Work Specified Elsewhere:
 - 1. Concrete Pads: Sections 03100 and 03300.
 - 2. Miscellaneous Pumps : Section 15135.
 - 3. Piping Systems: Section 15205.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASME Boiler and Pressure Vessel Code.
 - 3. UL listed.
 - 4. ASHRAE: 90.1b, Standard for Energy Efficiency.
 - 5. IPC 2003.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Certification.
 - 4. Operations and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of equipment, subassemblies, parts, relays and other items
- B. Water-Heater Equipment; UL listed and as follows:
 - 1. Capacity of storage-type water heaters and accessories: Kitchen, Restroom and Shower room.
 - 2. Water heaters fabricated of steel in accordance with the following additional requirements:
 - a. Less than 120-gallon capacity: Applicable local plumbing code.

3. Glass-lined tanks insulated with minimum 1-1/2 inch fibrous-glass blanket, or manufacturer's standard insulation with metal jacket over insulation.
4. Heating elements of double Incoloy rod-type for operation at voltage shown.
 - a. Water heaters with capacity of 20 gallons or less equipped with single heating element.
 - b. Water heaters with capacity of more than 20 gallons equipped with two or more heating elements.
5. Furnished with complete automatic controls including temperature protector designed to shut-off power supply if water temperature in tank rises to 205F.
6. Low-water cutoff to protect system from operating when water level drops below electrical probe.
7. Immersion-type thermostats and dial-indicating temperature gauge.
8. In-line hot-water recirculating pump: Section 15135.
9. Meets ASHRAE 90.1b, Standard for Energy Efficiency.
10. Designed for 100 °F recovery.

C. Nameplates:

1. Securely attached plate on each water heater showing manufacturer's name, model number and serial number.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances within space provided and make readily serviceable.
- B. Provide supports, concrete pads, hangers and anchor bolts necessary for proper installation of equipment as recommended by manufacturer.
- C. Install complete potable make-up water system as shown and in accordance with Section 15205.

END OF SECTION

SECTION 15515

WATER-TUBE BOILERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies providing packaged, water-tube boilers, trim, and accessories for generating heating hot water
- B. Related Work Specified Elsewhere:
 - 1. Insulation: 15080
 - 2. Piping Systems: 15205
 - 3. Heating Equipment: 15765
 - 4. Water Treatment System: 15186
 - 5. Vibration Isolation: 15070
 - 6. Breechings, Chimneys, and Stacks: 15550

1.02 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. UL Compliance: Test boilers for compliance with UL 726, "Oil-Fired Boiler Assemblies"; and UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.03 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, Nox emission certification, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
- C. Source quality-control test reports.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.
- G. Startup service reports.

1.04 FIELD SERVICE

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace drums, tubes, headers, cabinets, atmospheric gas burners, and pressure vessels of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Drums, Tubes, Headers, Cabinets, and Atmospheric Gas Burner: Five years from date of Substantial Completion, pro rata.
 - 2. Warranty Period for Pressure Vessel: 20 years from date of Substantial Completion, for thermal shock.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

- A. Description: Factory-fabricated, water-tube boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, supply and return connections, and controls.
- B. Heat-Exchanger Design: Straight, steel tubes rolled into steel headers.
- C. Combustion Chamber: Equipped with poured refractory on floor and lap-jointed cast refractory with fiber-blanket joint seals on side walls. Combustion chamber shall have flame observation ports in front and back.
- D. Casing:
 - 1. Insulation: Insulating board and mineral-fiber insulation surrounding the heat exchanger and combustion chamber.
 - 2. Top Flue Connection: Constructed of aluminized steel.
 - 3. Jacket: Galvanized sheet metal, with screw-fastened closures and baked-enamel protective finish.
 - 4. Mounting base to secure boiler to concrete base.
 - 5. Control Compartment Enclosure: NEMA 250, Type 1A.
- E. Barometric Damper: Galvanized-steel assembly with flue-gas thermometer.

2.02 GAS-FIRED BURNER

- A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for natural gas. Mount burner on hinged access door to permit access to combustion chamber.
- B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
 - 1. Motors: Comply with Section 16225.
- C. Gas Train: Control devices and control sequence.
- D. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
- E. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.

2.03 OIL-FIRED BURNER

- A. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil. Mount burner on hinged access door to permit access to combustion chamber.
- B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
 - 1. Motors: Comply with Section 16225.

- C. Oil Supply: Control devices and control sequence.
- D. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid flame-safety control.
- E. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.

2.04 TRIM

- A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
- B. Aquastat Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- E. Boiler Air Vent: Automatic piped full size to floor drain.
- F. Drain Valve: Full size of boiler connection but not less than NPS 3/4 hose-end gate valve.
- G. Tankless Heater: Carbon-steel or Bronze header with copper-tube heat exchanger, mounted in a port of upper drum and sealed with fiber gasket.
- H. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle.
- I. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 shall have rising stem.
- J. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

2.05 CONTROLS

- A. Refer to Division 15 Section "Control Equipment."
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
- C. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

2.06 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 16 Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

2.07 SOURCE QUALITY CONTROL

- A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER INSTALLATION

- A. Install boilers level on concrete base. Concrete base is specified in Division 15 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.
- B. Vibration Isolation: Elastomeric isolator pads or mounts. Vibration isolation devices and installation requirements are specified in Division 15 Section "Vibration Isolation."
- C. Install gas-fired boilers according to NFPA 54.
- D. Install oil-fired boilers according to NFPA 31.
- E. Assemble boiler tubes in sequence and seal each tube joint.
- F. Assemble and install boiler trim.
- G. Install electrical devices furnished with boiler but not specified to be factory mounted.
- H. Install control wiring to field-mounted electrical devices.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- D. Connect oil piping full size to burner inlet with shutoff valve and union.
- E. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.

- F. Install piping from safety relief valves to nearest floor drain.
- G. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- H. Connect breeching to full size of boiler outlet. Comply with requirements in Division 15 Section "Breechings, Chimneys, and Stacks" for venting materials.
- I. Ground equipment according to Division 16 Section "Grounding and Bonding."
- J. Connect wiring according to Division 16 Section "Wire, Cable and Busways."

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Perform installation and startup checks according to manufacturer's written instructions.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Performance Tests: Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Authority's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION

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SECTION 15550

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies providing breechings, chimneys, and stacks for fuel-fired equipment.
 - 1. Listed single and double-wall vents and chimneys.
 - 2. Listed refractory-lined breechings and stacks.
 - 3. Field-fabricated metal breechings and chimneys.
- B. Related work specified elsewhere:
 - 1. Water Tube Boilers: Section 15515.
 - 2. Insulation: Section 15080.

1.02 QUALITY ASSURANCE

- A. Source limitation: Obtain listed system components through one source from a single manufacturer.
- B. Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel," for hangers and supports and AWS D9.1, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.
- C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Chimney liners.
 - 2. Type B and BW vents.
 - 3. Type L vents.
 - 4. Special gas vents.
 - 5. Building-heating-appliance chimneys.
 - 6. Refractory-lined metal breechings and chimneys.
 - 7. Guy wires and connectors.
- B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
 - 2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Welding certificates.
- D. Warranties: Special warranties specified in this Section.

1.04 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof penetrations. These items are specified in Section 07730.

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
- B. Warranty Period: 10, 15, or 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LISTED CHIMNEY LINERS

- A. Description: Straight or Corrugated, single-wall chimney liner tested according to UL 1777 and rated for 1000 deg F continuously, or 2100 deg F for 10 minutes; with negative or positive flue pressure complying with NFPA 211 and suitable for general usage.
- B. Straight Liner Materials: ASTM A 666, Type 304 or 316 stainless steel.
- C. Corrugated Liner Materials: ASTM A 240, Type 321, ASTM A 240, Type 430, or ASTM A 959, Type 29-4C.
- D. Accessories:
 - 1. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
 - 2. Sealant: Manufacturer's standard high-temperature sealant.
 - 3. Insulating Fill: Manufacturer's standard high-temperature insulation fill material in annular space surrounding chimney liner including high-temperature, ceramic-fiber insulation required to seal chimney at top and bottom.

2.02 LISTED TYPE B AND BW VENTS

- A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B, or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211 and suitable for certified gas-fired appliances.
- B. Construction: Inner shell and outer jacket separated by at least a 1/4-inch airspace.
- C. Inner Shell: ASTM B 209, Type 1100 aluminum, ASTM B 209, Type 3003 aluminum, ASTM B 209, Type 3105 aluminum, or ASTM A 666, Type 430 stainless steel.
- D. Outer Jacket: Galvanized or Aluminized steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

2.03 LISTED TYPE L VENT

- A. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F continuously, or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211 and suitable for low-heat appliances.
- B. Construction: Inner shell and outer jacket separated by airspace filled with high-temperature.
- C. Inner Shell: ASTM A 666, Type 304 or 316 stainless steel.
- D. Outer Jacket: Galvanized, Aluminized, or Stainless steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

2.04 LISTED SPECIAL GAS VENT

- A. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211 and suitable for condensing-gas appliances.
- B. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

- C. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
- D. Outer Jacket: Aluminized or Stainless steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

2.05 LISTED BUILDING-HEATING-APPLIANCE CHIMNEYS

- A. Description: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F continuously, or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211 and suitable for dual-fuel boilers, oven vents, water heaters, or exhaust for engines.
 - 1. Construction: Inner shell and outer jacket separated by annular space filled with high-temperature insulation
 - 2. Inner Shell: ASTM A 666, Type 304 or 316 stainless steel.
- B. Description: Double-wall metal vents tested according to UL 103 and 959 and rated for 1400 deg F continuously, or 1800 deg F for 10 minutes; with positive or negative flue pressure complying with NFPA 211 and suitable for dual-fuel boilers, oven vents, water heaters, or exhaust for engines.
 - 1. Construction: Inner shell and outer jacket separated by annular space filled with high-temperature insulation.
 - 2. Inner Shell: ASTM A 666, Type 304 or 316 stainless steel.
- C. Description: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F continuously, or 2100 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211 and suitable for fireplaces and other solid-fuel-burning appliances.
 - 1. Construction: Inner shell and outer jacket separated by at least a 1-inch , 1-1/2-inch, 2-inch, or 4-inch annular space filled with high-temperature, ceramic-fiber insulation.
 - 2. Inner Shell: ASTM A 666, Type 304, ASTM A 666, Type 316, or ASTM A 240/A 240M, Type 430 stainless steel.
- D. Outer Jacket: Galvanized, Aluminized, or Stainless steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

2.06 LISTED, REFRACTORY-LINED METAL BREECHINGS AND CHIMNEYS

- A. Comply with ASME STS-1-1992.
- B. Design Wind Loads: 150 mph.
- D. Chimney Outer Jacket: Aluminized or Galvanized steel with riveted or welded seams.
- E. Refractory Lining: Tested according to UL 959 for temperature and acid resistance, and bearing the testing laboratory label.
- F. Finish: Factory-applied, high-heat-resistant paint; color as selected by Architect.
- G. Base Section: Acid-resistant-coated, cast-iron anchor lugs for securing stack to foundation with anchorage designed by manufacturer.
- H. Reinforced Cleanout Section: Smoke-tight connection, with gasketed and bolt-tightened inspection plate; neck shall be welded to stack section.
- I. T- or Y- Sections: Smoke-tight connection, with welded joints and refractory lining; finished with smooth transition and with no exposed metal on inside.

- J. Spark Screen: ASTM A 666, Type 316 stainless steel, 0.0625 inch thick, maximum 1/2-by-1/2-inch mesh, with ASTM A 666, Type 304 stainless-steel rolled angle and drawband.
- K. Guy Bands: 8-inch- wide bands of same material as jacket, with bolted fasteners.
- L. Roof Penetration: Factory-fabricated thimbles, flashings, and counterflashings.
- M. Fabricate sections, fittings, and accessories as individual pieces or in combination lengths for field handling.
- N. Fabricate components with centrifugally cast refractory lining in lengths suitable for connection with drawbands.
- O. Bond refractory to steel jacket with calcium aluminate cement to prevent separation in finished product during shipping, handling, and installation.
- P. Fabricate stacks with anchor lugs; cleanout; T-sections; flashings and counterflashings; and provisions for support, expansion, and contraction.

2.07 FIELD-FABRICATED METAL BREECHINGS AND CHIMNEYS

- A. Fabricate freestanding chimneys according to SMACNA's "Guide for Steel Stack Design and Construction."
- B. Fabricate breechings and chimneys from ASTM A 569 hot-rolled steel with continuously welded joints, complying with NFPA 211 for minimum metal thickness.
- C. Fabricate chimneys and vent connectors from galvanized steel, complying with NFPA 211 for minimum metal thickness.
- D. Fabricate chimneys and vent connectors from ASTM B 209, Type 1100 or 3003, aluminum or stainless steel, complying with NFPA 211 for the following minimum metal thicknesses:
- E. Fabricate cleanout doors from compatible material, same thickness as breeching, bolted and gasketed.

2.09 GUYING AND BRACING MATERIALS

- A. Cable: Galvanized, stranded wires.
- B. Pipe: Galvanized steel.
- C. Angle Iron: Galvanized steel.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all

accessories, without exceeding appliance loading.

- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- E. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.
- F. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.
- G. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

3.03 INSTALLATION OF UNLISTED, FIELD-FABRICATED BREECHINGS AND CHIMNEYS

- A. Suspend breechings and chimneys independent of their appliance connections.
- B. Align breechings at connections, with smooth internal surface.
- C. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- D. Support breechings and chimneys from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or beam clamps according to manufacturer's written instructions.

3.04 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION

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SECTION 15625

CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing complete factory-assembled packaged water-chilling units.
- B. Related Work Specified Elsewhere:
 - 1. Concrete pads: Sections 03100, 03200 and 03300.
 - 2. Water Treatment System: Section 15186.
 - 3. Piping systems: Section 15205.
 - 4. Insulation: Section 15080.
 - 5. Vibration isolation: Section 15070.
 - 6. Control equipment: Section 15900.
 - 7. Conduit, raceways and cabinets: Section 16130.
 - 8. Wire, cable and busways: Section 16120.
 - 9. Motors: Section 16225.
 - 10. Motor starters and control devices: Section 16425.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ASME Code.
 - 3. ARI: 550.
 - 4. ANSI: B9.1.
 - 5. ASHRAE Standards.
- B. Design Criteria:
 - 1. For single-chiller chiller plant: Select each water-chilling unit in accordance with the following criteria:
 - a. Water on evaporator: 55F.
 - b. Water off evaporator: 42F.
 - c. Water on condenser: 85F.
 - d. Water off condenser: 95F.
 - e. Net refrigeration effect, chilled-water flow rate and condenser water-flow rate: as shown on the Contract Drawings.
 - f. Control system compatible with AEMS system.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.

2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearance, method of field assembly, components, and location and size of each field connection.
 - a. Capacity curves for evaporator/compressor and compressor/condenser plotted on charts to ensure properly balanced refrigeration equipment under design conditions.
3. Certification:
 - a. Record of packaged water chillers in field operation for minimum of 12,000 operating hours for not less than ten individual units prior to shipment. Types that have already shown satisfactory operation for this period may have modifications, provided modifications will not increase maintenance and operating costs or decrease life of machine and complies with ARI 550.
 - b. Verification of successful use of material used for impeller wheel for centrifugal compressors, if other than aluminum alloy.
4. Operation and Maintenance Manuals.

1.04 JOB CONDITIONS:

- A. Safety Requirements:
 1. Properly guard belts, pulleys, chains, gears, couplings, projecting set screws, key and other rotating parts to prevent danger to personnel.

1.05 OPERATION AND MAINTENANCE TRAINING:

- A. In accordance with the General Requirements.

PART 2 – PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 1. Supply chiller with full operating charge of HFC-134a Refrigerant and oil. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies, parts, motors, starters and relays.
- B. Centrifugal Compressors:
 1. Single-stage, statically and dynamically balanced impeller.
 2. Driven by drive motor directly or by means of gears.
 3. Casing fabricated of cast iron, aluminum or steel plate with split sections gasketed and bolted.
 4. Impeller wheel constructed of aluminum alloy or other material that has been demonstrably successful in use.
 5. Impeller shaft fabricated of heat-treated alloy steel with sufficient rigidity for proposed operation at specified operating speeds.
 6. Shaft main bearings: Journal with bronze or babbitted liners or one-piece aluminum alloy inset.
 7. Lubrication: Forced feed to lubrication points.
 8. Differential oil-pressure cutout interlocked with compressor starter to allow compressor to operate only when recommended oil pressure is provided to bearings.
 9. Capacity reduction designed to provide automatic capacity modulation from 100 percent capacity to 10-percent capacity without cycling.
 10. Capacity-control system actuated by temperature of water leaving evaporator.

11. Transducers for remote surveillance and control by AEMS system as shown and in accordance with Section 15900.
- C. Water Cooler:
1. Removable bundle-type copper tube, constructed of seamless copper tubing minimum 0.035-inch wall thickness, plain or with integral fins individually replaceable and rolled or brazed into copper or steel-tube sheets, with baffles and tube supports of copper or steel.
 2. Complete refrigerant-feed control, designed to control feed to evaporator at each level of load range from 100 percent to 10 percent of package water-chilling capacity without use of hot-gas bypass.
 3. Performance based on water velocity of minimum three fps and maximum ten fps throughout full length of tubes and fouling factor of 0.00025 for individual machine.
 4. Water spaces in coolers designed for minimum 150-psi working pressure; tested in accordance with ASME Code.
 5. Water spaces not subject to the ASME Code due to size or other limitations, tested at pressure of not less than 1-1/2 times working pressure.
- D. Insulation:
1. Each water-chilling unit provided with insulation as specified in Section 15080.
- E. Condenser:
1. Shell-and-tube type permitting tubes to be cleaned from each end by removing water-box cover plates or head.
 2. Tubes fabricated of seamless copper tubing, minimum 0.035-inch wall thickness, with integral fins individually replaceable and rolled or brazed into copper or steel-tubed sheets.
 3. Performance based on rate of water flow specified and water velocity of 3-fps minimum and 10-fps maximum throughout full length of tubes and fouling factor of 0.0075.
 4. Water spaces in condenser designed for minimum 150-psi working pressure; tested in accordance with requirements of ASME Code.
 5. Refrigerant side of shell tested at 1-1/2 times refrigerant saturation pressure.
- F. Compressor Drive Motor, Hermetic Units:
1. Squirrel-cage induction, refrigerant gas-cooled, rated at 460 volts, three-phase and 60 Hertz and in accordance with Section 16225.
 2. Bearings: Sleeve-type.
 3. Pressure lubrication with pump and cooler.
 4. Gear cases oiltight.
 5. Motor starter conforming to recommendations of water-chiller manufacturer and as specified in Section 16425.
 6. Wiring as recommended by compressor manufacturer to provide complete automatic operation of centrifugal refrigeration system.
 7. Each centrifugal machine, driven through speed-increasing gears designed to ensure self-alignment, lubrication and minimum of unbalanced forces.
- G. Compressor Drive Motor, Open-Drive Units:
1. Dripproof, fully guarded, squirrel-cage induction and as specified in Section 16225.
- H. Controls, Control Panel and Gauges: Provide refrigerant monitors suitable for refrigerant R-134a per ASHRAE Standards.

1. Provide a microprocessor control panel which can monitor and display various chiller parameters and alarms. As a minimum, monitor the following points:
 - a. Analog points:

1)	Chilled water enter temperature	DEG F
2)	Chilled water return temperature	DEG F
3)	Condenser water enter temperature	DEG F
4)	Condenser water return temperature	DEG F
5)	Condenser water pressure	PSI
6)	Chilled water pressure	PSI
7)	Condenser refrigerant pressure	PSI
8)	Evaporator refrigerant pressure	PSI
9)	Chiller oil pressure	PSI
10)	Chiller KW demand	KW
11)	Chiller efficiency	KW/TON
 - b. Alarm points:

1)	Chiller oil temperature	DEG F
2)	Chiller bearing temperature	DEG F
 - c. In addition, for future interface with an Energy Management System, provide a 4-20 mA signal output for each analog point and a dry contact closure for each alarm point.
 2. Each water-chilling unit provided with electronic controls as specified in Section 15900.
 3. Capacity-control mechanism to be integral part of packaged water chiller maintaining leaving water temperature within 0.75 degrees F of setting temperature from 100 percent to 10 percent of chiller capacity.
 4. Control mechanism: Compressor stopped when chiller output drops below 10 percent and automatically restarted when leaving water rises to preset temperature.
 5. Timing device: Restarting unit limited to four starts per hour, minimum 15 minutes apart.
 6. Modulating chilled-water operating control having adjustable throttling range, with means of calibration by adjusting chilled-water temperature control point. Pneumatic or solid-state electronic control.
 7. Control panel provided on each unit with compressor-operating control, START/STOP switch and the following gauges and protective devices:
 - a. Suction-pressure gauge.
 - b. Condensing-pressure gauge.
 - c. Oil-pressure gauge.
 - d. Low-refrigerant-pressure cutout.
 - e. High-pressure cutout, manual reset only.
 - f. Low-oil-pressure cutout, manual reset only.
 - g. Low-water-temperature cutout, manual or automatic reset.
 - h. Motor-winding high-temperature cutout, manual reset only.
 - i. Running-time meter.
 8. Signal lights for protective devices.
 9. Alarm-circuit terminals in basic chiller-package control panel designed to actuate alarm device in event of machine cutout of protective devices.
- I. Evacuation System:
1. Manually started and stopped evacuation system when positive-pressure refrigerant is used and chiller package is not designed to permit pumpdown storage and isolation of entire charge in condenser.

2. Motor-driven, air-cooled or water-cooled reciprocating condensing unit and receiver of sufficient capacity to store entire refrigerant charge of largest water-chilling system.
 3. Receiver in accordance with ASME Code, mounted on floor brackets and provided with rupture members and dual relief valves in series.
 4. Entire system completed with valves, piping and controls so that evacuation system may be utilized for pumpout, without temporary piping or wiring.
- J. Receiver, Refrigerant:
1. Horizontal liquid receiver designed, fitted and rated in accordance with ASME Code.
 2. Each receiver having storage capacity 25 percent minimum in excess of that required for fully charged system.
 3. Inner surfaces thoroughly cleaned by sandblasting.
 4. Each receiver equipped with inlet, outlet drip pipe, drain plug, purging valve, relief valves of capacity and setting in accordance with ANSI B9.1 and two bulls-eye liquid sight glasses.
 5. Sight glasses installed in same vertical plane, 90 degrees apart, perpendicular to the axis of the receiver and not over 3-inches horizontally from drip pipe measured along axis of receiver.
 6. Receiver constructed and tested in accordance with ASME Code.
- K. Starter:
1. Motor starters: Section 16425.
- L. Tools:
1. One complete set of special tools as recommended by manufacturer for field maintenance of system.
- M. Factory Wiring:
1. In accordance with manufacturer's standard practice.
- N. Nameplates:
1. Securely attached to each chiller showing manufacturer's name, model number and serial number.

PART 3 – EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances within space provided and make readily serviceable.
- B. Provide concrete pads, platforms and hangars necessary for proper installation of equipment.
- C. Install chillers on concrete pads 6-inches minimum height in accordance with Sections 03100, 03200 and 03300.
- D. Install chillers on vibration isolators in accordance with Section 15070.
- E. Coordinate work with other trades.
- F. Mount tools on tool board in equipment room, as directed.

- G. For piping system installation, see Section 15205.
- H. For water treatment installation, see Section 15186.
- I. For conduit, raceways and cabinets installation, see Section 16130.
- J. For wire cable, and busways, installation, see Section 16120.

3.02 FIELD SERVICES:

- A. Hermetic Units: Obtain on-site services for two man-days of manufacturer's engineering representative to advise on the following:
 - 1. Pressure test on hermetic water-chilling unit for leaks.
 - 2. Evacuation and dehydration of machine to minus 12 degF wet bulb or to absolute pressure of not over 0.204-inch of mercury for 24 hours minimum.
 - 3. Charging machine with refrigerant.
 - 4. Starting machine and instructing representative of the Authority as to its proper care and operation.
- B. Open Units: Obtain on-site services for two man-days of manufacturer's engineering representative to advise on the following:
 - 1. Erection, alignment, testing and dehydrating.
 - 2. Charging machine with refrigerant.
 - 3. Starting machine and instructing Authority personnel in proper care and operation of machine.

END OF SECTION

SECTION 15626
ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL

1.02 SUMMARY

- A. This Section includes packaged, water and air-cooled, electric-motor-driven, rotary-screw water chillers with the following features:
 - 1. Motor controller.
 - 2. Microprocessor-based controls.

1.03 DEFINITIONS

- A. EER: Energy-efficiency ratio.
- B. IPLV: Integrated part-load value.

1.04 SUBMITTALS

- A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Complete set of manufacturer's certified prints of water chiller assemblies, control panels, sections, and elevations, and unit isolation. Include the following:
 - 1. Assembled unit dimensions.
 - 2. Operating weight and load distribution.
 - 3. Required clearances for maintenance and operation.
 - 4. Size and location of piping and wiring connections.
 - 5. Vibration Isolation Calculations and Details: Signed and sealed by a qualified professional engineer.
 - 6. Wiring Diagrams: Power, signal, and control wiring.
- D. Certificates: For certification required in "Quality Assurance" Article.
- E. Source quality-control test reports.
- F. Startup service reports.
- G. Operation and Maintenance Data: For each water chiller to include in emergency, operation and maintenance manual.
- I. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

- A. ARI Certification: Signed by manufacturer certifying compliance with requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for

safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.

- C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NFPA 70.
- E. Comply with UL 1995.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Ship water chillers from the factory fully charged with refrigerant or nitrogen.

1.07 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship.

PART 2 - PRODUCTS

2.02 PACKAGED WATER CHILLERS

- A. Description: Factory-assembled and -tested water chiller complete with casing, compressor, evaporator, condenser, controls, interconnecting unit piping and wiring, indicated accessories, and mounting frame.
 - 1. Casing: Weatherproof, constructed of hot-dip galvanized steel with factory-painted finish.
 - 2. Fans: Propeller type, statically and dynamically balanced, with vertical air discharge for high efficiency and low sound; located in its own compartment to eliminate cross flow of condenser air during fan cycling; and equipped with heavy-gage, weather-protected fan guard.
 - 3. Fan Motor: Direct drive, weatherproof, with bearings permanently lubricated, and having built-in current- and thermal-overload protection.
- D. Fabricate water chiller mounting frame and attachment to the pressure vessel with reinforcement strong enough to resist water chiller movement during a seismic event when the water chiller mounting frame is anchored to the building structure.

2.03 COMPRESSORS

- A. Description: Positive displacement, oil injected with direct-drive, hermetically sealed motor.
 - 1. Casing: Cast iron, precision machined for minimum clearance about periphery of rotors.
 - 2. Rotors: Single or Twin screw.
- B. Capacity Control: Hydraulically operated, modulating or stepped sliding valve to maintain chilled-water temperature set point without hunting within throttling range.
- C. Oil Lubrication System: Positive-displacement submersible pump with heater, oil filter, and sight glass.
- D. Refrigerant and Oil: HCFC-22, HFC-134a, R-407c, or R-410a.
- E. Refrigerant Compatibility: Seals, O-rings, motor windings, and internal water chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- F. Refrigerant Circuit: Independent circuits. Each circuit shall include a thermal expansion valve, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter drier, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

2.04 HEAT EXCHANGERS

- A. Evaporator:
 - 1. Description: Shell-and-tube design, ASME labeled.
 - 2. Shell Material: Carbon steel.
 - 3. Tube Construction: Copper, individually replaceable, expanded into tube sheets.
- B. Condenser:
 - 1. Description: Shell-and-tube design, ASME labeled.
 - 2. Shell Material: Carbon steel.
 - 3. Tube Construction: Copper, externally enhanced and individually replaceable, expanded into tube sheets.
 - 4. Water Box: Standard or Marine, having flanged or grooved mechanical-joint coupling water-nozzle connections with a thermistor-type temperature sensor factory installed in each nozzle.
- C. Air-Cooled Condenser: Copper tubes with mechanically bonded aluminum fins, integral subcooling circuit, leak tested at 450 psig.

2.05 INSULATION

- A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type II, for sheet materials.

2.06 ACCESSORIES

- A. Pressure Relief Valve: Single- or multiple-reseating-type, spring-loaded relief valve.

2.07 CONTROLS

- A. Control Panel: Stand-alone, microprocessor based.
- B. Enclosure: Unit-mounted enclosure, hinged or lockable; factory wired with a single-point power connection and a separate control circuit.
- C. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad.
- E. Manually Reset Safety Controls shall shut down water chiller and require manual reset.
- F. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control chilled-water set point and chiller-control displays and alarms.

2.08 MOTORS

- A. Comply with requirements in Division 16 Section "Motors."
 - 1. Open-drive motors shall have flanged or flexible coupling suitable for direct connection to compressor.

2.09 MAGNETIC ENCLOSED CONTROLLERS

- A. Enclosure: Unit mounted with hinged access door with lock and key or padlock and key.
- B. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of enough capacity to operate connected pilot and indicating and control devices.
- C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of water chiller control microprocessor.
- D. Star-Delta Controller: NEMA ICS 2, closed transition.
- E. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.
 - 1. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - 2. Light-emitting-diode indicators showing motor and control status.
- F. Accessories: Devices shall be factory installed in controller enclosure.

2.10 SOURCE QUALITY CONTROL

- A. Factory test and rate water chillers, before shipping, according to ARI 550/590, "Water

- Chilling Packages Using the Vapor Compression Cycle." Stamp with ARI label.
- B. Factory test heat exchangers hydrostatically at 1.50 times the design pressure.
 - C. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
 - D. Factory test and inspect water boxes at 150 percent of working pressure.
 - E. Rate sound power level according to ARI 575 or ARI 370 procedure.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Before water chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WATER CHILLER INSTALLATION

- A. Install water chillers on concrete base. Concrete base is specified in Division 15 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.
- B. Concrete Bases: Anchor chiller mounting frame to concrete base.
- C. Vibration Isolation: Rubber pads, restrained spring isolators or vibration isolation equipment base. Vibration isolation devices and installation requirements are specified in Division 15 Section "Vibration Isolation."
- F. Maintain manufacturer's recommended clearances for service and maintenance.
- G. Charge water chiller with refrigerant if not factory charged.

3.03 CONNECTIONS

- A. Chilled- and condenser-water piping installation requirements are specified in Division 15 Section 15205.
- B. Install piping adjacent to chiller to allow service and maintenance.
- F. Ground water chillers according to Division 16 Section "Grounding and Bonding."
- G. Connect wiring according to Division 16 Section "Basic Electrical Materials and Methods."
- H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions.
- D. Prepare a written startup report that records results of tests and inspections.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Authority's maintenance personnel to adjust, operate, and maintain water chillers.

END OF SECTION

SECTION 15628
RECIPROCATING/SCROLL WATER CHILLERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section includes packaged, water and air-cooled, electric-motor-driven, reciprocating/scroll water chillers
- B. Related Work Specified Elsewhere
 - 1. Concrete pads: Sections 03100 and 03300.
 - 2. Water Treatment System: Section 15186.
 - 3. Piping systems: Section 15205.
 - 4. Insulation: Section 15080.
 - 5. Vibration isolation: Section 15070.
 - 6. Control equipment: Section 15900.
 - 7. Conduit, raceways and cabinets: Section 16130.
 - 8. Wire, cable and busways: Section 16120.
 - 9. Motors: Section 16225.
 - 10. Motor starters and control center: Section 16425.

1.02 DEFINITIONS

- A. EER: Energy-efficiency ratio.
- B. IPLV: Integrated part-load value.

1.03 QUALITY ASSURANCE

- A. ARI Certification: Signed by manufacturer certifying compliance with requirements in ARI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."
- B. ASHRAE Certification: Signed by manufacturer certifying compliance with ASHRAE 15 for safety code for mechanical refrigeration. Comply with ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
- C. ASME Compliance: Fabricate and label water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NFPA 70.
- E. Comply with UL 1995

1.04 SUBMITTALS

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Complete set of manufacturer's certified prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
 - a. Assembled unit dimensions.
 - b. Weight and load distribution.
 - c. Required clearances for maintenance and operation.
 - d. Size and location of piping and wiring connections.
 - e. Vibration Isolation Calculations and Details: Signed and sealed by a qualified professional engineer.
 - f. Wiring Diagrams: Power, signal, and control wiring.
 - 3. Certificates: For certification required in "Quality Assurance" Article.
 - 4. Source quality-control test reports.
 - 5. Startup service reports.
 - 6. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
 - 7. Warranties: Special warranties specified in this Section.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Ship water chillers from the factory fully charged with refrigerant or nitrogen.

1.06 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.07 WARRANTY

- A.. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship.

PART 2 - PRODUCTS

2.01 PACKAGED WATER CHILLERS

- A. Description: Factory-assembled and -tested water chiller complete with casing, compressor(s), evaporator, condenser, controls, interconnecting unit piping and wiring, indicated accessories, and mounting frame.
 - 1. Casing: Weatherproof, constructed of hot-dip galvanized steel with factory-painted finish.
 - 2. Acoustical sound blanket.
 - 3. Acoustical compressor enclosure.
 - 4. Fans: Propeller type, statically and dynamically balanced, with vertical air discharge for high efficiency and low sound; located in its own compartment to eliminate cross flow of condenser air during fan cycling; and equipped with heavy-gage, weather-protected fan guard.
 - 5. Fan Motor: Direct drive, weatherproof, with bearings permanently lubricated, and having built-in current- and thermal-overload protection.
- D. Fabricate water chiller mounting frame and attachment to the pressure vessel with reinforcement strong enough to resist water chiller movement during a seismic event when the water chiller mounting frame is anchored to the building structure.

2.02 RECIPROCATING COMPRESSORS

- A.. Description: Positive-displacement, direct drive with suction and discharge service valves, crankcase oil heater, and suction strainer. The compressor shall be capable of operating at part-load conditions without increased vibration over normal vibration at full-load operation and shall be capable of continuous operation at its lowest step of unloading.
- B. Capacity Control: Combinations of cylinder unloading and on-off compressor cycling of multiple compressors.
- C. Oil Lubrication System: Reversible, positive-displacement pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
- D. Refrigerant and Oil: HCFC-22, HFC-134a, HFC-407c, or HFC-410a.
- E. Refrigerant Compatibility: Seals, O-rings, motor windings, and internal water chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- F. Refrigerant Circuit: Independent circuits. Each circuit shall include a thermal expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter drier, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

2.03 SCROLL COMPRESSORS

- A. Description: Positive displacement, direct drive with suction and discharge service valves, crankcase oil heater, and suction strainer. The compressor shall be capable of operating at part-load conditions without increased vibration over normal vibration at full-load operation and shall be capable of continuous operation at its lowest step of unloading.
- B. Capacity Control: Hot-gas bypass.
- C. Refrigerant and Oil: HCFC-22, HFC-134a, HFC-407c, or HFC-410a.
- D. Refrigerant Compatibility: Seals, O-rings, motor windings, and internal water chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- E. Refrigerant Circuit: Independent circuits. Each circuit shall include a thermal expansion valve, refrigerant charging connections, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter drier, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

2.04 HEAT EXCHANGERS

- A. Evaporator:
 - 1. Description: Shell-and-tube design, ASME labeled.
 - 2. Shell Material: Carbon steel.
 - 3. Tube Construction: Copper, individually replaceable, expanded into tube sheets.
- B. Condenser:
 - 1. Description: Shell-and-tube design, ASME labeled.
 - 2. Shell Material: Carbon steel.
 - 3. Tube Construction: Copper, externally enhanced and individually replaceable, expanded into tube sheets.
- C. Air-Cooled Condenser: Copper tubes with mechanically bonded aluminum fins, integral subcooling circuit, leak tested at 450 psig.

2.05 INSULATION

- A. Cold Surfaces: Closed-cell, flexible elastomeric, thermal insulation complying with ASTM C 534, Type II, for sheet materials.

2.06 CONTROLS

- A. Control Panel: Stand-alone, microprocessor based.
- B. Enclosure: Unit-mounted enclosure, hinged or lockable; factory wired with a single-point power connection and a separate control circuit.
- C. Status Display: Multiple-character liquid-crystal display or light-emitting diodes and keypad.
- E. Manually Reset Safety Controls shall shut down water chiller and require manual reset.
- F. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control chilled-water set point and chiller-control displays and alarms.

2.07 MOTORS

- A. Comply with requirements in Section 16225.

2.08 MAGNETIC ENCLOSED CONTROLLERS

- A. Enclosure: Unit mounted, with hinged access door with lock and key or padlock and key.
- B. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of enough capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.

- C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of water chiller control microprocessor.
- D. Across-the-Line Controller: NEMA ICS 2, Class A, full voltage, nonreversing; include isolation switch and current-limiting fuses.
- E. Across-the-Line Combination Controller: Factory-assembled combination NEMA ICS 2, Class A, full-voltage, nonreversing controller and disconnect switch.
- F. Accessories: Devices shall be factory installed in controller enclosure.

2.09 SOURCE QUALITY CONTROL

- A. Factory test and rate water chillers, before shipping, according to ARI 550/590, "Water Chilling Packages Using the Water Compression Cycle." Stamp with ARI label.
- B. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- C. Rate sound power level according to ARI 575 or ARI 370 procedure.

PART 3 - EXECUTION

3.01 EXAMINATION

- A.. Before water chiller installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping, and electrical to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WATER CHILLER INSTALLATION

- A.. Install water chillers on concrete base. Concrete base is specified in Section 15050 and concrete materials and installation requirements are specified in Division 3.
- B. Concrete Bases: Anchor chiller mounting frame to concrete base.
- C. Vibration Isolation: Rubber pads, restrained spring isolators or vibration isolation equipment base as specified in 15070.
- F. Maintain manufacturer's recommended clearances for service and maintenance.
- G. Charge water chiller with refrigerant if not factory charged.
- H. Install separate devices furnished by manufacturer.

3.03 CONNECTIONS

- A. Chilled and condenser-water piping installation requirements are specified in Section 15205. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.

- F. Ground water chillers according to Section 16060.
- G. Connect wiring according to Section 16120.
- H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions.
- D. Prepare a written startup report that records results of tests and inspections.

3.05 DEMONSTRATION

- A. Upon completion of installation, in accordance with the General Requirements, furnish on-site services of the manufacturer's engineering representative with specialized experience in the equipment to instruct Authority personnel in proper operation and maintenance.

END OF SECTION

SECTION 15640

COOLING TOWERS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing factory-assembled, counterflow, vertical-discharge, blow-through, cooling towers.
- B. Related Work Specified Elsewhere:
 - 1. Piping systems: Section 15205.
 - 2. Vibration isolation: Section 15070.
 - 3. Sound attenuators: Section 15825.
 - 4. Control equipment: Section 15900.
 - 5. Motors: Section 16225.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NFPA: 214.
 - 3. CTI: Bulletin ATP-105.
 - 4. ASME: Performance Test Code PTC-23.
 - 5. ASTM: A653, B117.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Certification:
 - a. Certificates stating that the sound power level of cooling tower based on 10^{-12} watts does not exceed following decibel ratings, without attenuators:

Octave Band Center Frequency/Hertz	Sound Power Level/dB
63	97
125	95
250	92
500	90
1000	86
2000	85
4000	82
8000	78

- b. Certified field test reports as specified and as directed.
4. Operation and Maintenance Manuals.

1.04 JOB CONDITIONS:

- A. Safety Requirements:
 1. Properly guard belts, pulleys, chains, gears, couplings, projecting set screws, keys and other rotating parts to prevent danger to personnel.

1.05 OPERATION AND MAINTENANCE TRAINING:

- A. Upon completion of installation, furnish on-site services of manufacturer's engineering representative with specialized experience in components of system for minimum of 1/2 man-day to instruct Authority personnel in proper operation and maintenance of each system.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 1. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies, parts, motor starters and relays.
 2. Galvanized-steel sheets: ASTM A653; coating designation G90 with raw edges coated with a zinc-rich compound.
 3. Galvanized surfaces finished with zinc-chromate primer and aluminum-paint finish coat or finished with manufacturer's standard coating, with the following additional requirements:
 - a. Coating permitting no corrosion on steel when exposed to 20-percent salt spray at 95F for a minimum of 400 consecutive hours.
 - b. Coating tested in accordance with ASTM B117.
- B. Cooling Towers:
 1. Each cooling tower designed to meet the following performance criteria:
 - a. Water-flow rate: As scheduled.
 - b. Cooling: From 95F to 85F minimum.

- c. Ambient temperature: 78F wet bulb.
 - d. Water-pressure drop: Not exceeding value shown.
2. Sump sections:
- a. Galvanized steel, heavy-gauge.
 - b. Provided with outlet connection, overflow, valved drain and electric water-level control consisting of magnetic-type electric float switch in moisture proof housing and control solenoid valve in makeup water line.
 - c. Outlet connections with large-area lift-out strainer with perforated openings sized smaller than spray-nozzle orifices, mounted in assembly and baffled to prevent cavitation.
 - d. Pipe drain and overflow connections as shown or to nearest drain leading to sewer.
3. Fan sections:
- a. Hot-dip galvanized steel.
 - b. Fans forward-curved, centrifugal, with one or more wheels, statically and dynamically balanced.
 - c. Designed to overcome resistance of tower, its enclosure, connecting ductwork and sound attenuators, if any, and quiet in operation.
 - d. Air inlets designed for smooth air entry.
 - e. Hot-dip galvanized bird screen at fan air inlets.
4. Fan bearings:
- a. Heavy-duty ball bearings, precision-grade, incorporating cast-iron pillow blocks and self-aligning with wide inner rings for greater load capacity.
 - b. Slip-fit bearings equipped with eccentric locking collars to provide for positive means of securing bearings to shaft.
 - c. Prelubricated bearings, ready for immediate service.
 - d. Grease-fitting for relubrication.
 - e. Lithium-base grease, waterproof, containing inhibitor and effective for temperature range of minus 65F to plus 250F.
5. Fan drives:
- a. Fan driven by electric motors through V-belt drives.
 - b. Belt guard of expanded metal, wire mesh or solid side panels.
 - c. Adjustable motor brackets.
 - d. Entire fan drive, including sheaves, belts, keys and other items manufacturer-rated for minimum of 1.5 times maximum horsepower required to drive fan.
 - e. Rating taken from manufacturer's standard catalog data.
 - f. Fan-shaft sheave-pitch diameter minimum 35 percent of fan wheel outside diameter.
6. Fan motors: Section 16225, with the following additional requirements:
- a. Four-pole, totally enclosed, fan-cooled and guarded.
7. Casings:
- a. Fabricated of heavy-gauge hot-dip galvanized steel using channel-type sheets.
 - b. Gasketed access doors for strainer.
 - c. Towers designed for live load of 40 pounds per square foot on horizontal deck surfaces and wind load of minimum 100 miles per hour for vertical surfaces.
 - d. Ladder: Aluminum or hot-dip galvanized steel for towers having water-distribution section more than eight feet above roof or grade.
8. Tower fill and drift eliminators:
- a. Tower fill (wet deck) fabricated in modular layers consisting of hot-dip galvanized, wave-formed, 26-gauge surface sheets or manufacturer's equivalent standard product.

- b. Drift eliminators fabricated of materials specified for fill but located at top of tower and assembled in easily handled removable sections to provide access to spray tree and nozzles.
 - 9. Water distribution:
 - a. Water evenly distributed over tower fill area through spray tree consisting of hot-dip galvanized steel header and removable hot-dip galvanized steel branches.
 - b. Branches and spray nozzles retained in place by means of snap-in rubber grommets to provide for ease of removal for cleaning and replacement of spray nozzles.
 - c. Plastic nozzles provided.
 - d. Spray tree and spray nozzles designed for total flow rate for each tower as specified.
 - e. Spray header with plugged tap for measurement of pressure.
 - f. Separate regulating and stop valves for complete balancing and complete shutoff for each tower.
 - 10. Makeup-water solenoid valve:
 - a. 120-volt, 60-Hertz solenoid valve installed in makeup-water line.
 - b. Maximum operating pressure-drop across valve: 10 psi.
 - c. Solenoid valve controlled by electric float switch.
- C. Nameplates:
 - 1. Securely attached plate on each cooling tower showing manufacturer's name, model number and serial number as specified in Section 15075.
- D. Sound Attenuators: Section 15825.
- E. Controls: Section 15900.
- F. Vibration Isolators: Section 15070.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Start ladders at roof or grade level.
- B. Provide support beams, concrete pads, platforms, hangers and anchor bolts for proper installation of equipment as recommended by the manufacturer.
- C. Install complete potable makeup-water system as shown and as specified in Section 15205.
- D. Mount units on vibration isolators in accordance with Section 15070.

3.02 FIELD QUALITY CONTROL:

- A. Field Tests:
 - 1. Test cooling towers in accordance with ASME Performance Test Code PTC-23 or CTI Bulletin ATP-105, using services of independent testing agency.
 - 2. Prior to commencing tests, submit name of testing agency for approval.

3. Tests will be observed by the Authority and calculations performed immediately following tests. Have tests and calculations signed by observers.
4. Submit computations to the Engineer together with six complete sets of test results.
5. Compute and test in accordance with particular test procedure employed by testing agency.
6. When the Engineer considers the performance of cooling towers unsatisfactory, the Engineer will direct that cooling towers be retested.
7. Should tests show that cooling towers are deficient, modify or replace towers to provide specified capacities.
8. If cooling tower performance is proven satisfactory, cost of tests will be borne by the Authority. If cooling tower performance is proven unsatisfactory, cost of tests will be borne by the Contractor.

END OF SECTION

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SECTION 15725

VENTILATING UNITS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing ventilating units.
- B. Related Work Specified Elsewhere:
 - 1. Concrete pads: Sections 03100, 03200 and 03300.
 - 2. Vibration isolation: Section 15070.
 - 3. Air conditioning units: Sections 15732, 15733, 15737.
 - 4. Heating equipment: Section 15765.
 - 5. Control equipment: Section 15900.
 - 6. Electrical connections: Sections 16120 and 16130.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of equipment, subassemblies, parts, motors, starters and relays.
- B. Ventilating Units:
 - 1. Ventilating units furnished in accordance with Sections 15732, 15733, and 15737 but without cooling-coil section in ventilating units.

2. Provide heating when required as per Section 15765.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances to space provided and make readily serviceable.
- B. Mount ventilating units on concrete pads and vibration isolators in accordance with Sections 03100, 03200, 03300, and 15070.
- C. Provide supports, hangers and anchor bolts necessary for proper installation of equipment as recommended by manufacturer.
- D. Wire, cable and boxes: Sections 16120 and 16130.

END OF SECTION

SECTION 15732
ROOFTOP AIR CONDITIONERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specified providing rooftop air conditioners:
 - 1. Cooling and heating units 6 tons and smaller.
 - 2. Cooling and heating units 7-1/2 to 20 tons.
 - 3. Cooling and heating units larger than 20 tons.

- B. Related work specified elsewhere:
 - 1. Filters: Section 15865
 - 2. Conduits, Raceways and Cabinets: Section 16130
 - 3. Wire, Cable and Busways: Section 16120
 - 4. NOT USED
 - 5. Heating Equipment: Section 15765
 - 6. Water Coils: Section 15734
 - 7. Piping Systems: Section 15205
 - 8. Vibration Isolation: Section 15070
 - 9. Ductwork: Section 15810
 - 10. Control Equipment: Section 15900
 - 11. Motors: Section 16225
 - 12. Motor Starters and Control Centers: Section 16425

1.02 DEFINITIONS

- A. DDC: Direct-digital controls.

1.03 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical, characteristics, furnished specialties, and accessories.

- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:
 - 1. Wiring Diagrams: Power, signal, and control wiring.

- C. Certification: Field quality-control test reports.

- D. Operation and Maintenance Data: For rooftop air conditioners to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop air conditioners and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- C. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

- D. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

- E. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

- F. Comply with NFPA 54 for gas-fired furnace section.
- G. ARI Certification: Units shall be ARI certified and listed.
- H. ARI Compliance for Units with Capacities Less Than 135,000 Btuh: Rate rooftop air-conditioner capacity according to ARI 210/230, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment."
- I. Sound Power Level Ratings: Comply with ARI 270, "Sound Rating of Outdoor Unitary Equipment."

1.05 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- C. Coordinate size, location, and installation of rooftop air-conditioner manufacturer's roof curbs and equipment supports with roof installer.

PART 2 - PRODUCTS

2.01 ROOFTOP AIR CONDITIONERS 6 TONS AND SMALLER

- A. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, indoor and outside refrigerant coils, indoor fan and outside coil fan, refrigeration and temperature controls, filters, and dampers.
- B. Casing: Manufacturers standard galvanized-steel construction with enamel paint or powder paint finish, removable panels or access doors with neoprene gaskets for inspection and access to internal parts, minimum 1-inch thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.
- C. Indoor Fan: Forward curved, centrifugal, motor.
- D. Outside Coil Fan: Propeller type, directly driven by motor.
- E. Refrigerant Coils: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- F. Compressor: Hermetic compressor with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
- G. Refrigeration System with R-22 or 134a.
- H. Filters: Section 15865.
- I. Heat Exchanger: Aluminized steel construction for natural gas-fired burners.
- J. Electric Heat: Helix-wound, nickel-chrome, electric-resistance elements, factory wired for single-point wiring connection; with time delay for element staging, and overcurrent and overheat protective devices.
- K. Hot Water Heating Section: Section 15734.
- L. Outside-Air Damper: Linked damper blades, for 0 to 25 percent outside air, with fully modulating, spring-return damper motor and hood.
- M. Economizer: Return- and outside-air dampers with neoprene seals, outside-air filter, and hood.
- N. Power Connection: Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.
- O. Unit Controls: Solid-state control board and components.

- P DDC: Install stand-alone control module providing link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Section 15900.
- Q Thermostat: Programmable, electronic; with heating setback and cooling setup with seven-day programming.
- R Roof Curb: Steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches.

2.02 ROOFTOP AIR CONDITIONERS 7-1/2 TO 20 TONS

- A Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, indoor and outside refrigerant coils, indoor fan and outside coil fan, refrigeration and temperature controls, filters, and dampers.
- B Casing: Galvanized-steel construction with enamel paint finish, removable panels or access doors with neoprene gaskets for inspection and access to internal parts, minimum 1 inch thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.
- C Indoor Fan: Forward curved, centrifugal, belt driven with adjustable motor sheaves, grease-lubricated ball bearings, and motor.
- D Outside Coil Fan: Propeller type, directly driven by permanently lubricated motor
- E Refrigerant Coils: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- F Compressor(s): One or more hermetic compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater(s).
- G Refrigeration System with R-22 or 134a.
- H Filters: Section 15865.
- I Heat Exchanger: Aluminized-steel or Stainless-steel construction for natural gas-fired burners.
- J Electric Heat: Helix-wound, nickel-chrome, electric-resistance elements, factory wired for single-point wiring connection; with time delay for element staging, and overcurrent and overheat protective devices.
- K Economizer: Return- and outside-air dampers with neoprene seals, outside-air filter, and hood.
- L Power Connection: Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.
- M Unit Controls: Solid-state control board and components.
- N DDC Temperature Control: Install stand-alone control module providing link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Section 15900.
- O Thermostat: Programmable, electronic; with heating setback and cooling setup with seven-day programming.
- P Roof Curb: Steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards.
- Q

2.03 ROOFTOP AIR CONDITIONERS LARGER THAN 20 TONS

- A. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, indoor and outside refrigerant coils, indoor fan and outside coil fan, refrigeration and temperature controls, filters, and dampers.
- B. Casing: Manufacturer's standard galvanized sheet metal construction with exterior enamel paint finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1-inch-thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.
- C. Indoor Fan: Forward curved, backward inclined or airfoil, centrifugal, belt driven with adjustable fixed motor sheaves, grease-lubricated ball bearings, and motor. Mount fan and motor assembly on base with spring isolators having 2-inch deflection.
- D. Return-Air Fan: Forward curved, Airfoil, backward inclined, centrifugal, belt driven with adjustable motor sheaves, grease-lubricated ball bearings, and motor. Mount fan and motor assembly on base with spring isolators having 2-inch deflection.
- E. Outside Coil Fan: Propeller type, directly driven by permanently lubricated motor.
- F. Refrigerant Coils: Aluminum-plate fin and seamless copper tube in galvanized-steel casing with equalizing-type vertical distributor and thermal expansion valve; tested to 450 psig and leak tested to 300 psig with air under water. Insulate coil section. Provide stainless-steel drain pan under indoor coil.
- G. Compressor(s): Number as scheduled compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heaters.
- H. Refrigeration System with R-134a.
- I. Filters Section: See Section 15865.
- J. Heat Exchanger: Stainless-steel construction for natural gas-fired burners.
- K. Electric Heat: Helix-wound, nickel-chrome, electric-resistance elements, factory wired for single-point wiring connection; with time delay for element staging, and overcurrent and overheat protective devices; control in stages.
- L. Water Heating Coils: Aluminum-plate fin and seamless copper tube in galvanized-steel casing, tested to 300 psig and leak tested to 200 psig with air under water; with modulating control valve and actuator. Insulate coil section.
- M. Economizer: Return- and outside-air dampers with neoprene seals, outside-air filter, and hood.
- N. Power Connection: Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in circuit breaker.
- O. Unit Controls: Solid-state control board and components.
- P. DDC Temperature Control: Install stand-alone control module providing link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Section 15900.
- Q. Thermostat: Programmable, electronic; with heating setback and cooling setup with seven-day programming.
- R. Roof Curb: Steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches.

2.04 MOTORS

- A. Comply with requirements in Division 16 Section "Motors."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install units level and plumb, maintaining manufacturer's recommended clearances
- B. Curb Support: Install roof curb on roof structure, level and secure, according to NRCA's standards. Install and secure rooftop air conditioners on curbs and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
- C. Unit Support: Install unit level. Secure units to structural support with anchor bolts.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Section 15205.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Duct installation requirements are specified in other Division 15 Sections.
- D. Electrical System Connections: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls.
- E. Ground equipment according to Division 16 Section "Grounding and Bonding."
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform field quality-control tests and inspections and prepare test reports.
- C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions.

3.05 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Authority's maintenance personnel to adjust, operate, and maintain rooftop air conditioners.

END OF SECTION

THIS PAGE NOT USED

SECTION 15733

AIR CONDITIONING UNITS - CHILLED WATER COOLED

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing factory-built air-conditioning units with cabinet-type fan sections and coil sections.
- B. Related Work Specified Elsewhere:
 - 1. Equipment foundations: Sections 03100, 03200 and 03300.
 - 2. Water coils: Section 15734.
 - 3. Filters: Section 15865.
 - 4. Ductwork: Section 15810.
 - 5. Piping systems: Section 15205.
 - 6. Vibration isolation: Section 15070.
 - 7. Control equipment: Section 15900.
 - 8. Raceways, boxes and cabinets: Section 16130.
 - 9. Wire, cable and busways: Section 16120.
 - 10. Motors: Section 16225.
 - 11. Motor starters and control devices: Section 16425.
 - 12. Chillers: Sections 15625, 15626, 15628

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NFPA: 90A.
 - 3. ARI: 430.
- B. Qualifications of Manufacturer:
 - 1. Furnish air-conditioning units which are the products of a manufacturer who is a member of AMCA.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, included rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field condition
 - 3. Certification:
 - a. Each air-conditioning unit fan.
 - 4. Operation and Maintenance Manuals.

1.04 JOB CONDITIONS:

- A. Safety Requirements:
 - 1. Properly guard belts, pulleys, chains, gears, couplings, projecting set screws, keys and other rotating parts to prevent danger to personnel.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies, parts, motors, starters and relays.

- B. Fans:
 - 1. Class I or II: Double width, double inlet, centrifugal, meeting ARI 430 and bearing ARI seal.
 - 2. Blades backward inclined or airfoil type, with the following additional requirements:
 - a. Forward curved blades may be furnished for fan wheel diameter 24 inches or less.
 - 3. Inlets with smooth, rounded edges.
 - 4. Fan housing fabricated of zinc-coated steel sheets, heavy-gauge consistent with size and use of unit.
 - 5. Fan wheels having heavy-gauge rims, blades of heavy-gauge steel consistent with blade size and for capacity, with matching heavy-gauge backplates. Steel, painted with zinc-oxide primer or corrosion-proof plastic coating.
 - 6. Fan wheels and sheaves: Splined or keyed, fastened to shafts with set screws.
 - 7. Shafts of steel, solid or hollow, ground to tolerance on working surfaces.
 - 8. Nonworking surfaces of shafts coated with factory-applied corrosion proof plastic coating.

- C. Fan Bearings:
 - 1. Self-aligning, antifriction type, designed to prevent leakage of lubricant and entrance of dirt.
 - 2. Design life: 200,000 hours minimum.
 - 3. Extended grease fittings when bearings are located internally.

- D. Fan Operating Characteristics:
 - 1. Brake horsepower necessary to drive fan at air volume and static pressure shown.
 - 2. Fans which do not approach 25 percent of first critical speed of shaft during normal operation or while attaining speed.
 - 3. Prior to shipment, statically and dynamically balance fans on their own shafts in their own units at design speed.

- E. Fan Drives:
 - 1. Fan driven by electric motor through high-capacity, V-belt drive.
 - 2. Drives protected with belt guard of expanded-metal wire mesh or solid-metal side panels with tachometer opening.
 - 3. Adjustable motor brackets and sheaves with nominal rating at midpoint.
 - 4. Gasketed, hinged access doors with quick-opening latches or removable access panels.
 - 5. Entire fan drive, including sheaves, belts, keys and other items rated by manufacturer at minimum 1.5 times maximum horsepower required to drive fan.
 - 6. Ratings in accordance with manufacturer's standard catalog data.

7. Fan-shaft sheave-pitch diameter: 30-percent minimum outside diameter of fan wheel.
 8. Metal label riveted to unit stating size of replacement belt.
 9. Variable frequency controllers (VFC) for use with variable air volume systems.
- F. Fan Motors: Section 16225, with the following additional requirements:
1. Four-pole, dripproof, fully guarded.
 2. Compatible with VFC in variable air volume systems.
- G. Motor Starters and Control Centers: Section 16425.
- H. Unit Casings:
1. In sections to facilitate handling.
 2. Fabricated of steel sheets, manufacturer's standard heavy-gauge.
 3. Steel sheets, angles and other structural shapes used in construction of casings: Zinc-coated steel or chemically pretreated and painted with enamel primer and exterior surface finished with factory-applied enamel coating.
 4. Panels removable for access.
 5. Cadmium-plated steel bolts, screws and washers.
 6. Structural frame fabricated with members rigidly braced to hold parts in line and to prevent distortion when operating.
 7. Structural frame of welded construction; slag and splatter removed after welding.
 8. Welds painted with two coats of approved primer and one finish coat of aluminum epoxy paint.
 9. Fan sections and coil sections factory-insulated.
 - a. Insulation: Minimum one-inch thick neoprene-coated fibrous glass, 1-1/2 pounds per cubic foot density, securely adhered to panel inner surface with adhesive and weld pins on minimum two-foot centers.
 - b. Exposed edges coated with adhesive.
 - c. Insulation and adhesive: NFPA 90A.
 10. Fan section or fan-coil section connected by flexible connections as specified in Section 15820.
 11. Filters: Section 15865.
 12. Drain pan:
 - a. Drain pan under fan and coil section where cooling coil used.
 - b. Drainage connection: As shown.
 - c. Insulate entire drain pan with 1/2-inch cellular foam.
 13. Coil: Section 15734.
- I. Nameplates:
1. Securely attached plate to each air-conditioning unit showing manufacturer's name, model number and serial number.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances within space provided and make readily serviceable.
- B. Provide foundations, platforms and hangers necessary for proper installation of equipment.
- C. Construct equipment foundations four inches minimum height in accordance with Sections 03100, 03200 and 03300.

- D. Install units on vibration isolators where shown as specified in Section 15070.
- E. Electrical connections: Sections 16130 and 16120.
- F. Condensate piping: Section 15205.
- G. After installation, adjust fans to operate without noticeable vibration.
- H. Arrange belt guards to permit oiling, testing and using tachometer with guards in place.

END OF SECTION

SECTION 15734

WATER COILS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing chilled water and hot water coils in factory-built air-conditioning units.
- B. Related Work Specified Elsewhere:
 - 1. Air Conditioning Units: Section 15732, 15733, 15737.
 - 2. Piping: Section 15205

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. ARI: 410.
- B. Qualifications of Manufacturer:
 - 1. Furnish water coils which are the products of a manufacturer who is a member of ARI.
- C. Source Quality Control:
 - 1. Factory test water coils at 350-psi air pressure underwater.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data including rated capacities and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, location and size of each field connection.
 - 3. Certification
 - 4. Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies and parts.
 - 2. Coil section to interface directly with sections on sides without use of transition sections.
 - 3. Meet ARI 410.
- B. Water Coil:
 - 1. Seamless deoxidized-copper tubes, minimum 0.025-inch thick wall with aluminum fins.
 - 2. Coil casings of zinc-coated, rust-resistant steel.

3. End panels: Heavy-gauge steel.
4. Side panels: 16 gauge for tube lengths up to 90 inches; 14 gauge for tube lengths of 91 to 120 inches.
5. Top and bottom casing flanges formed into box shape for strength and durability with flat surface for coil stacking.
6. Coils with 48 to 84-inch tube lengths provided with one center tube support; for longer coils, up to 120-inch tube lengths, provided with two intermediate supports.
7. Maximum fin spacing: 12 per inch of tube.
8. Water velocity: Minimum two fps and maximum six fps throughout tube length.
9. Maximum water-pressure drop through coils: 35 feet water gauge.
10. Maximum air velocity through coil face: 550 fpm.
11. Designed with continuous circuits from inlet header to outlet header.
12. Drainable, pitched 3/16 inch per foot toward return header for complete drainage.
13. Self-venting with supply connection at bottom of supply header and return connection at top of return header.
14. Vent connection provided in supply header and drain connection in return header.

C. Nameplates:

1. Securely attached to each coil showing manufacturer's name, model number and serial number.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Support coils on rails and make readily removable.
- B. Make supply connection to header giving counter flow as shown.
- C. Use of coils to support piping is prohibited.

END OF SECTION

SECTION 15735

PACKAGED TERMINAL AIR CONDITIONING UNITS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing factory-packaged self-contained air-conditioning units with direct expansion coil, electric heating coils, air-cooled condensers and automatic controls.
- B. Related Work Specified Elsewhere:
 - 1. Filters: Section 15865.
 - 2. Conduit, raceways and cabinets: Section 16130.
 - 3. Wire, cable and busways: Section 16120.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ARI: 210.
 - 3. UL listed.
- B. Design Criteria:
 - 1. Select units in accordance with requirements shown.
- C. Factory wiring:
 - 1. In accordance with manufacturer's standard practice.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicated dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Certification.
 - 4. Operation and Maintenance Manuals.

PART 2- PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for the interchangeability of items of piping equipment, subassemblies, parts, motors, starters and relays.
 - 2. Each unit completely piped, wired, charged and factory-tested as a package and designed for through-wall installation.

3. Meet ARI 210.
 4. UL listed
- B. Cabinet:
1. Welded cabinet constructed of heavy-gauge steel, zinc-coated or chemically pretreated, painted with enamel primer and exterior surface finished with factory-applied enamel coating.
 2. Containing junction boxes, polarized sockets and plugs for chassis electrical connection.
 3. Discharge grilles, front panels and return air grilles assembled to be removable for cleaning and access.
 4. Interior casing lined with sound-absorbing insulation material resistant to moisture, vermin and rot.
 5. Discharge grille with adjustable louver blades, fabricated of extruded aluminum.
- C. Compressor:
1. Hermetically and semi-hermetically sealed, refrigerant-cooled, suitable for operation with refrigerant R-22.
 2. High-pressure cutout with manual reset and low-pressure cutout with automatic reset.
 3. Compressor motor protected by means of overload relays and internal-winding thermostat.
 4. Mounted on rubber-isolated spring mountings.
- D. Evaporator Coil:
1. Direct expansion, fabricated of seamless copper tubing with aluminum fins, tightly bonded to tubing.
 2. Cooling-capacity selection based on space conditions and the following as shown:
 - a. Entering wet-bulb temperature at evaporator.
 - b. Entering ambient temperature at condenser coil.
 3. Single thermal-expansion valve for refrigerant control or capillary tube.
 4. Tested at minimum 300 psig.
- E. Condenser Coil:
1. Air-cooled type, fabricated of seamless copper tubing with aluminum fins, tightly bonded to tubing.
 2. Capable of a total heat rejection based on condensing and ambient temperatures as shown.
 3. Tested at minimum 425 psig.
- F. Electric Heating Coil:
1. Consisting of finned, metal-sheathed elements, anchored to ensure noiseless expansion and contraction.
 2. Fins furnace-brazed to steel sheath.
 3. Sheath and fins coated with heavily-fired ceramic capable of resisting spalling under operating conditions.
 4. Automatic-reset, snap-action, thermal-overheat switch.
 5. Voltage: As shown.
- G. Evaporator Fan and Motor:
1. Centrifugal fan of corrosion-resistant construction.
 2. Fan wheels dynamically and statically balanced.
 3. Motors: Air-conditioning unit manufacturer's standard for intended use and location.

4. Brake horsepower selected to drive fan at air volume and static pressure shown.
- H. Condenser Fan and Motor:
1. Propeller fan of corrosion-resistant construction.
 2. Fan dynamically and statically balanced.
 3. Motors: Air-conditioning unit manufacturer's standard for intended use and location.
 4. Brake horsepower selected to drive fan at air volume and static pressure as shown.
- I. Filters:
1. Replaceable (throwaway)-type: Section 15865.
- J. Ventilation-Control Damper:
1. Ventilation-control damper furnished in one piece, rotating on oilless bearings and capable of air-tight closure.
 2. Damper fabricated from heavy-gauge galvanized steel.
- K. Chassis:
1. Complete factory-wired, packaged heating and cooling-unit chassis consisting of the following:
 - a. Electric heating bank.
 - b. Hermetically sealed compressor.
 - c. Condenser coil and fan.
 - d. Evaporator coil and fan.
 - e. Self-contained temperature controls.
 - f. Protective devices.
- L. Condensate Pan:
1. Condensate pan provided with opening for drain connection or provision for condensate drains into condenser-coil pans to be evaporated by condenser heat.
- M. Wall Sleeves:
1. Watertight, connection provided between cabinet and wall louver.
 2. Constructed from corrosion-resistant material.
 3. Baffles provided to separate flow paths of ventilating and condenser inlet and outlet air.
- N. Wall Louver:
1. Wall louver fabricated from extruded aluminum with 16-gauge enclosing frame.
 2. Louver blades fabricated from heavy-gauge aluminum.
 3. Removable louver for access.
- O. Automatic-Control Kit:
1. Automatic-control package for both cooling and heating consisting of the following:
 - a. Manual changeover-selector switch for cooling or heating.
 - b. Multiple-position thermostat for desired temperature setting.
 - c. Fresh-air control for filtered outside air.
 - d. Heating control relays for staging heating elements.
 - e. Head-pressure control to maintain proper condensing pressure at low outdoor temperature.
 - f. Compressor motor to start after evaporator fan motor starts operating.
- P. Self-Contained Unit Controls:

1. Controls capable of maintaining mechanical cooling and heating operation, factory-mounted and wired to terminal blocks in unit-control compartment.
2. Room-air thermostat.
3. Thermostat-setting dial.
4. Damper operators.
5. Heating and compressor contacts.
6. Condenser and evaporator fan contactors.
7. Interlock switch to de-energize entire unit when front panel is removed.
8. Push-button selector switch for OFF/FAN/COOLING/HEATING operations.
9. Control sequence: Room-air thermostat cycles condenser fan and compressor or heater to maintain room at thermostat setting.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Interlock heating coil with evaporator fan motor, so that heating coil will not operate when evaporator fan motor is operating.
- B. Fit equipment and appurtenances within space provided and make readily serviceable.
- C. Provide supports and hangers required for proper installation of equipment.
- D. Ensure that fans operate without noticeable vibration after installation
- E. Electrical connections: Sections 16120 and 16130.

END OF SECTION

SECTION 15737

AIR CONDITIONING UNITS - AIR-COOLED SPLIT SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing air-cooled split-system air-conditioning units.
- B. Related Work Specified Elsewhere:
 - 1. Concrete pads: Sections 03100, 03200 and 03300.
 - 2. Insulation: Section 15080.
 - 3. Piping systems: Section 15205.
 - 4. Filters: Section 15865.
 - 5. Wire, cable and busways: Section 16120.
 - 6. Conduit, raceways and cabinets: Section 16130.
 - 7. Heating Equipment: Section 15765
 - 8. Vibration Isolation: Section 15070
 - 9. Identification of Mechanical Equipment and Piping: Section 15075
 - 10. Water Coils: Section 15734

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ARI: 210.
 - 3. UL listed.
- B. Design Criteria:
 - 1. Select units in accordance with requirements.
 - 2. Provide completely matched combination between evaporator unit and condensing unit.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicated dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Certification.
 - 4. Operation and Maintenance Manuals.

1.04 JOB CONDITIONS:

- A. Safety Requirements:
 - 1. Properly guard belts, pulleys, chains, gears and other rotating parts to prevent danger to personnel.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for the interchangeability of items of piping equipment, subassemblies, parts, motors, starters and relays.
 - 2. UL listed.
 - 3. Meet ARI 210.
- B. Evaporator Unit: As shown or as specified below:
 - 1. Cabinet:
 - a. Welded, constructed of heavy-gauge steel, zinc-coated or chemically pretreated, painted with enamel primer and exterior surface finished with factory-applied enamel coating.
 - b. Interior of cabinet completely lined with sound-absorbing thermal insulation resistant to moisture, vermin and rot.
 - c. Casing provided with insulated condensate-drain pan.
 - 2. Evaporator coil:
 - a. Direct expansion, fabricated of seamless copper tubing with aluminum fins tightly bonded to tubing.
 - b. Selection of cooling capacity of coils based on space conditions and the following as shown:
 - 1) Entering dry-bulb/wet-bulb temperature at evaporator coil.
 - 2) Entering ambient temperature at condenser coil.
 - c. Factory-mounted thermal-expansion valve:
 - 1) For units of 10 tons or more: Coils double-circuited and provided with two expansion valves.
 - d. Tested at minimum 300 psig.
 - 3. Evaporator fan and motor:
 - a. Centrifugal fans of corrosion-resistant construction.
 - b. Fan wheels dynamically and statically balanced.
 - c. Fan belt drives designed for 150 percent of required fan-motor brake horsepower.
 - d. Motor mounted on adjustable base.
 - e. Brake horsepower selected to drive fan at air volume and static pressure shown.
 - f. Fan motors: Air-conditioning unit manufacturer's standard for intended use and location.
 - 4. Filters Section: See Section 15865.
- C. Air-Cooled Condensing Unit: As shown or as specified below:
 - 1. Casing:
 - a. Weatherproof suitable for outdoor installation.

- b. Fabricated of heavy-gauge steel, zinc-coated or chemically pretreated, painted with enamel primer and exterior surface finished with factory-applied enamel coating.
 - c. Removable panels provided for access to accessories
 - 2. Condenser coils:
 - a. Air-cooled, fabricated of seamless copper tubing with aluminum fins tightly bonded to tubing.
 - b. Condenser coil capable of total heat rejection based on condensing and ambient temperature shown.
 - c. Tested at minimum 425 psig.
 - 3. Condenser fan and motor:
 - a. Fan of corrosion-resistant construction.
 - b. Fans dynamically and statically balanced.
 - c. Fans protected with heavy-gauge welded-wire fan guards.
 - d. Motors: Air-conditioning unit manufacturer's standard for intended use and location.
 - 4. Compressor:
 - a. Hermetically semi-hermetic sealed, refrigerant-cooled, suitable for operation with refrigerant R-22.
 - b. Capacity control provided for compressor of 10 tons and more to permit partial operation at low-load conditions.
 - c. High and low-pressure cutouts.
 - d. Compressor motor protected by means of overload relays and internal-winding thermostat.
 - e. Compressor mounted on internal spring isolator or on rubber-in-shear mounting pads.
 - f. Number of compressors:
 - 1) For units rated up to and including 7-1/2 tons: One compressor.
 - 2) For units rated at 10 or more tons: Two compressors with two separate refrigerant circuits.
 - 5. Refrigerant piping: Section 15205.
 - 6. Refrigerant-piping insulation: Section 15080.
 - 7. Refrigeration circuits:
 - a. Provide the following components in refrigeration circuits:
 - 1) Back-seating service valves in liquid and hot-gas lines.
 - 2) Filter drier on liquid line.
 - 3) Moisture-indicating sight glass on liquid line.
 - 4) Charging valves on suction side.
 - 5) Hot-gas muffler on discharge side.
- D. Heating Section: provide as required for systems; electric, gas-fired, or hot water. See section 15765.
- E. Air-Cooled Split-System Air-Conditioning Unit Controls: As shown or as specified below:
 - 1. Stand-alone DDC controls, factory-wired in separate control cabinet remote mounted in mechanical room near air handling unit..
 - 2. Heating and compressor contactors.
 - 3. Condenser and evaporator-fan contactors.
 - 4. High-pressure cutout with automatic reset.
 - 5. Low-pressure cutout with manual reset.
 - 6. Reset relay to prevent unit from cycling on automatic resetting of safety controls.
 - 7. Noncycling pumpdown control.
 - 8. Controls provided near evaporator unit:

- a. Discharge air temperature control for systems incorporating duct mounted heaters.
 - b. Damper operators.
9. Selector switch for HAND/OFF/AUTO operations, mounted on evaporator unit.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances within space provided and make readily serviceable.
- B. Provide foundation, platforms and hangers necessary for proper installation of equipment.
- C. Install equipment on concrete pads minimum of six inches in height in accordance with Section 03100, 03200 and 03300.
- D. Ensure that fans operate without noticeable vibration after installation.
- E. Arrange belt guards to permit use of tachometer, oiling and testing with guards in place.
- F. Charge refrigerant in accordance with manufacturer's recommendations.
- G. Electrical connections: Sections 16120 and 16130.
- H. Gas Connections: Section 15205.
- I. Hot Water Connections: 15205.

END OF SECTION

SECTION 15765

HEATING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing heating equipment and electric heat tracing for piping.
- B. Related Work Specified Elsewhere:
 - 1. Vibration isolators: Section 15070.
 - 2. Water Tube Boilers: Section 15515.
 - 3. Ventilating Units: Section 15725.
 - 4. Water Coils: Section 15734.
 - 5. Control equipment: Section 15900.
 - 6. Filters: Section 15865.
 - 7. Motors: Section 16225.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. UL: 1025.
- B. Source Quality Control:
 - 1. Test electric heating coils dielectrically at 2,000 volts before shipment.
 - 2. Factory test water coils at 350 psi air pressure under water.
 - 3. Comply with ANSI Z21.47, "Gas-Fired Central Furnaces", and NFPA 54, "National Fuel Gas Code".

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicated dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Certification:
 - a. Successful dielectric testing of electric heating coil at 2,000 volts.
 - b. Gas-Fired Units design and certified by and bearing label of American Gas Association.
 - 4. Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of equipment, subassemblies, parts, motors, starters and relays.

- B. Electric Heating Coils:
 - 1. Casings:
 - a. Frame members, casings, terminal box, terminal-box cover and similar sheet metal parts fabricated of minimum 18-gauge, die-formed steel with integral corrosion-resistant coating.
 - b. Casing assembled into rigid structure by means of welding or threaded fastenings.
 - c. Flanged in-line heater for inclusion in duct or ventilating unit.
 - d. Coil-section panels factory-insulated.
 - 2. Heating element:
 - a. Heating elements composed of individual flange-mounted, finned-tube heating elements with highest grade nickel-chromium alloy resistor wire centered within tubes and embedded in compacted insulating material.
 - b. Flanges and fins permanently furnace-brazed to elements for rigid support and rapid heat transfer.
 - c. Finned tubes of copper-plated or ceramic-coated steel.
 - 3. Controls:
 - a. In accordance with Section 15900, with the following additional requirements:
 - (1) Heaters provided with built-in step controllers.
 - (2) Heaters of 30 kw or less with manufacturer's standard steps.
 - (3) Heaters larger than 30 kw having six equal steps.
 - (4) An automatic-reset, snap-action, thermal-overheat switch provided to instantly de-energize heating coil when safe operating temperatures are exceeded.
 - (5) Heating coil interlocked with fan to prevent energization of heating coil while fan is not running.

- C. Electric Unit Heaters:
 - 1. Factory-assembled unit heaters consisting of heating element, fan, fan motor, housing and outlet diffuser.
 - a. Casings:
 - (1) Fabricated of galvanized steel or bonderized steel, factory-primed and finished with baked enamel.
 - (2) Parts rigidly stiffened to prevent vibration and to hold working parts in line.
 - (3) Casings for suspended-type units designed for direct attachment to hangers.
 - (4) Ceiling or wall-mounted, spring-type brackets furnished as necessary to support unit.
 - (5) Casings readily removable for access to interior parts.
 - (6) Adjustable horizontal vanes, arranged to give uniform air distribution without objectionable drafts.
 - b. Fan and fan motor:
 - (1) Propeller fan directly connected to fan motor.

- (2) Fan air throw: As shown.
- (3) Fan factory-balanced dynamically and designed for quiet operation.
- (4) Unit heater/fan motor: As standard with manufacturer.
- (5) Each unit equipped with combination fan guard/motor support resiliently mounted to absorb motor vibration.
- (6) Motor speed: 1,750-rpm maximum.
- (7) Integral transformer where fan-motor voltage differs from line voltage.
- c. Heating element:
 - (1) Resistance wire of corrosion-resistant metal surrounded by finned metal sheath, interspace filled with ceramic material or magnesium oxide.
 - (2) Each heating element wired to built-in, line-voltage, automatic-reset, thermal-overheat protection.
 - (3) Complete controls, contactors, control-circuit transformers factory-assembled and factory-wired.
 - (4) Unit heaters tested and listed under UL 1025.
 - (5) Thermostats: Built-in or remote as required.
 - (6) Disconnect switch near unit heater.
- d. Unit heaters with capacities of 10 kW or higher equipped with H.O.A. switches.

D. Electric Wall Convectors:

- 1. Factory-assembled consisting of heating element, connection boxes, controls, surface-mounted steel cabinet and wall-mounted thermostat.
- 2. Convector cabinet: Fabricated of heavy-gauge reinforced steel with inlet and outlet grilles.
- 3. Surface-mounted cabinet, chemically treated to resist corrosion and finished in baked prime coat.
- 4. Cabinets equipped with disconnect switch and automatic-reset thermal-overload protection.
- 5. Heating elements of steel-sheath or aluminum-sheath enclosed construction, nonhumming, with fins permanently brazed to tube for quick and efficient heat transfer.
- 6. Heating elements having a nonoxidizing heat-resistant finish.
- 7. Completely factory-wired, tested and UL-listed.
- 8. Capacity and operating characteristics: As shown.

E. Electric Heat Tracing for Piping:

- 1. Heat-traced pipe insulated after installation of heating tape in accordance with Section 15080.
- 2. Heating tape with single or twin heating elements embedded in impact-resistant, high-dielectric refractory material, UL-listed and with stainless-steel exterior protective sheath acting as electrical ground in case heating element touches sheath.
- 3. Heating tape rated for voltage shown and capable of producing wattage shown.
- 4. Heating tape flexible with minimum bending radius of not more than six times diameter of tape.
- 5. Heating tape compatible with pipe temperature-sensing thermostat: Section 15900.
- 6. Heating tape connected to power source and controls through nonheating leads minimum seven feet in length.

- F. Indirect-Fired Heating and Ventilating Units
1. Packaged units.
 - a. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters and indirect-fired gas furnace to be installed inside the building.
 2. Cabinet.
 - a. Cabinet: Galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Where applicable, cabinet shall be fully weatherized for outside installation.
 - b. Access Panels: Piano hinged with cam-lock fasteners for furnace and fan motor assemblies on both sides of unit.
 - c. Internal Insulation: Fibrous-glass duct lining, comply with ASTM C1071, Type II, applied on complete unit.
 - d. Finish: Heat-resistant, baked enamel.
 - e. Discharge: Galvanized-steel assembly with diffusers incorporating individually adjustable vanes.
 - f. Roof Curb: Full-perimeter curb of sheet metal, minimum 16 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing
 3. Supply-Air Fan
 - a. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft.
 - b. Motor: Totally enclosed, single-speed motor.
 - c. Drive: V-belt with matching fan pulley and adjustable motor sheaves and belt assembly.
 - d. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with spring isolators.
 - 4.. Outdoor-Air Intake
 - a. Outdoor-Air Hood: Galvanized steel with rain baffles, bird screen, and finish to match cabinet; and sized to supply maximum percent outdoor air.
 5. Air Filter Section
 - a. Frame: Galvanized to comply with required filters per Section 15865.
 6. Dampers
 - a. Outdoor-Air Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. Ft. of damper area, at differential pressure of 2-inch wg.
 - b. Damper Operator: Direct couples, electronic with spring return or fully modulating as required by the control sequence.
 7. Indirect-Fired Gas Furnace
 - a. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and NFPA 54, "National Fuel Gas Code."
 - b. Venting: Gravity or power vent with integral, motorized centrifugal fan interlocked with gas valve.
 - c. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.
 - d. Inside Unit External Housing: Steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.
 - e. Outside Unit External Housing: Weatherproof steel cabinet with integral support inserts and removeable bottom arranged to serve as drain pan.
 - f. Internal Casing: Aluminized steel, arranged to contain airflow, with duct flanges at inlet and outlet.
 - g. Heat Exchanger: Steel.

- h. Heat-Exchanger Drain Pan: Stainless steel.
 - i. Safety Controls.
 - 8. Controls
 - a. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
 - b. Control Panel: Surface-mounted remote panel, with engraved plastic cover.
 - c. Refer to Section 15900 for control equipment.
 - d. Temperature Control: Operates gas valve to maintain supply-air temperature.
 - e. DDC: Stand-alone control module for link between unit controls and DDC system. Control module shall be compatible with temperature-control system specified in Section 15900.

- G. Gas-Fired Duct Heaters.
 - 1. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.9, "Gas-Fired Duct Furnaces."
 - 2. Venting:
 - a. Indoor, gravity vented.
 - b. Indoor, equipped with sealed combustion-product-collection chamber, power venter, and electronic spark ignition.
 - c. Venting: Indoor, separated combustion, equipped with power venter.
 - d. Power Venter: Integral, motorized centrifugal fan interlocked with gas valve.
 - 3. Indoor External Housing: Steel cabinet with integral support inserts and removable bottom arranged to serve as drain pan.
 - 4. Internal Casing: Aluminized steel, arranged to contain airflow, with duct flanges at inlet and outlet.
 - 5. Heat Exchanger: Stainless steel.
 - 6. Burners: Stainless steel.
 - 7. Controls: Regulated redundant 24-V ac gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

- H. Gas-Fired Unit Heaters
 - 1. Description: Factory assembled, piped, and wired, and complying with AGA Z83.8, "Gas Unit Heaters."
 - 2. Venting: Gravity or powered.
 - 3. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
 - 4. Heat Exchanger: Stainless steel.
 - 5. Burners: Stainless steel.
 - 6. Unit Fan:
 - a. Propeller fan with aluminum blades dynamically balanced and resiliently mounted.
 - b. Steel, centrifugal fan dynamically balanced and resiliently mounted.
 - 7. Controls: Regulated redundant 24-V ac gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 - 8. Discharge Louvers: Independently adjustable horizontal blades.

- I. Hot Water Cabinet Unit Heaters
 - 1. Description: A factory-assembled and -tested unit complying with ARI 440.
 - a. Comply with UL 2021.
 - 2. Cabinet: Steel with baked-enamel finish.
 - 3. Filters: 1" throwaway.

4. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
5. Fan and Motor Board: Removable.
6. Basic Unit Control.
7. Electrical Connection: Factory wire motors and controls for a single field connection.

J. Hot Water Unit Heaters

1. Description: An assembly including casing, coil, fan, and motor in vertical or horizontal discharge configuration with adjustable discharge louvers.
2. Comply with UL 2021.
3. Comply with UL 823.
4. Casing:
 - a. Cabinet: Removable panels for maintenance access to controls.
 - b. Cabinet Finish: Manufacturer's standard customer baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
 - c. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
5. Coils:
 - a. Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
 - b. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure or 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
6. Fan:
 - a. Propeller type, aluminum wheel directly mounted on motor shaft in the fan venturi.
7. Fan Motors:
 - a. Motor Type: permanently lubricated, multispeed.
8. Controls:
 - a. Control Devices:
 - (1) Wall-mounting fan-speed switch.
 - (2) Wall-mounting thermostat.
 - (2) Unit mounted thermostat.

K. Electric Finned-Tube Radiators:

1. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.
2. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded into fins, with high-temperature cutout and sensor running the full length of the element.
3. Rust-Resistant Front Panel: G60 galvanized steel.
4. Wall-Mounting Back Panel: Steel, full height, with full-length channel support for front panel without exposed fasteners.
5. Floor-Mounting Pedestals: Conceal conduit for power and control wiring and maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel.
6. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
7. Finish: Baked-enamel finish in a manufacturer's standard color.

8. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, integral with enclosure.
9. Unit Controls: Integral low-voltage relay and control transformer for remote thermostat.
10. Accessories: Integral disconnect switch, filler sections, corners, relay sections and splice plates all matching the enclosure and grille finishes.

L. Hot-Water Finned-Tube Radiators

1. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One tube end shall be belled.
2. Element Supports: ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
3. Front Panel: G60 galvanized steel.
4. Wall-Mounting Back Panel: Steel, full height, with full-length channel support for front panel without exposed fasteners.
5. Floor-Mounting Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.
6. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
7. Finish: Baked-enamel finish in manufacturer's standard color.
8. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, integral with enclosure.
9. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

M. Hot-Water Convectors:

1. Convector Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into brass headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum 100 psig.
2. Front and Top Panel: Steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
3. Wall-Mounting Back and End Panels: Steel.
4. Floor-Mounting Pedestals: Conceal conduit for power and control wiring at maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel.
5. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
6. Insulation: 1/2-inch thick, fibrous glass on inside of the back of the enclosure.
7. Finish: Baked-enamel finish in manufacturer's standard color.
8. Damper: Knob-operated internal damper.
9. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, integral with enclosure.

N. Electric Radiant Heaters

1. Quartz lamp Heating Elements: Coiled tungsten-wire heating element enclosed in clear quartz tube.
2. Quartz Tube Heating Elements: Nickel-chromium-wire heating element enclosed in quartz tube.
3. Metal-Sheathed Heating Elements: Nickel-chromium-wire heating element embedded in magnesium oxide powder and enclosed in metal sheath. Comply with UL 1030.
4. Comply with UL 499 and UL 2021.

5. Enclosures: Aluminized, stainless, or painted -steel housing with anodized-aluminum reflector.
6. Unit Controls:
 - a. Line-voltage thermostat.
 - b. Enclosed contactor for remote thermostat.
 - c. Snow and ice detector and moisture sensor and integral temperature sensor.
- Q. Nameplates:
 1. Securely attached to each major item of equipment showing manufacturer's name, model number and serial number.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Fit equipment and appurtenances to space provided and make readily serviceable.
- B. Mount electric unit heaters on vibration isolators in accordance with Section 15070.
- C. Provide supports, hangers and anchor bolts necessary for proper installation of equipment as recommended by manufacturer
- D. Provide heat tracing on piping where shown.
- E. Install electric heating coil where shown.
- F. Apply insulation on heat-traced piping in accordance with manufacturer's recommendations.
- G. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."
- H. Install roof curb on roof structure according to ARI or NRCA guidelines. Install and secure indirect-fired H&V units on curbs, and coordinate roof penetrations and flashing with roof construction.
- I. Install floor-mounted units on spring isolators; refer to Section 15070.
- J. Install controls and equipment shipped by manufacturer for field installation with indirect-fired H&V units.
- K. Startup Service:
 1. Engage a factory-authorized service representative to perform startup service.
 2. Complete installation and startup checks according to manufacturer's written instructions.
- L. Install units level and plumb.
- M. Install equipment level and plumb.
- N. Install equipment to comply with NFPA 90A.

3.2 CONNECTIONS:

- A. Piping installation requirements are specified in Section 15205.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors.
- D. Comply with safety requirements in UL 1995.
- E. Ground equipment according to Division 16 Section "Grounding and Bonding".
- F. Connect wiring according to Division 16 Section "Wire, cable and Busways".
- G. Connect hot-water units and components to piping according to Section 15205.

END OF SECTION

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SECTION 15810

DUCTWORK

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing ductwork.
- B. Related Work Specified Elsewhere:
 - 1. Insulation: Section 15080.
 - 2. Duct Accessories: Section 15820.
 - 3. Firestopping: Section 07841.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. SMACNA:
 - a. HVAC Duct Construction Standards - Metal and Flexible.
 - 3. ASTM: A36, A53, A653.
 - 4. NFPA: 90A
 - 5. AASHTO: M81.
 - 6. UL: Building Materials Directory, 181, 555.
- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel", for hangers and supports, AWS D1.2, "Structural Welding Code - Aluminum," for aluminum supporting members, and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Sheet metal duct materials, material thicknesses, and duct construction methods.
 - 2. Shop Drawings: Drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts.
 - a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - b. Duct layout indicating sizes and pressure classes.
 - c. Elevations of top and bottom of ducts.
 - d. Dimensions of main duct runs from building grid lines
 - e. Coordination with reflected ceiling plans.
 - f. Fittings.
 - g. Reinforcement and spacing.
 - h. Penetrations through fire-rated and other partitions.
 - i. Duct accessories, including access doors and panels.

- j. Hangers and supports, including methods for duct and building attachment, vibration isolation.
3. Certification.
4. Welding certificates.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Galvanized Sheet Steel: ASTM A653.
- B. Steel Plate: ASTM A36, Grade A.
- C. Steel Pipe: ASTM A53, Grade A.
- D. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653 and having G60 or G90 coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 2 mils thick on opposite surfaces.
- E. Carbon-Steel Sheets: ASTM A 366, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
- F. Stainless Steel: ASTM A 480, Type 316 or 304.
- G. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14 with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- H. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
- I. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- J. Paint:
 1. Zinc-rich gray, No. 721, Detroit Graphite or equal.

2.02 FABRICATION:

- A. Rectangular Duct Fabrication
 1. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 2. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
 3. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", Figure 1-4, using corner, bolt, cleat, and gasket details.

- B. Instrument Test Holes:
1. Factory-fabricated, airtight, non-corrosive instrument test hole with screw cap and gasket.
- C. Round and Flat-Oval Duct and Fitting Fabrication
1. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
 2. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standard - Metal and Flexible".
 3. Flat-Oval, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible". Fabricate ducts larger than 72 inches in diameter with butt-welded longitudinal seams.
- D. Duct Joints
1. Ducts up to 20 inches in diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 2. Ducts 21 to 72 inches in diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
 3. Ducts larger than 72 inches in diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standard - Metal and Flexible", Figure 3-2.
 4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
 5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
- E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", with metal thicknesses specified for longitudinal-seam straight ducts.
- F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- G. Fabricate elbows using die-formed, gored, pleated, or metered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows.
1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", unless otherwise indicated.
 2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
 - a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
 - b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
 - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
 - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.
 3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
 - a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
 - b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
 - c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
 - d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.

4. Flat-Oval Mitered Elbows: Welded construction with the same metal thickness as longitudinal-seam flat-oval duct.
5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
6. Round Elbows 8 Inches or Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows 9 through 14 inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
8. Round Elbows Larger than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-Piece Welded Construction.
10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.

H. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded and painted with PVC aerosol spray.
2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
3. Round Elbows 28 to 60 Inches in Diameter: Standard gored construction, riveted and bonded.
4. Other Fittings: Riveted and bonded joints.
5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

2.09 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch-thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
 - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
 - a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
 - b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
 - c. Ducts 44 to 60 Inches in Diameter: 0.22 inch with single-rib spiral-seam construction.
 - d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.

4. Perforated Inner Ducts: Fabricate with 0.028-inch thick sheet metal having 3/32-inch diameter perforations, with overall open area of 23 percent.
 5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.
- B. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.
1. Solid Inner Ducts: Use the following sheet metal thicknesses:
 - a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
 - b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
 - c. Ducts 60 to 88 inches in Diameter: 0.040 inch.
 2. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION:

- A. Install dampers so as to permit adjustment after completion of the work.
- B. Install dampers without strain or distortion of any part of dampers.
- C. Adjust moving parts to move freely without binding.
- D. Caulk dampers airtight around frames.
- E. Adjust damper adjusting rods to operate freely between open and closed positions.
 1. Cut off projecting ends of rods after adjustment and bend over two inches from bushings.
 2. Leave cut ends smooth and free from burrs.
- F. Where diffuser is located at end of rectangular duct, extend duct minimum of one-neck diameter beyond center line of neck.
- G. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", unless otherwise indicated.
- H. Replace damaged ductwork and appurtenances.
- I. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- J. Install ducts with fewest possible joints.
- K. Install fabricated fittings for changes in directions, size, and shape and for connections.
- L. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- M. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

- N. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- O. Coordinate layout with suspended ceiling, fire-and smoke-control dampers, lighting layouts, and similar finished work.
- P. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- Q. Fire-Related partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Section 15820. Firestopping materials and installation methods are specified in Section 07841.
- R. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction".
- S. Provide sheet metal caps on duct ends that are to be connected to future ductwork.

3.02 PVC-COATED DUCT, SPECIAL INSTALLATION REQUIREMENTS

- A. Repair damage to PVC coating with manufacturer's recommended materials.

3.03 UNDERSLAB DUCTS, SPECIAL INSTALLATION REQUIREMENTS

- A. Verify undamaged condition of ducts before enclosure with fill or encasement.
- B. Protect ducts from damage by equipment used in placing fill materials and concrete on or around ducts.
- C. Protect duct openings from damage and prevent entrance of foreign materials.

3.04 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction - Metal and Flexible" for duct pressure class indicated.
 - 1. For pressure classes lower than 2-inch wg, seal transverse joints.
- B. Seal ducts before external insulation is applied.

3.05 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet at each floor.

- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.06 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Section 15820.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.07 FIELD QUALITY CONTROL

- A. Air-Leak Tests for Accessible Ductwork: Perform air-leak tests in accordance with SMACNA HVAC Air Duct Leakage Test Manual.

3.08 CLEANING OF AIR SYSTEM

- A. Before air conditioning or filters are operated, clean inside of air system, including ductwork used for air supply or return.
- B. Accomplish cleaning by means of industrial vacuum cleaners which will effectively remove dust and foreign material from surfaces swept by air stream.
- C. Clean exposed ductwork and leave in satisfactory condition, free from grease, oil and foreign material prior to application of insulation or finish painting.
- D. Clean ducts after the system has been used for adjusting, testing or temporary ventilation.

END OF SECTION

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SECTION 15820

DUCT ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies providing duct accessories.
- B. Related work specified elsewhere:
 - 1. Ductwork: Section 15810.
 - 2. Identification of Mechanical Equipment and Piping: Section 15075.
 - 3. System Balancing and Testing: Section 15950.
 - 4. Metal Louvers: Section 10200.

1.02 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- B. SMACNA:
 - 1. Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
- C. Dampers shall be tested and rated in accordance with AMCA Standard 500.

1.03 SUBMITTALS

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: For the following:
 - a. Backdraft dampers.
 - b. Volume dampers.
 - c. Fire dampers.
 - d. Smoke dampers.
 - e. Combination fire and smoke dampers.
 - f. Turning vanes.
 - g. Duct-mounting access doors.
 - h. Flexible connectors.
 - i. Flexible ducts.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - a. Special fittings.
 - b. Manual-volume damper installations.
 - c. Motorized-control damper installations.
 - d. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
 - e. Wiring Diagrams: Power, signal, and control wiring.

PART 2 - PRODUCTS

2.01 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653 and having or G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480.

- D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 BACKDRAFT DAMPERS

- A. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

2.03 VOLUME DAMPERS

- A. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
- B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications. Select metal compatible with duct.
- C. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
- D. Jackshaft: 1-inch-diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
- E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.05 FIRE DAMPERS

- A. Fire dampers shall be labeled according to UL 555.
- B. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
- C. Fusible Links: Replaceable, 165 deg F or 212 deg F rated.

2.07 SMOKE AND COMBINATION FIRE AND SMOKE DAMPERS

- A. General Description: Labeled according to UL 555S. Combination fire and smoke dampers shall be labeled according to UL 555.
- B. Fusible Links: Replaceable.
- C. Frame and Blades: Galvanized sheet steel.
- D. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
- E. Damper Motors: Modulating and two-position action.

2.08 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single or double-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

2.09 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness for duct pressure class. Include vision panel and butt or piano hinge and cam latches.
- C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and thickness. Include cam latches.
- D. Pressure Relief Access Door: Single or double wall and duct mounting; fabricated of galvanized sheet metal with insulation fill and thickness for duct pressure class. Include vision panel, latches, and retaining chain.
 - 1. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- F. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 FLEXIBLE CONNECTORS

- A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Metal-Edged Connectors: Factory fabricated with a fabric strip attached to two strips of galvanized sheet steel or 0.032-inch-thick aluminum sheets. Select metal compatible with ducts.
- C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
- D. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
- E. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
- F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

2.11 FLEXIBLE DUCTS

- A. Noninsulated Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
- B. Insulated Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor barrier film.
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 to suit duct size.

2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside.
- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.
- E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- F. Provide test holes at fan inlets and outlets.
- G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.
- H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units.
- I. Label access doors according to Section 15075.
- J. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- K. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- L. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- M. Install duct test holes where indicated and required for testing and balancing purposes.

3.02 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Section 15950.

END OF SECTION

SECTION 15825

SOUND ATTENUATORS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing factory-fabricated sound attenuators.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AMCA Standards.
 - 3. SMACNA HVAC Duct Construction Standards.
 - 4. UL: 723.
 - 5. NFPA: 130, 255.
 - 6. ASTM: E84.
- B. Source Quality Control:
 - 1. Run tests for subway ventilation-fan attenuators on dynamic insertion-loss performance by duct-to-reverberation-room method with air flowing through sound attenuator at rated capacity.
 - 2. Test methods to eliminate effects due to end reflection, vibration, flanking transmission and standing waves in reverberant room.
 - 3. Take air flow and pressure loss data in accordance with AMCA Standards.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings.
 - 2. Certification.
 - a. Certify that values for sound-pressure levels, i.e., decibels, Re 0.0002 microbar, of cooling tower with attenuators do not exceed those scheduled below measured at 50 feet in free field in any direction.

Octave Band Center Frequency/Hertz	Sound Pressure Level/dB at 50 Feet with Inlet and Outlet Attenuators
63	66
125	61
250	54
500	45
1000	42
2000	41
4000	39
8000	39

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
1. In design and purchase of equipment, provide for interchangeability of items of equipment, subassemblies and parts.
- B. Subway Ventilation-Fan and Jet-Fan Attenuators:
1. Factory-fabricated with nominal rectangular cross section and length as shown.
 2. Outer casing constructed of minimum 22-USSG, galvanized sheet steel in accordance with SMACNA HVAC Duct Construction Standards.
 3. Interior partitions minimum 24-USSG, galvanized, perforated steel sheet.
 4. Factory-banded with 1-1/2 inch square by 1/8-inch steel angle flanges and two-inch bar straps.
 5. Airtight when operated at two inches water-gauge static pressure and rated capacity.
 6. Acoustic filler material:
 - a. Inorganic fibrous glass, permanently odorless.
 - b. Minimum five-percent compression to eliminate voids and setting.
 - c. Combustion rating when tested in accordance with ASTM E84, NFPA 255, or UL 723, maximum 20 for flame spread, 20 for smoke developed and 15 for fuel contributed.
 7. Designed for maximum pressure drop as specified for 100-percent forward flow and 70-percent reverse flow for air flow volume as shown.
 8. Minimum dynamic insertion loss (dB) under operating conditions shown in accordance with Table 15825-1.
 9. Comply with high temperature requirements given in NFPA 130.
- C. Cooling-Tower Sound Attenuators:
1. Factory-fabricated, packaged-type, furnished by tower manufacturer.
 2. Outer casing constructed of minimum 22-USSG, hot-dip galvanized sheet steel in accordance with SMACNA HVAC Duct Construction Standards.
 3. Panels lines:

- a. With weatherproof, inorganic, permanently odorless, fibrous-glass acoustic material.
 - b. Combination rating when tested in accordance with ASTM E84, NFPA 255, or UL 723, maximum 25 for flame spread, 20 for smoke developed and 20 for fuel contributed.
- 4. Lining secured in place with galvanized-steel screening.
 - 5. Removable panels: For access to the eliminator sections and upper interior of tower.
 - 6. Exposed metal surfaces finished with zinc-chromate aluminum paint or manufacturer's standard finish providing equal or greater corrosion protection.
 - 7. Intake attenuators designed to bolt directly to the cooling tower, having removable access doors at ends for entry to moving parts of unit.
 - 8. Discharge attenuators designed to mount directly to top of tower and requiring no additional structural support.
 - 9. Galvanized-sheet-metal hooded inlet provided for protection from weather.
- D. Nameplates:
- 1. Securely attached to each attenuator showing manufacturer's name, model number and serial number.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit sound attenuators within space available without restricting air flow.
- B. Install attenuators in accordance with manufacturer's recommendations and printed instructions.
- C. Provide sheet metal transitions, supports and concrete pads for fan attenuators.
- D. Provide self-supported cooling tower attenuators which can be readily attached.

TABLE 15825-1 MINIMUM DYNAMIC INSERTION LOSS									
<u>Std. Type</u>	<u>Max. Press. Length Ft.</u>	<u>Drop In.-wg.</u>	<u>Dynamic Insertion Loss/Hertz</u>						
			<u>125 Hz</u>	<u>250 Hz</u>	<u>500 Hz</u>	<u>1000 Hz</u>	<u>2000 Hz</u>	<u>4000 Hz</u>	<u>8000 Hz</u>
3A	3	.31	5	8	15	16	14	10	8
5A	5	.31	8	13	25	28	21	14	10
7A	7	.31	9	18	31	38	28	18	12
3B	3	.31	7	12	19	24	23	18	11
5B	5	.37	10	18	30	42	33	23	14
7B	7	.40	14	24	36	48	44	31	18

END OF SECTION

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SECTION 15830

FANS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing fans.
- B. Related Work Specified Elsewhere:
 - 1. Vibration isolation: Section 15070.
 - 2. Ductwork: Section 15810.
 - 3. Control equipment: Section 15900.
 - 4. Motors: Section 16225.
 - 5. Motor starters and control devices: Section 16425.
 - 6. Variable frequency drives: Section 16269.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. AISI Standards.
 - 3. AMCA: 210, 99-2408.
 - 4. NFPA: 130.
 - 5. SAE: 1035,1040.
 - 6. UL 705
- B. Factory Wiring:
 - 1. In accordance with manufacturer's standard practice.
- C. Source Quality Control:
 - 1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from laboratory Test Data". Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans". Label fans with the AMCA-Certified Ratings Seal.
 - 2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including construction, electrical characteristics, furnished specialties, and accessories.
 - 2. Shop Drawings: Detail assemblies and indicate dimensions, weights, required clearances, method of field assembly, components and wiring diagrams.
 - a. Performance tests certified by AMCA or performed either in accordance with AMCA 210 or in a laboratory approved by AMCA, for capacities shown.

- b. Performance curves for each fan showing brake horsepower, static pressure and static efficiency plotted against air volume and noise level. For reversible fans, submit curves for both forward and reverse modes.
- 3. Certification:
 - a. For under-platform-exhaust fans, dome-exhaust fans certify that fans are rated and tested in accordance with AMCA 210.
- 4. Operation and Maintenance Manuals.

1.04 JOB CONDITIONS:

- A. Safety Requirements:
 - 1. Properly guard belts, pulleys, chains, gears, couplings, projecting set screws, keys and other rotating parts to prevent danger to personnel.
- B. Coordinate size and location of structural-steel support members.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- D. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories".

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Utility Fan Sets:
 - 1. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
 - 2. Housing: Fabricated of steel or aluminum with side sheets fastened with a deep lock seam or welded to scroll sheets.
 - a. Housing Discharge Arrangement: Adjustable to eight standard positions.
 - 3. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
 - 4. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 5. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
 - 6. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - a. Service Factor Based on Fan Motor Size: 1.5.
 - b. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - c. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - d. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
 - 7. Accessories:
 - a. Inlet and Outlet: Flanged.
 - b. Companion Flanges: Rolled flanges for duct connections of same material as housing.

- c. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
 - d. Access Door: Gasketed door in scroll with latch-type handles.
 - e. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
 - f. Inlet Screens: Removable wire mesh.
 - g. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
 - h. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
- 8. Coatings: Powder-baked enamel.
 - 9. Fans designed to ensure that resonance frequency of blade assembly is not within 15 percent of harmonics of rotational frequency.
 - 10. Finished parts of fans, such as shafts and bearings, protected from rust prior to operation by means of wrappings or protective grease or plastic coatings.
 - 11. Exhaust fans under-platform-exhaust fans and dome-exhaust fans, provided with firestats to stop fan when temperature of air being handled reaches 125F.
 - a. Firestat having adjustable range from 100F to 200F and manual reset.
 - 12. Fans with wheels less than 12 inches in diameter, and utility fans operating at less than 0.75 inches WG may have forward-curved blades.
 - 13. Fan construction suitable for operating conditions defined in AMCA 99-2408.

B. Centrifugal Roof Ventilators

- 1. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- 2. Housing: Removable, spun-aluminum, dome top and outlet baffle, square, one-piece, aluminum base with venturi inlet cone.
 - a. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
 - b. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- 3. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- 4. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features.
 - a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - d. Fan and motor isolated from exhaust airstream.
- 5. Accessories:
 - a. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - b. Bird Screens: Mesh aluminum or brass wire.
 - c. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - d. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- 6. Roof Curbs: Galvanized steel; mitered and welded corners; rigid, fiberglass insulation adhered to inside walls; and wood nailer. Size as required to suit roof opening and fan base.

- C. Axial Roof Ventilators
1. Description: Direct- or belt-driven axial fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
 2. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base.
 - a. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
 3. Fan Wheel: Aluminum hub and blades.
 4. Belt-Driven Drive Assembly: Resiliently mounted to housing with the following features:
 - a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 5. Accessories:
 - a. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - b. Bird Screens: Removable mesh aluminum or brass wire.
 - c. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - d. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
 6. Roof Curbs: galvanized steel; mitered and welded corners; rigid, fiberglass insulation adhered to inside walls; and wood nailer. Size as required to suit roof opening and fan base.
- D. Upblast Propeller Roof Exhaust Fans
1. Description: Direct- or belt-driven propeller fans consisting of housing, wheel, butterfly-type discharge damper, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base and accessories.
 2. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.
 3. Fan Wheel: Replaceable, extruded-aluminum airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
 4. Belt-Driven Drive Assembly: Resiliently mounted to housing; weatherproof housing of same material as fan housing with the following features:
 - a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - b. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
 - c. Pulleys: cast-iron, adjustable-pitch motor pulley.
 - d. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.
 5. Roof Curbs: galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
- E. Centrifugal Wall Ventilators
1. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
 2. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

3. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
4. Belt-Driven Drive Assembly: resiliently mounted to housing, with the following features:
 - a. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - b. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - c. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - d. Fan and motor isolated from exhaust airstream.
5. Accessories:
 - a. Disconnect Switch: nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
 - b. Bird Screens: Removable mesh aluminum or brass wire.
 - c. Wall Grille: Ring type for flush mounting.
 - d. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
 - e. Motorized Dampers: parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Ceiling-Mounting Ventilators

1. Description: Direct or belt driven Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.
2. Housing: Steel, lined with acoustical insulation.
3. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
4. Grille: Aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.
5. Electrical requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
6. Accessories:
 - a. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - b. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 - c. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
 - d. Filter: Washable aluminum to fit between fan and grille.
 - e. Isolation: Rubber-in-shear vibration isolators.
 - f. Manufacturer's standard roof jack or wall cap, and transition fittings.

G. In-Line Centrifugal Fans

1. Description: in-line belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets and accessories.
2. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
3. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
4. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
5. Accessories:
 - a. Variable-Speed Controller.

- b. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
- c. Companion Flanges: For inlet and outlet duct connections.
- d. Fan Guards: Galvanized steel mesh in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
- e. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

H. Propeller Fans

1. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.
2. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
3. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
4. Fan Wheel: replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
5. Belt-Driven Drive Assembly: resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - a. Service Factor Based on Fan Motor Size: 1.4.
 - b. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - c. Shaft Bearings: permanently lubricated, permanently sealed, self-aligning ball bearings.
 - d. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 - e. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - f. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - g. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

I. Centrifugal Fans:

1. Class I or II, nonoverloading.
2. Fan blades:
 - a. Fan wheels larger than 30 inches: Backward-inclined air-foil section.
 - b. Fan wheels 30 inches or less: Backward-inclined plate-type blades.
3. Air entering fan uniformly over inlet area.
4. Fan housing: Fabricated of steel sheets, manufacturer's standard heavy-gauge construction, except for those of low-pressure fans of less than 5,000-cfm capacity which may be fabricated of aluminum, 0.080-inch thick or heavier.
5. Fan wheel rims and blades: Fabricated of steel, manufacturer's standard heavy-gauge construction.
6. Fan wheels: Aluminum or steel provided with manufacturer's standard corrosion-resistant coating.
7. One layer of corrosion-resistant coating on nonworking surfaces of shafts, factory-applied.
8. Inspection openings provided for fan housing having wheels larger than 22 inches in diameter.
 - a. Cover plate having pressure latches on fan housing on scroll sheets located opposite outlets.

9. Large fan housings provided in sections to permit installation or removal through openings available in structure.
10. Field joints: Flanged and bolted.
11. Fans designed to provide self-limiting, nonoverloading power characteristics.
12. Fan driven by V-belt rated at 150 percent of driving-motor brake horsepower.
 - a. Adjustable sheaves furnished on motor, capable of 20-percent adjustment in fan speed, with design fan-capacity setting at approximately midpoint of adjustment.
 - b. Drives provided with belt guard of expanded-metal wire mesh or belt guards with solid-metal side panels with tachometer opening.
13. Motors:
 - a. One-half horse power and above: Totally enclosed, fan-cooled and guarded in accordance with Section 16225.
 - b. Less than 1/2 horsepower: Manufacturer's standard for intended use.
14. Vibration isolators: In accordance with Section 15070.

J. Tubular Centrifugal Fans:

1. Class I or II, belt-drive, nonoverloading, designed for straight through airflow.
2. Housing: Manufacturer's standard heavy-gauge steel for construction.
 - a. Flanged inlet and outlet for connection to ductwork, with inlet and outlet identical in size.
 - b. Welded, cylindrical construction, braced to prevent vibration.
 - c. Fan bearings and drive enclosed and isolated from air stream.
3. Fan wheels:
 - a. Welded construction, centrifugal wheel, with backward-inclined blades.
 - b. Fan wheels 27 inches in diameter or larger supplied with double thickness, air-foil blades.
 - c. Fan wheels less than 27 inches in diameter supplied with plate-type blades.
 - d. Fan wheels statically and dynamically balanced.
4. Fans supplied with stationary conversion vanes on discharge side of wheel designed to reduce turbulence.
5. Fan bearings:
 - a. Heavy-duty, self-aligning ball bearings.
 - b. Lubrication fittings extended to fan casing and provided with covers to effectively exclude water and dirt.
6. Fan shaft accurately machined and ground for proper fit to wheel hub and bearing and designed to operate well below first critical speed.
7. Inside and outside of fan housing factory-painted with baked-enamel primer. Exterior surfaces given an additional factory-coat of corrosion-resistant finish enamel.
8. One coat of corrosion-resistant coating on nonworking surfaces of shafts, factory-applied.
9. Fan driven by V-belt rated at 150 percent of driving-motor brake horsepower.
 - a. Adjustable sheaves furnished on motor allowing 20-percent adjustment in fan speed, with design-capacity setting at approximately midpoint of adjustment.
10. Fan wheels and sheaves splined or keyed and fastened to the shaft with set screws.
11. Internal and external belt guards as necessary for complete protection.
12. Motors:
 - a. One-half horsepower and above: Totally enclosed, fan-cooled and guarded in accordance with Section 16225.
 - b. Less than 1/2 horsepower: Manufacturer's standard for intended use.

- K. Axial Fans:
1. Direct-driven or belt-driven.
 2. Welded tubular-steel casings, except for low-pressure fans of less than 5,000-cfm capacity, which may have aluminum casings.
 3. Equipped with stationary discharge conversion blades and adjustable motor mounts.
 4. Air-foil blades: High-strength cast aluminum or steel.
 5. Blade pitch:
 - a. Fans with wheels 18 inches or larger: Blades field-adjustable without removing wheel from casing.
 - b. Fans with wheels less than 18 inches in diameter: May be equipped with stationary blades.
 6. Flanged-type for fan-casing connections to ductwork.
 7. Internal and external belt guards, as appropriate.
 8. Inlets with smooth, rounded edges.
 9. Air entering and leaving fan axially.
 10. Belt-driven fans:
 - a. Provide with high-grade, open-hearth steel fan shaft accurately machined and ground for proper fit to wheel hub and bearings.
 - b. Fan bearings and drive shafts enclosed and isolated from the air stream.
 - c. Bearings sealed mechanically against dust and dirt, self-aligning and grease-lubricated.
 - d. Fan driven by V-belt rated at 150 percent of driving-motor brake horsepower.
 11. Motors:
 - a. 1/2 horsepower and above:
 1. Belt-driven fans: Totally enclosed, fan-cooled and guarded in accordance with Section 16225.
 2. Direct-driven fans: Totally enclosed, air-over, fully guarded in accordance with Section 16225.
 - b. Less than 1/2 horsepower: Manufacturer's standard for intended use.
- L. Power Roof Ventilators:
1. Direct-driven or belt-driven.
 2. Consisting of fan with housing and weatherproof hood mounted on factory-supplied acoustical-thermal curb.
 3. Fan housing constructed of spun aluminum and arranged to facilitate access for servicing from roof.
 - a. Discharge openings with 1/2-inch wire-mesh bird screen of aluminum or provided with corrosion-resistant coating.
 - b. Acoustical-thermal curb: Product of power roof-ventilator manufacturer.
 - c. Aluminum-blade back-draft dampers sized to fit curb opening.
 - d. Power roof-ventilator housing secured to curb to resist winds of 100 MPH.
 4. Motor: Totally enclosed weatherproof housing located outside of air stream and as specified in Section 16225.
 - a. Motor having unfused power-disconnect switch, mounted under fan housing adjacent to motor.
 - b. Permanently sealed, grease-lubricated, ball bearings or roller bearings.
 5. Belt-driven unit and belt drivers rated for 150 percent of motor-nameplate horsepower.
 - a. Adjustable sheaves to permit 20-percent adjustment in fan speed, with design fan capacity at approximately midpoint of adjustment.
 6. Wheel and drive assembly isolated from base section by means of rubber-in-shear isolators.
- M. Propeller Fans:
1. Direct-connected or belt-connected, motor-driven.

2. Wheels having steel or aluminum blades; statically and dynamically balanced at the factory.
3. Cast or die-formed mounting rings or plates.
 - a. Mounting plates designed to prevent distortion.
 - b. Mounting plates turned up at edges or braced with steel angles.
4. Wire-mesh guard completely surrounding fan blades.
5. Steel shafts for fans which are not mounted directly on motor shafts.
 - a. Shafts accurately finished on working surfaces.
6. Self-aligning sleeve bearings or ball bearings:
 - a. Sleeve bearings:
 1. Ring oiled sleeve bearings or wool-packed and provided with oil reservoirs.
 2. Oiling device arranged in manner so that oil can be added while fan is running without danger of over-oiling.
 - b. Ball bearings:
 1. Prelubricated sealed bearings.
 2. Factory-installed grease fittings to permit external bearing relubrication.
7. Motors:
 - a. Up to and including 1/2 HP: Manufacturer's standard.
 - b. Above 1/2 HP: Section 16225.

N. Under-Platform-Exhaust Fans and Dome-Exhaust Fans:

1. Tube axial, direct-driven, reversible.
2. Air volume in reverse: Minimum of 70 percent of that in forward direction.
3. Minimum efficiency: 75 percent at specified forward direction and operating conditions.
4. Brake horsepower: Not exceeding 100 percent of associated motor-nameplate rating at any point on fan power curve.
5. Construction:
 - a. Fan housing constructed of minimum 1/4-inch welded steel plate, reinforced as necessary and flanged for connection to system ductwork or for mounting as otherwise shown.
 - b. Wheel and motor entirely enclosed within fan housing.
 - c. Stationary curved guide vanes integrally welded with housing and located on discharge side of wheel to straighten motion of air leaving blades.
 - d. Fan wheels: Fabricated of high-strength cast aluminum or steel with air-foil shaped, adjustable blades.
 - e. Blades adjustable without removing wheel. Index and stops at hub to prevent overload of motor.
 - f. Positive-locking device installed for attaching rotor to motor shaft.
 - g. Drain fittings located in low parts of fan housing.
 - h. Fan fabricated of corrosion-resistant materials.
7. Fan motors: Section 16225, with the following additional requirements:
 - a. Totally enclosed, air-over, squirrel cage, induction, reversible, fully guarded.
 - b. Adequate cooling in both directions at 50 percent of flow.
 - c. Motor bearings precision-grade anti-friction type, packed at the factory with special lubricant designed for maximum radial and thrust loads to be encountered in both directions of air flow.
 - d. Double-shielded bearings, minimum 200,000-hour life, regreasable with readily accessible inlet grease fittings and outlet grease plug to allow for in-service greasing, and metering the amount of grease which actually enters the bearings to protect against over-lubrication.
 - e. Grease fittings brought to outside of fan housing and provided with covers which effectively exclude water and dirt between lubrications.

- f. Each motor with a drain plug at bottom of shell.
 - g. Motor speed not to exceed 1,200 rpm.
 - 8. High temperature: Fans and motors capable of meeting high temperature requirements specified in NFPA 130.
- O. Nameplates:
- 1. Fans: Securely attached on each fan showing manufacturer's name, model number and serial number.
 - 2. Motors: As specified in Section 16225.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Section 07730 for installation of roof curbs.
- B. Label units according to requirements specified in Section 15075.
- C. Fit fans and appurtenances within space provided and make readily serviceable.
- D. Provide support beams, concrete pads, support legs, platforms, hangers and anchor bolts required for proper installation of equipment as recommended by manufacturer.
- E. Vibration isolation for fans: As specified in Section 15070.
- F. Concrete pads: As specified in Section 15050.
- G. Axial and tubular centrifugal fans: Provide service access in accordance with Section 15810.
- H. Motor starters and control centers: As specified in Section 16425.

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories".
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding".
- D. Connect wiring according to Division 16 Section "Wire, Cable and Busways."

3.03 FIELD QUALITY CONTROL

- A. Perform the following field test and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 15 Section "System Balancing and Testing" for testing, adjusting and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION

THIS PAGE NOT USED

SECTION 15834

AIR CURTAINS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies providing air curtains with hot-water heat, electric heat, gas-fired heater.

1.02 QUALITY ASSURANCE

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NFPA 70.
 - 3. AMCA 220.
 - 4. ARI 410.
 - 5. NSF 37.

1.03 SUBMITTALS

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each unit.
 - 2. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - a. Include plans, elevations, sections, details, and attachments to other work.
 - b. Wiring Diagrams: Power, signal, and control wiring.
 - 3. Operation and Maintenance Data: For air curtains to include in maintenance manuals.

1.04 COORDINATION

- A. Coordinate layout and installation of air curtains and suspension system components with other construction, including light fixtures, fire-suppression-system components, and partition assemblies.
- B. Coordinate installation of wall penetrations and louvers. These items are specified in Section 10200.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Housing Materials: Heavy-gage, electroplated-zinc steel with welded construction and polyester-coated finish.
- B. Intake Louvers: Integral part of the housing, mechanically field adjustable and capable of reducing air-outlet velocity by 60 percent with louver in totally closed position.
- C. Discharge Nozzle: Integral part of the housing, containing adjustable air-directional vanes

- with 20 degree sweep front to back.
- 2.02 FANS**
- A. Fans: Centrifugal, forward curved, double width, double inlet; statically and dynamically balanced.
 - B. Fan Drives: Belt, equipped with belt guards and adjustable sheaves and pulleys for adjusting air-outlet velocity.

- 2.03 MOTORS**
- A. Motor Type: Two speed resiliently mounted, continuous duty, totally enclosed, fan cooled, with integral thermal-overload protection.
 - B. Bearings: Permanently sealed, lifetime, prelubricated, ball bearings.
 - C. Disconnect: Internal power cord with plug and receptacle.

- 2.04 WATER COILS**
- A. Description: Self-draining coil.
 - B. Piping Connections: Threaded on same end.
 - C. Tubes: Copper, complying with ASTM B 75.
 - D. Fins: Copper with.
 - E. Fin and Tube Joint: Mechanical bond.
 - F. Headers: Seamless copper tube with brazed joints, prime coated.
 - G. Frames: Galvanized-steel channel frame.
 - H. Ratings: According to ASHRAE 33.

- 2.05 ELECTRIC HEATING COILS**
- A. Coil Assembly: Comply with UL 1995.
 - B. Frame: Galvanized-steel frame.
 - C. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
 - D. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device;

serviceable through terminal box without removing heater from duct or unit.

1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- E. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
1. Magnetic contactor.
 2. Mercury contactor.
 3. Solid-state stepless pulse controller.
 4. Toggle switches; one per step.
 5. Step controller.
 6. Time-delay relay.
 7. Pilot lights; one per step.
 8. Airflow proving switch.

2.06 GAS-FIRED HEATERS

- A. Comply with AGA Z83.8, "Gas Unit Heaters."
1. AGA Approval: Bear AGA label.
 2. Type of Gas: Natural.
- B. Assembly and Wiring: Heaters factory assembled, piped, wired, and tested for 120-V ac.
- C. Housing: Steel, with integral draft hood and inserts for suspension-mounting rods.
1. External Casings and Cabinets: Baked enamel over corrosion-resistant-treated surface.
- D. Heat Exchanger: Stainless steel.
- E. Burners: Cast iron or aluminized steel with stainless-steel inserts.
- F. Venting Provision: Gravity.
- G. Power Venter: 120-V ac, with stainless-steel shaft.
- H. Automatic Gas Control: Single-stage, 24-V ac valve.
- I. Ignition: Electronically control spark with flame sensor.

2.07 FILTERS

- A. Washable Panel Filters: Removable, stainless-steel, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch- thick, stainless-steel filter frame.
- B. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.08 ACCESSORIES

- A. Built-in Thermostat: Line voltage, factory installed and wired to the junction box on air curtain.

- B. Automatic Door Switch: Plunger type installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.
- C. Start-Stop, Push-Button Switch: Manually activates and deactivates air curtain.
- D. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 hours.
- E. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, Type 1 enclosure.
- F. Mounting Brackets: Adjustable mounting brackets for drum-type roll-up doors.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install air curtains with clearance for equipment service and maintenance.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections.
- B. Install piping adjacent to air curtain to allow service and maintenance.
- C. Breaching: Comply with applicable requirements in Division 15 Section, "Breechings, Chimneys, and Stacks." Connect breaching to full size at flue outlet.
- D. Ground equipment according to Division 16 Section "Grounding and Bonding."
- E. Connect wiring according to Division 16 Section "Wire, Cable and Busways."

3.04 FIELD QUALITY CONTROL

- A. Repair or replace malfunctioning units and retest as specified above.

3.04 ADJUSTING

- A. Adjust belt tension.
- B. Adjust motor and fan speed to achieve specified airflow.
- C. Adjust discharge louver and dampers to regulate airflow.
- D. Adjust air-directional vanes.

END OF SECTION

SECTION 15840

AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section specifies providing the following:
 - 1. Bypass single-duct air terminal units
 - 2. Dual-duct air terminal units.
 - 3. Fan-powered air terminal units.
 - 4. Induction air terminal units.
 - 5. Shutoff single-duct air terminal units.
 - 6. Integral-diffuser air terminal units.
- B. Related work specified elsewhere.
 - 1. Identification of Mechanical Equipment and Piping: Section 15075.
 - 2. Piping Systems: Section 15205.
 - 3. Ductwork: Section 15810.
 - 4. Outlets and Grilles: Section 15850.
 - 5. Control Equipment: Section 15900.
 - 6. Grounding and Bonding: Section 16060.
 - 7. Wire, Cable and Busways: Section 16120.
 - 8. Wiring and Control Devices: Section 16145.

1.02 SUBMITTALS

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each.
 - 1. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - a. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
 - b. Wiring Diagrams: Power, signal, and control wiring.
 - 3. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. include the following:
 - a. Instructions for resetting minimum and maximum air volumes.
 - b. Instructions for adjusting software set points.

1.03 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.04 COORDINATION

- A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 BYPASS SINGLE-DUCT AIR TERMINAL UNITS

- A. Configuration: Diverting-damper assembly inside unit casing with control components located inside a protective metal shroud.
- B. Casing: 0.034-inch steel.
- C. Diverter Assembly: Galvanized-steel gate, with polyethylene linear bearings.
- D. Multioutlet Attenuator Section: With multiple diameter collars; each with locking butterfly balancing damper.
- E. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
- F. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed.
- G. Electric Controls: Damper actuator and thermostat.
- H. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat.

2.02 DUAL-DUCT AIR TERMINAL UNITS

- A. Configuration: Two volume dampers inside unit casing with mixing attenuator section and control components located inside a protective metal shroud.
- B. Casing: Steel or aluminum.
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- D. Attenuator Section: Steel or aluminum sheet metal.
- E. Multioutlet Attenuator Section: With multiple diameter collars; each with locking butterfly balancing damper.
- F. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 15 Section 15900.

2.03 FAN-POWERED AIR TERMINAL UNITS

- A. Configuration: Volume-damper assembly and fan in series or in parallel arrangement inside unit casing with control components inside a protective metal shroud.
- B. Casing: Steel or aluminum
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- D. Fan Section: Galvanized-steel plenum, with direct-drive, forward-curved fan with air filter and backdraft damper.
- E. Attenuator Section: Steel or aluminum sheet metal.
- F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
- G. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed.
- H. Factory-Mounted and -Wired Controls: Electrical components shall be mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
- I. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

- J. Electronic Controls: Bidirectional damper operator and microprocessor-based controller with integral airflow transducer and room sensor shall be compatible with temperature controls specified in Section 15900.

2.04 INDUCTION AIR TERMINAL UNITS

- A. Configuration: Volume-damper assembly inside unit casing with mechanical induction damper mounted on casing and control components located inside a protective metal shroud.
- B. Casing: Steel or aluminum.
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- D. Induction Damper: Galvanized-steel, multiblade assembly with self-lubricating bearings.
- E. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
- F. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed.
- G. Electronic Controls: Electronic damper operators, electronic controller integral airflow transducer, and electronic thermostat.

2.05 SHUTOFF SINGLE-DUCT AIR TERMINAL UNITS

- A. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.
- B. Casing: Steel or aluminum.
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- D. Attenuator Section: Steel or aluminum sheet metal.
- E. Multioutlet Attenuator Section: With multiple diameter collars; each with locking butterfly balancing damper.
- F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig; and factory installed.
- G. Electric Heating Coil: Slip-in-type, open-coil design with integral control box factory wired and installed.
- H. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in Division 15 Section 15900.

2.06 INTEGRAL-DIFFUSER AIR TERMINAL UNITS

- A. Configuration: Volume-damper assembly inside unit casing with integral or attached diffuser.
- B. Casing: Steel or Aluminum.
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- D. Diffuser: Galvanized-steel insulated plenum with extruded-aluminum or sheet-steel diffuser, having fixed or variable geometry designed to operate from 100 percent to minimum airflow, manual adjustment of airflow direction, and white baked-enamel finish.
- E. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor shall be compatible with temperature controls specified in Section 15900.

- F. Integral thermally powered actuators, sensing duct and room temperature, control diffusion dampers.

2.07 SOURCE QUALITY CONTROL

- A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in Division 15 Section 15205.
- B. Install piping adjacent to air terminal units to allow service and maintenance.
- C. Hot-Water Piping: In addition to requirements in Division 15 Section 15205, connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- D. Connect ducts to air terminal units according to Division 15 Section 15810
- E. Ground units with electric heating coils according to Division 16 Section 16060.
- F. Connect wiring according to Division 16 Section 16120 "Wire, Cable and Busways", and 16145 "Wiring and Control Devices."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform field tests and inspections and prepare test reports.
- C. Remove and replace malfunctioning units and retest as specified above.

3.04 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

3.05 DEMONSTRATION

- A. Upon completion of installation, in accordance with the General Requirements, furnish on-site services of the manufacturer's engineering representative with specialized experience in the system and its components to instruct Authority personnel in the proper operation and maintenance of each system.

END OF SECTION

SECTION 15850

OUTLETS AND GRILLES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing outlets and grilles.
- B. Related Work Specified Elsewhere:
 - 1. System balancing and testing: Section 15950.
 - 2. Ductwork: Section 15810
 - 3. Duct Accessories: Section 15820

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
- B. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets".

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: For each type of project indicated, include rated capacities, furnished specialties, sound power ratings, and accessories.
 - 2. Shop drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - a. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
 - b. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw drop, static-pressure drop, and noise ratings.
 - 3. Certification.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Grilles and Registers
 - 1. Adjustable Bar Grille:
 - 2. Material: Aluminum, Stainless Steel
 - 3. Finish: Baked enamel, white.

4. Face Blade Arrangement: Fixed horizontal spaced 3/4 inch apart, zero-degree deflection.
5. Frame: 1-1/4 inches.
6. Mounting: Countersunk screw.
7. Damper Type: Adjustable opposed-blade assembly.

B. Ceiling Diffuser Outlets

1. Rectangular and Square Ceiling Diffusers:
 - a. Material: Steel, Aluminum.
 - b. Finish: Baked enamel, white.
 - c. Face Size: 24 by 24 inches.
 - d. Face Style: Three cone.
 - e. Mounting: T-bar, surface.
 - f. Pattern: Adjustable.
 - g. Dampers: Combination damper and grid.
 - h. Accessories:
 - (1) Equaling grid.
 - (2) Plaster ring.
 - (3) Safety chain.
 - (4) Wire guard.
 - (5) Sectorizing baffles.
 - (6) Operating rod extension.
2. Perforated Diffuser:
 - a. Material: Steel backpan and pattern controllers, with steel face.
 - b. Finish: Baked enamel, white.
 - c. Face Size: 24 by 24 inches.
 - d. Duct Inlet: Round or Square. See plans for configuration.
 - e. Face Style: Flush.
 - f. Pattern Controller: Fixed with curved blades at inlet.
 - g. Mounting: T-bar.
 - h. Dampers: Combination damper and grid.
 - i. Accessories:
 - (1) Equaling grid.
 - (2) Plaster ring.
 - (3) Safety chain.
 - (4) Wire guard.
 - (5) Sectorizing baffles.
 - (6) Operating rod extension.
3. Louver Face Diffuser:
 - a. Material: Steel or aluminum.
 - b. Finish: Baked enamel, white.
 - c. Mounting: T-bar, surface.
 - d. Dampers: Combination damper and grid.
 - e. Accessories:
 - (1) Square to round neck adaptor.
 - (2) Adjustable pattern vanes.
 - (3) Plaster ring.
 - (4) Safety chain.
 - (5) Wire guard.
 - (6) Sectorizing baffles.
 - (7) Operating rod extensions.

C. Linear Slot Outlets

1. Linear Bar Grille:
 - a. Material: Aluminum.
 - b. Finish: Baked enamel, white.
 - c. Pencil-Proof Core Spacing Arrangement: 7/32" thick bars spaced 7/16" apart, zero-degree deflection.
 - d. Frame: 1-1/4 inches wide.
 - e. Mounting: Countersunk screw.
 - f. Damper Type: Adjustable opposed-blade assembly.
2. Linear Slot Diffuser:
 - a. Material - Shell: Steel, insulated.
 - b. Material - Diffuser Face: Aluminum.
 - c. Finish: Baked enamel, white.
 - d. Slot Width: 3/4 inch.
 - e. Number of Slots: Two.
 - f. Length: 24 inches, 48 inches.
 - g. Accessories: Plaster frame, inlet damper, insulation.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas where diffusers, registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install diffusers, registers and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features of other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service.

3.03 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns required before starting air balancing.

END OF SECTION

THIS PAGE NOT USED

SECTION 15856

INTAKE AND RELIEF VENTILATORS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies providing roof-mounted intake and relief ventilators.
 - 1. Louvered penthouses.
 - 2. Roof hoods.
 - 3. Goosenecks.
- B. Related work specified elsewhere.
 - 1. Roof Accessories: Section 07730.
 - 2. Ductwork: Section 15810.
 - 3. Duct Accessories: Section 15820.

1.02 QUALITY ASSURANCE

- A. Source Limitations: Obtain ventilators through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of intake and relief ventilators and are based on the specific equipment indicated. Refer to Division 1 Section "Product Requirements."
 - 1. Do not modify intended aesthetic effects, as judged solely by Authority Representative, except with Authority's approval. If modifications are proposed, submit comprehensive explanatory data to Authority for review.
- D. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2, "Structural Welding Code--Aluminum."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Intake and relief ventilators shall be capable of withstanding the effects of gravity loads, wind loads, and thermal movements without permanent deformation of components, noise or metal fatigue, or permanent damage to fasteners and anchors.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For intake and relief ventilators. Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure.
- C. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which roof curbs and ventilators will be attached.
 - 2. Sizes and locations of roof openings.
- D. Samples for Verification: For each type of exposed finish required for intake and relief ventilators.
- E. Welding certificates.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653, G90 zinc coating, mill phosphatized.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 or 6 finish.
- E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.
- F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.02 FABRICATION, GENERAL

- A. Factory or shop fabricate intake and relief ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.03 LOUVER PENTHOUSES

- A. Construction: All-welded assembly louvers, mitered corners and aluminum, galvanized-steel, or stainless-steel sheet roof.
- B. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and blades.
- C. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch for frames and 0.064 inch for blades.
- D. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.062 inch, with grain running parallel or perpendicular to length of blades and frame members.
- E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
- F. Bird Screening: Galvanized-steel, 1/2-inch-square mesh, 0.041-inch wire, Aluminum, 1/2-inch-square mesh, 0.063-inch wire, Flattened, expanded aluminum, 3/4 by 0.050 inch thick, or Stainless-steel, 1/2-inch-square mesh, 0.047-inch wire.
- G. Galvanized-Steel Sheet Finish:

1. Factory Priming for Field-Painted Finish.
2. Baked-Enamel Finish: Manufacturer's standard.

2.04 ROOF HOODS

- A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.
- B. Materials: Galvanized-steel sheet, minimum 0.064-inch-thick base and 0.040-inch thick-, or Aluminum sheet, minimum 0.063-inch-thick base and 0.050-inch-thick hood; suitably reinforced.
- C. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
- D. Bird Screening: Galvanized-steel, 1/2-inch- square mesh, 0.041-inch wire, Aluminum, 1/2-inch- square mesh, 0.063-inch wire, Flattened, expanded aluminum, 3/4 by 0.050 inch thick, or Stainless-steel, 1/2-inch-square mesh, 0.047-inch wire.
- E. Galvanized-Steel Sheet Finish:
 1. Factory Priming for Field-Painted Finish.
 2. Baked-Enamel Finish: Manufacturer's standard.

2.05 GOOSENECKS

- A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 5-5; with a minimum of 0.052-inch-thick, galvanized-steel sheet.
- B. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
- C. Bird Screening: Galvanized-steel, 1/2-inch- square mesh, 0.041-inch wire, Aluminum, 1/2-inch- square mesh, 0.063-inch wire, Flattened, expanded aluminum, 3/4 by 0.050 inch thick, or Stainless-steel, 1/2-inch- square mesh, 0.047-inch wire.
- D. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch or Stainless-steel, 18-by-18 mesh, 0.009-inch wire.
- E. Galvanized-Steel Sheet Finish:
 1. Factory Priming for Field-Painted Finish.
 2. Baked-Enamel Finish: Manufacturer's standard.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install intake and relief ventilators level, plumb, and in alignment with adjacent work.
- B. Secure intake and relief ventilators to roof curbs. Use concealed anchorages where possible.
- C. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.
- D. Install intake and relief ventilators with clearances for service and maintenance.
- E. Install perimeter reveals and openings of uniform width for sealants and joint fillers.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07900 for sealants applied during installation.
- G. Label intake and relief ventilators according to requirements specified in Section 15075.
- H. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

- I. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories.

3.03 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

END OF SECTION

SECTION 15861

DUST COLLECTION SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section specifies providing wet centrifugal, dust collection systems:
 - 1. Industrial exhaust fans, ductwork and duct fittings, inlet fittings, dust elimination and collection devices, accessories.
- B. Related work specified elsewhere:
 - 1. Duct Accessories: Section 15820.
 - 2. Fans: Section 15830.
 - 3. Wiring Connection: Section 16125.
 - 4. Motors: Section 16225.

1.02 QUALITY ASSURANCE

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. ACGIH 2091 - American Conference of Governmental Industrial Hygienists.
 - 3. AMCA: 210, 300, 310.
 - 4. ASTM: A90/A90M, A167, A653/A653M, A92M/A924M, A1011/A1011M.
 - 5. AWS D9.1.
 - 6. NFPA 91.
 - 7. NIST PS 15.
 - 8. SMACNA.
 - 9. UL: 181, 214.
- B. Maintain one copy of each document on site.

1.03 SUBMITTALS

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified in each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, electrical characteristics, furnished specialties, and accessories.
 - a. Fan performance curves.
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, water requirements, and location and size of each field connection.
 - 3. Certification
 - 4. Operations and Maintenance Manuals.

1.04 JOB CONDITIONS

- A. Safety Requirements:
 - 1. Properly guard belts, pulleys, chains, gears, couplings, projecting set screws, keys and other rotating parts to prevent danger to personnel
- B. Coordinate size and location of structural-steel support members.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03300.
- D. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07730.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS

- A. Wheel and Inlet:
 - 1. Backward Inclined: Steel construction with smooth curved inlet flange, back plate, backward curved blades welded or riveted to flange and back plate; cast iron hub riveted to back plate and keyed to shaft with set screws.
 - 2. Radial: Steel construction with inlet flange, reinforced back plate, plate blades with reinforcing gussets and wearing strips welded or riveted to back plate and flange; cast iron hub riveted to back plate and keyed to shaft with set screws.
- B. Housing: Steel, continuously welded with inlet bell and shaped cut-off. Factory finished with enamel or prime coat.
- C. Motors and Drives:
 - 1. Motors: In compliance with Section 16225.
 - 2. V-Belt Drive.
 - 3. Belt Guard.
- D. Accessories:
 - 1. Fixed Inlet Vanes.
 - 2. Discharge Dampers.
 - 3. Inlet/Outlet Screens.

2.02 DUCTWORK AND DUCT ACCESSORIES

- A. Materials:
 - 1. Stainless Steel Ducts.
 - 2. Glass Fiber Reinforced Plastic Ducts.
- B. Ductwork:
 - 1. Fabricate and support to UL 181 in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible 2 inch pressure class Round Industrial Duct Construction Standard and Rectangular Industrial Duct Construction Standard and ACGIH Industrial Ventilation Manual except as indicated on Drawings.
 - 2. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Prime coat welded joints.
 - 3. Flexible Connectors: UL 214 listed, fire-retardant impregnated fabric.

2.03 CENTRIFUGAL SEPARATOR

- A. Cyclone dust collector consisting of cyclone with integral fan and structural stand incorporating dust storage.
- B. Heavy-duty Frame and Casing.
- C. Cyclone Efficiency.
- D. Fan.
 - 1. Motor: Refer to Section 16225.
- E. Accessories.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install Work in accordance with standards of authority having jurisdiction standards.
- B. Install fans with resilient mountings and flexible electrical leads. Refer to Section 15070.

- C. Install flexible connections at fan inlet and discharge. Install metal bands of connectors parallel with minimum 1 inch flex between ductwork and fan while running. Refer to Section 15820.
- D. Install Pitot tube openings at locations required for testing of systems, complete with metal cap with spring device or screw to prevent against air leakage. Refer to Section 15820.
- E. Location ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. Do not operate fans until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

THIS PAGE NOT USED

SECTION 15865

FILTERS

PART I -GENERAL

1.01 DESCRIPTION

- A. This section specifies providing air filters.
- B. Related Work Specified Elsewhere:
 - 1. Remote-surveillance devices: Section 15900.
 - 2. Ventilating Units: Section 15725.
 - 3. Rooftop Air Conditioners: Section 15732.
 - 4. Air Conditioning Units -
Chilled Water Cooled: Section 15733.
 - 5. Air Conditioning Units -
Air Cooled Split-System: Section 15737.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. UL 900 Class 1.
 - 2. ASHRAE: 52.1.
- B. Source Quality Control:
 - 1. Factory-tested or tested by an independent laboratory experienced in testing filters; certify compliance with requirements of ASHRAE Standard 52 for arrestance, efficiency, dust-holding capacity and pressure drop.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities and accessories..
 - 2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances and components.
 - 3. Certification.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design of equipment, provide for interchangeability of items of equipment, subassemblies, and parts.
- B. Throwaway (Replaceable) Filters:
 - 1. 1" Flat-panel filter units designed and fabricated for disposal when dust-load limit is reached.
 - 2. Dry or adhesive-coated filter media, as standard with the manufacturer.

3. Maximum air flow through filters: Not exceeding manufacturer's published rated capacity but not exceeding 500 feet per minute at 0.10-inch w.g.
4. Designed to fit within space available and constructed so as to prevent passage of unfiltered air.
5. Filter frames constructed of 18-gauge galvanized steel with air-tight access panels for filter inspection, cleaning and replacement.
6. Filters are UL 900 Class I listed.

C. Replaceable Prefilters

1. 2" Pleated Type
2. 30% Efficiency per ASHRAE Standard 52.
3. Maximum air flow through filters: Not exceeding manufacturer's published rated capacity but not exceeding 500 feet per minute at 0.10-inch w.g.
4. Designed to fit within space available and constructed so as to prevent passage of unfiltered air.
5. Filter frames constructed of 18-gauge galvanized steel with air-tight access panels for filter inspection, cleaning and replacement.
6. Filters are UL 900 Class I listed.

D. Bag Filters:

1. Horizontal air-flow filters of the high-density glass microfibers-type.
2. Capacity based on air-handling capacity of unit to which it is applied with velocity limited to maximum of 500 feet per minute through filter based on net filter area.
3. Provide high-density glass-microfiber filter media, reinforced with a backing to form a lofted filter blanket. Provide filter media with an average efficiency of 80 to 85 percent when tested by ASHRAE 52.1, and with an average arrestance of not less than 98 percent on that standard. Provide UL 900 Class 1 listed filters.
 - a. Remote-surveillance devices: In accordance with Section 15900.
4. Pocket construction: Pockets to consist of glass microfibers chemically bonded to a reinforced UL Class 1 backing. Sew pockets with a tapered stitch which forms a V or wedge-shaped pocket resulting in uniform velocity in the passages of the air-entering and air-exiting sides of the filter. Equip the pockets with a minimum of 40 support points per square foot of filter media:
 - a. Completely seal all stitching points with foam-seal or equivalent. Chemically adhere the pockets around the periphery of the galvanized-steel retainers. Provide retainers with rolled edges to reduce possible cuts to media, or lacerations to installers.
5. Enclosing frame: Construct enclosing frame of a J return channel of 16-gauge galvanized steel. The channel may be 7/8 inch or 1-1/8 inch.
6. Glide/Packs - for side-access applications: Factory fabricate and assemble filter housings. Construct the units of not less than 16-gauge galvanized steel, incorporating two access doors, extruded-aluminum tracks and individual universal holding frames designed to accommodate a wide range of standard size filters in varying efficiency ranges.
7. Leakage at rated airflow, upstream to downstream of filter, holding frame and slide mechanism to be less than one percent at 3-inch w.g. differential.
8. Leakage into housing from ambient atmosphere at rated airflow to be less than 0.5 percent at 3-inch w.g. negative. Manufacturer to submit substantiating test reports.
9. Construct access doors of 16-gauge galvanized steel and position them to facilitate removal and replacement of filters from either side of the housing. Equip each door with adjustable and replaceable post.
10. Provide factory installed 16-gauge galvanized steel transition plates on air-inlet and/or air-exit side to match air-handling unit.

- E. Controls:
 - 1. Control panels factory wired.
 - a. Adjustable pressure-differential sensing device and wiring for remote surveillance.
 - b. Pressure range of 0.02-inch w.g. to 1.0-inch w.g. Accuracy of plus-or-minus 0.03-inch w.g.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances within the space provided and make readily serviceable.
- B. Install bag filters with capacities as shown.
- C. Examine each bag filter's media before installation for seepage and adhesive to surface of container.
- D. Replace bag filters showing evidence of seepage.
- E. After final testing and cleaning of fans and ductwork, replace prefilters and final filter media with new, clean media.

END OF SECTION

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SECTION 15900

CONTROL EQUIPMENT

PART 1-GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing automatic temperature controls, remote surveillance and control and local control systems.

1.02 QUALITY ASSURANCE:

- A. Qualifications of Manufacturer:
 - 1. Select manufacturer who maintains full-time organization for installation and service in the Washington, D.C. metropolitan area.
 - 2. Have instruments, piping and wiring installed by representative of temperature control-equipment manufacturer.
- B. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NEMA: 250, ICS 2-1993
 - 3. UL: Electrical Construction Materials Directory.
- C. Design Criteria:
 - 1. Automatic temperature-control systems:
 - a. Design systems to perform functions and operate in sequence as shown or specified for heating, air conditioning, and ventilation.
 - b. Maintain conditions shown or specified.
 - c. Operate and control motor-operated dampers.
 - d. Design control system to interface with fire and smoke-detection system by others to shut off the following fans on activation of fire and smoke-detection system.
 - (1) Battery-room fans
 - (2) Air-conditioning and fans in excess of 2,000 cfm, except the following:
 - (a) Dome-exhaust fans.
 - 2. Remote surveillance and control systems:
 - a. Continuously measure parameters as shown including pressure, temperature and flow. Convert analog values of sensing transducer into seven-bit binary code and transfer to designated interface DTS terminals by relays.
 - b. Monitor abnormal operations, such as high and low limits on pressure, temperature, water level, water flow, damper position, mode-selector switch position and air flow as shown; provide contact closure to designated DTS terminals.
 - c. Design system to compensate for electrical losses in wiring. Design dc-power supplies and signal amplifiers, as necessary
- D. Source Quality Control:
 - 1. Test and stamp air storage tank in accordance with ASME Boiler and Pressure Vessel Code, Section VII, Div. I.
 - 2. Identify each transducer according to type, sensitivity, accuracy and operating range.
 - 3. Each remote-indication system installed to have accuracy shown.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Shop Drawings:
 - a. Complete catalog information and shop drawings for material and equipment including wiring and control diagrams.
 - b. Submittals include, but are not limited, to the following:
 - 1) Air compressors, with motors and controls.
 - 2) Compressed-air storage tanks.
 - 3) Dessicant air drier system including prefilters, after each if provided, after filter.
 - 4) Thermostats.
 - 5) Controllers.
 - 6) Damper operators, electric or pneumatic as applicable.
 - 7) Automatic valves and operators.
 - 8) Dampers.
 - 9) Control panels and cabinets.
 - 10) Gauges and indicators.
 - 11) Transducers.
 - 12) Data-transmission system-interface relays.
 - 13) Sensing devices.
 - 14) Wiring diagrams, control diagrams and layouts for each system.
 - 15) Control, indication and time-delay relays.
 - 16) Damper limit switches.
 - c. Complete set of floor plans of rooms showing by means of graphic coding actual location and mounting heights of thermostats and zone served by each thermostat.
 2. Operation and Maintenance Manuals:
 - a. Complete electrical schematic of each system showing and identifying each internal and external component and internal and external wiring.
 - b. Detailed piping and wiring diagrams showing graphic coding.
 - c. Terminal numbers for wire or pipe connections.
 - d. Complete parts list of internal and external components.

1.04 OPERATION AND MAINTENANCE TRAINING:

- A. Upon completion of installation, furnish services of competent field engineer with specialized experience in temperature control and remote surveillance and control system to train Authority personnel in accordance with the General Requirements and as follows:
1. Instructional period: Three consecutive man-days minimum. A minimum of one day to be devoted to hands-on demonstration of the equipment operation, trouble analysis, repair, adjustment and maintenance.
 2. Train operators in preventive maintenance of systems and to recognize malfunctions.
 3. Provide complete printed operating instructions in manual or handbook form, completely and clearly indexed for ready reference during actual operation and for use as text during instruction of operating personnel.
 - a. Include descriptions of systems, background information and complete procedures for adjustment, calibration, replacement and repair of components in system.

PART 2- PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
 - 1. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies, parts, motors, starters, relays and transducers.

- B. Automatic Temperature-Control System:
 - 1. Automatic valves:
 - a. Bodies, discs, stems and stuffing boxes designed for minimum working pressure of 125 psi.
 - b. Provide valves of type specified for each of the following body sizes:
 - (1) 1-1/2 inches or smaller: Brass or bronze with screwed or union ends.
 - (2) Four inches and larger: Iron bodies with brass or bronze trimmings and flanged ends.
 - (3) Two inches to three inches: Brass or bronze with screwed or union ends or iron bodies with brass or bronze trimmings and flanged ends.
 - c. Visible position indicators and renewable discs.
 - 2. Automatic dampers, except dome relief dampers:
 - a. Provided by automatic temperature-control manufacturer.
 - b. Factory-fabricated, opposed blade, balanced-type with factory-assembled linkages, mounted in galvanized-steel frames.
 - c. Blades: Flat or formed galvanized steel with interlocking edges or with compressible seals at point of contact.
 - (1) Air-temperature range of seals: Suitable for operation from minus 20F to plus 200F.
 - (2) Supported by thrust bearings for vertically mounted blades.
 - (3) Length of blades between bearings: 48 inches maximum.
 - (4) Width of blades: Eight inches maximum.
 - d. Leakage when closed: Maximum 20 cfm per square foot at static pressure of four inches water gauge.
 - e. Frames: Bar or channel, with corner bracing for rectangular dampers larger than four square feet in area.
 - f. Damper-operating linkage:
 - (1) Adjustable-length galvanized-steel rods capable of withstanding load of at least twice maximum operating force of damper operator without deflection.
 - (2) Joints: Brass pins and clevises or brass ball-and-socket joints.
 - g. Steel parts: Hot-dip galvanized after fabrication.
 - 3. Automatic dampers for dome-exhaust fan:
 - a. Automatic dampers factory-fabricated, constructed of galvanized sheet metal or extruded aluminum. Frames constructed of minimum 13-gauge galvanized sheet steel or extruded aluminum.
 - b. Dampers designed for control by electric motor operators. Mounting provisions for motor operators included in damper assembly.
 - c. Damper blades designed for air velocities to be encountered in system.
 - d. Blades: Maximum width eight inches and 24 inches maximum between bearings, fabricated of galvanized sheet steel, 16-gauge or double 22-gauge minimum.
 - e. Seals designed to withstand air temperatures ranging from minus 20F to plus 200F.

- f. Damper-operating linkage:
 - 1) Adjustable-length galvanized-steel rods capable of withstanding without deflection load of at least twice maximum operating force of damper operator.
 - 2) Joints: Brass pins and clevises or brass ball-and-socket joints.
 - 3) Damper operators attached to operating linkage so as to ensure positive operation without lost motion.
 - g. Motor mounting supported so that operator will not deflect from its normal path when operating under load.
 - h. Steel parts: Hot-dip galvanized after fabrication. Galvanizing: 1.25 ounces, in accordance with ASTM A153.
 - i. Conforming to NFPA 130 high temperature requirements.
4. Space thermostats:
- a. Supplied with subbase for mounting and guards.
 - b. Adjustment devices on controllers locked or concealed.
 - c. Operating points: Minimum range 10 degrees above and 10-percent below operating points shown.
 - d. Provide external thermometer with knob or lever-adjusting devices where shown.
 - e. Thermostat throttling range: 2F maximum.
 - f. Controllers, submaster controllers, lagged sensing elements and space thermostats provided with means for field adjustment of throttling range.
5. Duct thermostats:
- a. Remote sensing-element type, with controller mounted on apparatus control panel.
 - b. Enclosure for operating and adjusting mechanism: Metal or phenolic-resin case.
 - c. Thermostats used for freeze protection: Sensing element 20 feet minimum in length.
 - (1) Thermostat capable of operating when freezing condition exists at one-foot increments anywhere along sensing element.
 - d. Remote transmitter provided when distance from bulb to panel exceeds manufacturer's recommended capillary length.
6. Pipe thermostats:
- a. Immersion-type with liquid-filled separable sockets.
 - b. Remote sensing-element type, used where socket is located minimum five feet above floor.
 - c. Remote transmitter provided when distance from bulb to panel exceeds manufacturer's recommended capillary length.
 - d. Separable sockets: Stainless steel, heavy enough to withstand pulsations and turbulences in fluid controlled.
 - e. Pipe-sensing thermostat for electric heat tracing:
 - 1) Remote bulb suitable for attachment to outside of pipe as shown.
 - 2) Thermostat with DPST contacts, range of zero degree F to 100F and control differential of not more than 8F.
 - 3) Thermostat in NEMA 250, Type 4 enclosure, except NEMA 250, Type 12 enclosure for train tunnels, vent shafts or track-drainage pumping station.
 - 4) Contactor, as necessary, when total amperes of heating tape exceeds rated capacity of thermostat.
7. Pressure gauges:
- a. For individual-mounted controllers: Stem-mounted, two inches diameter minimum.
 - b. For panel-mounted controllers, individual gauges: Two inches minimum

- diameter.
 - c. For panel-mounted controllers, multiple-indication gauges: 3-1/2 inches minimum diameter.
 - 8. Apparatus control panels:
 - a. Separate apparatus control panel or metal cabinet for each air-handling and air-conditioning unit.
 - b. Control instruments located on panel, except fire and freeze-protection instruments.
 - c. Panel constructed of fire-resistant material with nonglare surfaces.
 - 9. Electric damper operators:
 - a. Spring-return type.
 - b. Two-position motor operation.
 - c. Spring returns damper to fail-safe position as shown in event of power failure or termination.
 - d. Opening time: 60 seconds maximum.
 - e. Adjustable stops to control open and closed positions.
 - 10. Time clock:
 - a. Suitable for automatic weekly switching operations of electrical equipment.
 - b. Seven-day cycle with ten-hour spring reserve to maintain programmed switching in event of power failure.
 - c. Capable of being programmed as desired.
 - d. Manual trip mechanism for overriding timer.
 - e. Mechanism powered by single-phase synchronous motor from available internal control power of 120 volts, 60 Hertz.
 - f. Motor capable of operating at temperatures ranging from zero degrees F to 120F.
 - g. Contacts of cadmium alloy, rated for 40-ampere, noninductive service at 120, 208/240, or 277 volts.
 - h. Enclosure: NEMA 250, Type 1, surface-mounted.
 - 11. Selector switch:
 - a. Positions labeled HAND/OFF/AUTOMATIC.
 - b. Maintained contact.
 - c. Oil-tight.
 - d. Contact-rating designation: NEMA ICS 2-1993, with the following additional requirements:
 - (1) Continuous current rating: 10 amperes.
 - (2) Voltage rating: 120 volts, 60 Hertz
 - 12. Damper limit switch:
 - a. Contacts: Single-pole; one NO, one NC; snap-action
 - b. Enclosure: NEMA 250, Type 1.
 - c. Actuator: Level-operated, rotary-type, adjustable, with spring return.
 - d. Mounting: Plug-in type with receptacle tapped for conduit size as shown.
 - e. Contact-rating designation: NEMA A600, with the following additional requirements:
 - (1) Continuous-current rating: 10 amperes.
 - (2) Voltage rating: 120 volts, 60 Hertz.
 - 13. Automatic alternator:
 - a. Equipped with ratchet mechanism to alternate opening and closing of two contacts after each ventilating-unit cycle.
 - b. Electrical requirements:
 - (1) Continuous-current rating: 10 amperes.
 - (2) Voltage rating: 120 volts, 60 Hertz.
 - (3) Enclosure: NEMA 250, Type 1.

- C. Remote Surveillance and Control:
1. DTS Relays:
 - a. Energized from command-center control via DTS.
 - b. Momentary-pulse type requiring no sustained power consumption.
 - c. Maximum coil load: 15 volt-amperes, resistive or suppressed inductive.
 - d. Coil voltage: 28 volts dc.
 - e. Contacts: Compatible with equipment controlled.
 2. General relays:
 - a. Control and indication relays:
 - (1) Functional designations and schematic connections as shown.
 - (2) Number and configuration of contacts as shown.
 - (3) Contact ratings:
 - (a) Maximum switched voltage: 600 volts ac
 - (b) Maximum continuous current: 10 amperes.
 - (c) Capable of making load of 720 volt-amperes ac.
 - (d) Capable of breaking load of 720 volt-amperes ac.
 - (e) Minimum open-contact resistance: 50 megohms, 400 volts dc.
 - (f) Maximum duration of bounce: 50 milliseconds.
 - (4) Modular convertible contacts enclosed in plastic.
 - b. Time-delay relays:
 - (1) Functional designations and schematic connections as shown.
 - (2) Number and configuration of contacts as shown.
 - (3) Capable of operating from minus 20F to plus 165F.
 - (4) Externally adjustable time delay.
 - (5) Contact rating:
 - (a) Current capacity of 20 amperes resistive at 120 volts ac for 100,000 operations.
 - (b) Insulation resistance: 50 megohms at 500 volts dc.
 - (c) Auxiliary contacts for instantaneous transfer or two-step timing as scheduled.
 3. Transducers:
 - a. Rise time: One-second maximum.
 - b. Sensitivity: Constant over operating range shown,
 - c. Adjustment for high and low operating ranges: Manual, calibrated and clearly identified.
 - d. Output: Accommodate three wires, marked with PLUS, MINUS and GROUND SHIELD symbols.
 - e. Transducers requiring external electric power to operate at 120 volts, single-phase, 60 Hertz.
 - f. Transducers requiring external air supply to operate from 20-psi source.
 - g. Housings: Moisture proof and disproof enclosure suitable for environment in which each transducer is located. Transducer nameplate attached to housing
 4. Drainage pumping surveillance:
 - a. Indicating malfunction upon loss of electric power from both sources.
 - b. Indicating malfunction when both pumps are running.
 - c. Indicating malfunction when water level is above or below preset range.
 5. Fan control cabinets:
 - a. Mode-selector switch mounted in front cover:
 - 1) Maintained contact.
 - 2) Oil-tight.
 - 3) Contacts conforming to NEMA ICS 2-1993 rated for 10 amperes continuous current at 120 volts, 60 Hertz.
 - b. Positions of mode-selector switch: Labeled on nameplate as follows:

REMOTE/OFF/LOCAL EXHAUST/LOCAL SUPPLY.

- c. Complete electrical schematic diagram of control cabinet affixed permanently to inner surface of front cover and protected by clear Lucite.
 - (1) Include on schematic diagram parts list for all components of panel and contents, showing complete manufacturer's name., nomenclature and parts number.
 - d. Pilot lights mounted in front cover.
 - (1) Polycarbonate lens.
 - (2) Push to test.
 - (3) Legend plate with mode indicated.
 - (4) 20,000-hour 6.3-volt lamp.
 - e. Control panel surface, lighted by fixture permanently mounted on panel.
 - (1) Fixture to include fireproof lampshade extending width of panel.
 - (2) Average lighting level: 40 foot-candles over entire surface of panel.
 - f. Panel constructed of fire-resistant material with non-glare surface
6. Flow sensor:
- a. Diaphragm differential sensor.
 - b. Single-pole, double-throw, snap-acting switch, 10-ampere rating.
 - c. NC contacts.
 - d. Adjustable set point.
 - e. Operating range of zero degree F to 180F.
7. Electric heat tracing: Section 15725.
- D. AC Switchboard Room Ventilating-Fan Controls:
- 1. Thermostat, flow switches, time-delay relay, selector switch, automatic alternator and limit switches.
 - 2. During each operating cycle, one fan to serve as primary fan and second fan as stand by.
 - 3. Control sequence:
 - a. Dampers on intake and discharge side to remain open when fans are not in operation.
 - b. When room temperature rises to 90F, relief damper(s) open, standby-fan intake damper closes and primary fan starts.
 - c. Control sequence to reverse when room temperature falls.
 - d. After each operating cycle, automatic alternator to reverse functions of automatic and standby fans.
 - 4. Abnormal operation: If primary fan fails to operate, primary-fan intake damper closes, standby-fan intake damper opens and standby fan starts. Relief dampers to remain open during standby-fan operation.
- E. DC Breaker Room Ventilating-Fan Controls:
- 1. Single-stage space thermostat.
 - 2. HAND/OFF/AUTOMATIC switch.
 - 3. Operation:
 - a. Hand: Fan running, dampers open.
 - b. Off: Fan off, dampers closed.
 - c. Automatic:
 - (1) When room temperature rises to 90F, open dampers and start fan.
 - (2) Reverse control process on falling temperature.
- F. Battery Room Fan Controls:
- 1. Battery room exhaust fan to operate continuously.
 - 2. Magnetic starter.

- G. Fire Alarm for Shutdown Interface Box: Data transmission system (DTS) cabinet specified in Section 16130, with the following additional requirements:
 - 1. Cabinet: Hoffman A161206LP.
 - 2. Terminal strip: Terminal as required mounted in upper right-hand quadrant of cabinet.
 - 3. Exterior finish color: Sherwin-Williams Fire Protection Red.
 - a. Yellow letters, one-inch high on cover: FA-FAN SHUTDOWN.

PART 3-EXECUTION

3.01 INSTALLATION:

- A. Fit equipment and appurtenances within space provided and make readily serviceable. All gauges and indicators to be installed so they can be readily read without use of ladder or other means to reach installed items.
- B. Foundations, platforms, or hangers for apparatus in accordance with Sections 03200 and 03300.
- C. Install 18AWG minimum control wiring, as shown and in accordance with Sections 16120 and 16125.
 - 1. Identify each wire at interface cabinet locations.
 - 2. When communication fan-shutdown interface cabinets are installed by others, complete wiring to designated terminals.
- D. Automatic Temperature Control Systems:
 - 1. Install entire automatic temperature-control system, including piping and wiring under supervision of automatic temperature-control equipment manufacturer.
 - 2. Mount damper operators outside of duct or casing with support plates that are completely outside insulation or covering.
 - a. install support plates so as to prevent condensation on damper operator or on supports.
 - 3. Support valves and damper-operator motor mountings so that operator does not deflect from its normal path when operating under load.
 - 4. Locate sensing elements of duct thermostats where they will respond to representative temperature within duct or casing.
 - 5. Duct thermostats and remote transmitters:
 - a. Install outside of ducts and casings.
 - b. Where ducts or casing are insulated, mount thermostats flush with outside insulation, so that moisture will not condense on thermostats or on supports.
 - 6. Duct thermal capillary tubes and wires:
 - a. Install to pierce thermal insulation at least practicable number of points.
 - b. Seal insulation properly where capillaries and wiring pass through.
 - 7. Capillary tubes:
 - a. Protect by conduit, molding or flexible armor.
 - b. Coil capillary tube neatly and fasten excess lengths out of the way.
 - 8. Apparatus control panel:
 - a. Mount bottom of each panel 30 inches above floor.
 - b. Provide 30 inches clearance between rear of panel and wall where conduit or wiring enters panel from rear.
 - c. Mount controls, instrument gauges, thermostats and relays flush on front of panel.
 - d. Install wiring and tubing connections for accessibility in servicing.
 - 9. Apparatus control cabinets:
 - a. Make wiring and tubing connections to control instruments, indicating

- instruments and communication equipment inside cabinet.
 - b. Install pilot lights, manual switches, and pushbutton controllers in cabinet door, so they are visible and operable with door closed.
 - 10. Mount framed schematic temperature-control diagram adjacent to each apparatus control panel or cabinet.
 - 11. Mount time clock on control panel in accordance with manufacturer's recommendations.
 - 12. Mount selector switch in motor-starter enclosure of ventilating units in ac-switchboard rooms.
 - 13. Mount pushbutton station in motor-starter enclosure of exhaust fan in battery rooms.
 - 14. Limit switch:
 - a. Mount on automatic damper blades in AC-Switchboard rooms.
 - b. Set switch contacts to close when damper opens.
 - 15. Install automatic alternator in ac-switchboard rooms which have two ventilating units.
 - 16. Pipe-sensing thermostat for electric tracing:
 - a. Firmly attach remote bulb against pipe at location in which bulb does not touch heating tape.
 - b. Mount thermostat securely on wall at conveniently accessible location.
 - 17. Install electric-control system for the following:
 - a. Heating, ventilating, and air-conditioning systems.
 - b. Pumping Systems.
 - 18. Install flow sensor in designated fans as shown and adjust to open or close contacts as shown at full flow in respective directions.
- E. Remote Surveillance and Control:
 - 1. Coordinate design with the Engineer and provide necessary interface for complete compatibility with DTS system.
 - 2. Coordinate with the Engineer installation of fire-alarm sensors in air units.
 - 3. Provide shielding for sensing and signaling systems to prevent electrical interference.
 - 4. Install flow sensor in designated fan as shown and adjust to close contacts at full flow in respective directions.
- F. Fire-Detection Controls:
 - 1. Coordinate enclosure interface terminal block with the Engineer.
- G. Post diagrams under Lucite with aluminum-channel frames, waterproof glass-fiber backing adjacent to apparatus control panels.

3.02 FIELD QUALITY CONTROL:

- A. Acceptance Testing:
 - 1. Furnish equipment required to perform tests.
 - 2. Submit test procedure for approval.
 - 3. Perform approved tests to verify that control surveillance systems comply with requirements shown and specified.

END OF SECTION

THIS PAGE NOT USED

SECTION 15950

SYSTEM BALANCING AND TESTING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies balancing, adjusting and performance-testing of air-conditioning systems with ductwork and hydronic piping.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. NEBB: Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
 - 2. ASHRAE III: Practices for Measurement, Testing, Adjusting and Balancing of Building HVACR Systems.
- B. Instrument Calibration:
 - 1. Calibrate instruments required for air balance within six months prior to use on this project.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
 - 1. Shop Drawings:
 - a. Test and instrument location plans.
 - b. After initial balancing measurements, submit shop drawings for additional equipment such as balancing dampers, pressure taps and balancing cocks necessary to effect proper air and water balance.
 - 2. Certification:
 - a. Complete air balance report certified by professional engineer licensed in the jurisdiction where the work is to be performed.
 - b. Collect data in accordance with referenced standards.
 - c. Submit complete data on standard NEBB testing and balancing report forms without omissions or on approved report forms bearing identical data. Data to include types, serial numbers and calibration dates of instruments and to cover the following:
 - 1) Air-conditioning units: Sections 15733, 15735, and 15737.
 - 2) Rooftop conditioners: Section: 15732.
 - 3) Ductwork including transverse and pilot tube test: Section 15810.
 - 4) Heating Equipment: Section 15765.
 - 5) Outlets and Grilles: Section 15850
 - 6) Air terminal units: Section 15840.
 - 7) Ventilating units: Section 15725.
 - 8) Fans: Section 15830.

- d. Water-balance test reports to include data covering the following:
 - 1) Water coils: Section 15734.
 - 2) Chillers: Section 15625, 15626, and 15628.
 - 3) Cooling towers: Section 15640.
 - 4) Pumps: Sections 15135 and 15185.
 - 5) Control Valves: Section 15900.
 - 6) Heating equipment: Section 15765.
 - 7) Ventilating Units: Section 15725.
 - 8) Water tube boilers: Section 15515.
 - 9) Air terminal units: Section 15840.

PART 2 - PRODUCTS

- 2.01 Provide, as specified in Sections 15820 and 15205, additional equipment, such as balancing dampers, pressure taps and balancing cocks necessary to effect proper air and water balance.

PART 3 - EXECUTION

3.01 BALANCING AND PERFORMANCE TESTING:

- A. After completion of installation of air-conditioning systems, and prior to acceptance by the Engineer, adjust and balance air-handling systems and appurtenances applicable to those systems to deliver the air quantities as specified and as shown. Make final tests after modifications are completed. Seal instrument test holes upon completion of balancing operation.
- B. Air and Water Balance:
 - 1. Perform testing in accordance with referenced NEBB Standard, ASHRAE 111 or other approved standard.
 - 2. Perform tests, adjust and balance when outside conditions approximate design conditions as shown for heating and cooling functions.

END OF SECTION

SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Common electrical installation requirements.

1.02 RELATED SECTIONS

- A. Pertinent provisions of the following, also apply to the work of this Section, except as they may be modified herein, and are hereby made part of this Specification to the extent required:
 - 1. Section 16120 - Wire, Cable and Busway.
 - 2. Section 16119 - Medium Voltage Cable.

1.03 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.05 QUALITY ASSURANCE

- A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.06 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."
- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers

offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Firestopping."

2.03 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM, or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.02 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Firestopping."
- C. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- E. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- F. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
 - G. Cut sleeves to length for mounting flush with both surfaces of walls.
 - H. Extend sleeves installed in floors 2 inches above finished floor level.
 - I. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require a different clearance.
 - J. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
 - K. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Seals and Sealants" for materials and installation.
 - L. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with Division 7 Section "Firestopping."
 - M. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
 - N. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - O. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.03 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.04 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

3.05 FIELD QUALITY CONTROL

- A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

END OF SECTION

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SECTION 16055
POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 DESCRIPTION

- A. Work Included: The work of this Section consists of furnishing of short circuit studies, protective device evaluation studies, protective device coordination studies, and relay settings for both temporary and permanent systems.
- B. The studies shall include, but not be limited to, portions of the electrical distribution system from the incoming Pepco power source or sources to and including the 480 distribution system down to the 120-Vac level for the electrical distribution system shown on the One Line Diagrams for this project. Normal system connections and those that result in maximum fault conditions shall be included in the study. Provide study to each system with Pepco incoming power source.
- C. A professional electrical engineer registered in the State of Maryland and the District of Columbia shall perform the studies.
- D. Contractor shall submit the studies before receiving final approval from the CM for shop drawings for the power distribution system equipment.
 - 1. If formal completion of the studies causes delay in equipment manufacture, approval may be obtained for a preliminary submittal of sufficient study data to verify that the information indicating device ratings and characteristics will be satisfactory.
- E. Short circuit study and protective device evaluation study, protective device coordination study, load flow study and voltage drop to the farthest point on the system shall be performed.

1.02 RELATED SECTIONS

- A. Section 16130 – Raceways and Boxes.

1.03 SUBMITTALS

- A. In accordance with the requirements of Project management.

1.04 DATA COLLECTION FOR THE STUDIES

- A. Contractor shall provide the required data for preparation of the studies. The primary switchgear/power transformer manufacturer shall furnish Contractor with a listing of the required data immediately after award of the Contract.
- B. Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or before release of the equipment for manufacture.
- C. Characteristic data shall be derived from actual, applicable components obtained from the approved shop drawings.
- D. Contractor shall coordinate with the CM in obtaining short-circuit data from Pepco.

1.05 SHORT CIRCUIT STUDY AND PROTECTIVE DEVICE EVALUATION STUDY

- A. The short circuit study shall be performed with the aid of a digital computer program and shall be in accordance with applicable IEEE and ANSI standards.
- B. The study input data shall include the power company's short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected and other source impedances.
- C. Short circuit close and latch duty values and interrupting duty values shall be calculated on the basis of assumed 3-phase and single phase bolted short circuits at each switchgear bus, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include symmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.
- D. A protective device evaluation study shall be performed to determine the adequacy of circuit breakers, molded case switches, automatic transfer switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied. Problem areas or inadequacies in the equipment due to short circuit currents shall be corrected, at no additional cost to the Agency.

1.06 PROTECTIVE DEVICE COORDINATION STUDY

- A. A protective device coordination study shall be performed to provide the calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. The studies shall be in accordance with applicable IEEE and ANSI standards, and satisfy the requirements of the National Electrical Code (NEC) and local electrical codes.
- B. The coordination study shall include, but not be limited to, medium and low voltage classes of equipment from the utility service connection protective devices to and including the largest rated device in the low voltage motor control centers, panelboards, down to typical 120 VAC branch circuits. The motor management relay, phase and ground overcurrent protection shall be included, as well as settings of adjustable protective devices.
- C. The time-current characteristics of the specified protective devices shall be drawn on log-log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall be conformed to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis. A sufficient number of separate curves shall be used to indicate the coordination achieved.
- D. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment and recommended settings. A tabulation of the recommended power fuse selection shall be provided for the medium voltage fuses where applied in the system.
- E. Discrepancies, problem areas, inconsistencies or inadequacies shall be corrected, at no additional cost to the Authority.

1.07 STUDY REPORT

- A. A preliminary report shall be submitted to the CM for review and approval.

- B. The results of the power system studies shall be summarized in a final report.
- C. The report shall be prepared and stamped by a professional electrical engineer registered in the State of Maryland and the District of Columbia.
- D. Six bound copies of the final report shall be submitted.
- E. The report shall include the following sections:
 - 1. Description, purpose, base, and scope of the study, and an overall single line diagram of the power system that is included within the scope of the study.
 - 2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding the same.
 - 3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding the same.
 - 4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
 - 5. Load flow study.
 - 6. Voltage drop to the furthest point shown on the Drawings.
- F. One copy of the final report shall be submitted to the Power Company for their review.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

THIS PAGE NOT USED

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing complete grounding and bonding system.
- B. Related Work Specified Elsewhere:
 - 1. Fencing: Division 2.
 - 2. Concrete reinforcement: Division 3.
 - 3. Piping systems: Section 15205.
 - 4. Wire, cable and busways: Section 16120.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. National Electrical Code (NEC)
 - 3. ANSI/IEEE 80-2000, IEEE Guide for Safety in AC Substation Grounding.
 - 4. UL 467, Grounding and Bonding Equipment..
 - 5. American Standards of Testing and Materials (ASTM) B187-00, Standard Specification for Copper Bar, Bus Bar, Rod and Shapes.
 - 6. ITS: Directory of ITS Listed Products.
- B. Source Quality Control:
 - 1. Each item, except for exothermic-welded electrical connections, listed per referenced UL or ITS directory.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings.
- B. Certification.
 - 1. Certified test reports verifying that ground resistance of each ground grid when installed and each ground bus when connected to ground grid does not exceed specified values.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Mark each item in accordance with applicable reference standard.
- B. Ship each unit securely packaged and labeled for safe handling and to avoid damage.
- C. Store equipment in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Grounding and Bonding Equipment:
 - 1. General Requirements:
 - a. UL 467.
 - 2. Ground rods: Solid steel, with stainless steel or copper jacket, one-inch or 5/8-inch diameter as shown, by 10 feet long or of necessary length in 10-foot sections.
 - 3. Grounding conductor:
 - a. Grounding electrode conductors:
 - (1) Insulated or bare conductor, as shown, in accordance with the following:
 - (a) Insulated conductor: As specified in Section 16120 for single-conductor cable.
 - (b) Bare conductor: Section 16120.
 - (2) Size:
 - (a) For use in ground grid and for connecting of ground grid to ground bus: 4/0 AWG.
 - (b) For connection of ground bus in train-control, communications, electrical, dispatcher, Bell system and mechanical rooms to main ground bus in ac-switchboard rooms: 2/0 AWG.
 - (c) For other grounding electrode conductors: In accordance with the NEC.
 - b. Equipment grounding conductor:
 - (1) Sized in accordance with the NEC unless otherwise shown.
 - (2) Insulated equipment grounding conductor: Single-conductor cable as specified in Section 16120.
 - (3) Bare equipment grounding conductor integral with multiple-conductor cable: Section 16120.
 - c. Bonding conductor for stray current and cathodic protection and electrical continuity:
 - (1) Insulated or bare conductors, as shown, in accordance with the following:
 - (a) Insulated conductors: As specified in Section 16120 for single-conductor cable.
 - (b) Bare conductor: Section 16120.
 - (2) Size: As shown or as specified.
 - 4. Bus bar: ASTM B187-00, 98-percent-conductivity copper bus bar, size two inches wide by 1/4-inch thick, length as necessary.
 - 5. Terminal lugs:
 - a. For 4/0 AWG and smaller conductors: Copper compression terminal lugs.
 - b. For 250 MCM and larger: Long-barrel, copper, double-compression terminal lugs.
 - 6. Ground connector:
 - a. O-Z, Type KG or equal.
 - b. Two-piece, designed for connecting grounding conductor to bus bar.
 - c. Copper-alloy body and silicon-bronze bolt, nut and lock washer with interlocking clamp.

7. Jumpers: Copper braided or leaf-type flexible jumper, size as necessary.
8. Bus-bar insulators: Fiberglass reinforced-polyester insulator with ½-inch diameter threaded holes at both ends for bus-bar installation.
9. Exothermic welded electrical connections:
 - a. Exothermic process using powdered metals contained in a mold to form a molecular bond between materials to be connected without application of an external source of heat or power in accordance with ANSI/IEEE 80-2000.
 - b. Molds, weld metal and associated accessories designed for making electrical connections between copper and copper, copper and steel, copper and cast iron and copper and ductile iron as required.
 - c. Welding system designed for making connections suitable for the application as follows:
 - (1) Connections made outdoors for grounding using the standard process and not containing phosphorous or any caustic, toxic or explosive materials.
 - (2) Connections made indoors or in confined spaces for grounding using a low-smoke, low-emission process.
 - (3) Connections made specifically for cathodic protection applications using the standard process.
 - d. Molds made of graphite with permanent marking indicating name of manufacturer, model, conductor size, and type and size of welding mixture compatible with the welding process. Mold connection type suitable for making connections between various configurations of items as shown or specified.
 - e. Weld metal consisting of copper oxide and aluminum contained in a moisture-resistant container along with other necessary materials required for the specific application as determined by the manufacturer. Container for applications other than low-smoke, low-emission process to also include suitable starting material.
 - f. Container for weld metal identified with part number, type of metals to be connected and application such as standard outdoor, low emission or cathodic application.

PART 3 - EXECUTION

3.01 GROUNDING:

- A. Ground Connections:
 1. Weld buried ground connections exothermically, in accordance with manufacturer's recommendations. Clean and coat with coal-tar epoxy before backfilling. Encapsulate with epoxy resin buried ground connection of grounding electrode conductors running to ground bus.
 2. Use terminal lug to connect grounding conductor to equipment enclosure. Use ground connector to connect grounding conductor to ground bus. Secure connector or terminal lug to the conductor so as to engage all strands equally. Install terminal lug using tools and pressure recommended by the manufacturer. Indent mark terminal lug with the number of die used for installation.
 3. Exothermically weld connections to ground rods in handholes, junction boxes, manholes, and light poles.
 4. Splices in grounding conductor are prohibited.

5. For making ground connections located indoors and in confined spaces located outdoors such as manholes, use exothermic welds with low-smoke, low-emission process.
- B. Ground Grid:
1. Install ground grid consisting of ground-grid conductors and ground rods buried in earth in pattern and at locations shown.
 2. Use ground rod one-inch in diameter by 10 feet long or of greater length in 10-foot sections as shown.
 3. Bury top of ground rod 24 inches minimum below unfinished surfaces.
 4. Ensure 24-inch minimum separation between ground rods or bare grounding conductors and concrete structures or soldier piles bonded for stray current and cathodic protection.
 5. Interconnect ground rods using 4/0 AWG insulated or bare grounding conductor as shown.
 6. For connecting ground grid to ground bus in associated traction-power substation and ac-switchboard room, provide minimum of four 4/0 AWG insulated grounding electrode conductors as shown.
 7. For connecting ground grid to ground bus in dc tie-breaker station, chiller plant, fan shaft and drainage-pumping station, provide two 4/0 AWG insulated grounding electrode connections.
 8. For additional grounding of service transformer in outdoor location, provide one grounding electrode conductor from nearest ground grid to transformer pad.
 9. Unless otherwise shown, leave pigtail, three-foot six-inches minimum length, above finished floor for connection to ground bus or service-entrance equipment.
 10. When ground grid is provided for electrical room, connect ground grid to ground bus in electrical room with two 4/0 AWG insulated grounding electrode conductors.
- C. Ground Bus:
1. Install ground bus bar, two inches wide by 1/4-inch thick, around the inside periphery of traction-power substation, dc tie-breaker station, ac-switchboard room and electrical rooms; on full length of wall adjacent to service equipment such as switchboard and motor controls in chiller plants and mechanical rooms.
 2. Install ground bus bar, two inches by 1/4 inch by 24 inches long in train-control, communications, dispatcher, Bell system and mechanical rooms, kiosk, fan shafts, drainage-pumping stations, escalator pits, elevator rooms, battery rooms and where shown.
 3. Mount ground bus bar on insulators two feet above finished floor, unless otherwise shown, using cap screws and expandable threaded anchor.
 4. Provide insulator support at each end of ground bus and at three-foot intervals.
 5. In traction-power substation, dc tie-breaker station, ac-switchboard room, chiller plants, fan shafts, and drainage-pumping station, connect the ground bus to 4/0 AWG grounding electrode conductor running from associated ground grid.
 6. In train-control, communications, electrical, dispatcher, Bell system and mechanical rooms, escalator pits, elevator rooms, battery rooms and other locations shown, connect ground bus to main ground bus in associated ac-switchboard room, traction-power substation or dc tie-breaker station, using 2/0 AWG insulated conductor.
 7. Install 4/0 AWG insulated ground conductor, sub-ground bus, with one end connected to ground bus in ac-switchboard room, at following locations:
 - a. In each tunnel for mainline track, support grounding conductor on channel inserts in tunnel wall.

- b. In each cable trough and ductbank along mainline track, install grounding conductor in cable-trough area and conduit reserved for ac power.
 - c. In each cable space under station platform, install grounding conductor on channel inserts on wall.
 - 8. Installing grounding connections in train-control and communication rooms:
 - a. The only ground connection on the bus bar provided for train control and communication equipment grounding is the cable leading to the A. C. Switchboard room.
 - b. Do not bond equipment or metallic structure to the ground bus provided for train control equipment.
 - c. For items requiring bonding, have the bonding conductors go to the nearest ground bus beyond the ground bus provided for train control equipment.
 - d. Grounding transformers to the dedicated train control and communication room ground bus bars is not permitted.
- D. Equipment Grounding Conductor: Provide insulated equipment grounding conductor for following services and as shown:
 - 1. Feeders.
 - 2. Branch circuits.
- E. Grounding of Service Equipment:
 - 1. Ground in accordance with NEC.
 - 2. Ground enclosure and ground bus in switchgear, switchboard, motor-control center or panelboard to ground bus provided in substation or room using insulated grounding electrode conductor.
 - 3. Install copper bonding jumper between neutral and ground bus as shown.
- F. Grounding of Separately Derived AC System:
 - 1. Ground in accordance with NEC.
 - 2. Ground secondary neutral and enclosure of transformers to nearest ground bus or sub-bus using insulated grounding electrode conductor.
 - 3. For transformer located outside of building, install additional grounding connector between transformer secondary neutral/enclosure and ground bus or grid using insulated grounding electrode conductor.
- G. Grounding for Personnel Safety:
 - 1. In substation, electrical and mechanical rooms, tie-breaker stations, chiller plants, fan shaft and pumping stations, bond exposed metallic structure, motor frame, ac-equipment enclosure, ductwork and metallic piping to local ground bus, using minimum of 6AWG insulated grounding conductor as follows:
 - a. Ground multiple items of exposed metallic structure to local ground bus using a separate grounding conductor for each item or by using series-connected grounding conductors to connect two or more items.
 - b. Ground each ac equipment enclosure to local ground bus using a separate grounding conductor.
 - c. Connection of grounding conductor for ac equipment enclosure in series with grounding conductor for exposed metal structure is prohibited.
 - 2. Bond escalator's and elevator's motor frames, ac-equipment enclosures and metallic structures to equipment grounding conductor in ac-power feeder and to local ground bus bar. Provide a second ground path, connecting trusses and guide rails, using a #1/0 AWG insulated ground conductor connected to ground bus bar in A. C. Switchboard room. Leave 20-foot length of conductor coiled up in pits or wellway for

- making the grounding connections to trusses and guide rails by the escalator stage contractor.
3. Bond metallic ladders and stairs in fan shafts, vent shafts and other locations to local ground bus, using insulated grounding conductor, 6AWG minimum.
 4. Bond and ground exposed metallic structures in open areas to separate grounding electrode in accordance with the following requirements:
 - a. Metal pole for mounting light fixtures: Bond and ground each metal pole to separate 5/8-inch diameter by 10-foot long ground rod, buried with top two feet below grade with two-foot separation from footing, using 6AWG insulated grounding conductor.
 - b. Cable troughs alongside track: Bond and ground metal cable troughs to 5/8-inch diameter by 10-foot long ground rod, buried with top two feet below grade, at approximate 50-foot intervals and at each end with two-foot separation from reinforced or buried metallic structures, using 4AWG insulated grounding conductor. At expansion and contraction joints, install 4AWG insulated grounding conductor for electrical continuity.
 - c. Metallic railings and fences alongside track: Bond and ground railings and posts for galvanized steel fence to 5/8-inch diameter by 10-foot long ground rod, buried with top two feet below grade, at approximate 50-foot intervals and at each end, with two-foot separation from railing and fence-post footing and other reinforced structure, using 4AWG insulated grounding conductor. For electrical continuity, where necessary, install flexible copper braided or leaf-type jumper or 4 AWG insulated grounding conductor. In addition to the above requirements for grounding galvanized steel fences, provide the following for grounding PVC-coated steel fences:
 - (1) Bond and ground each fence post to bottom tension wire using 6AWG bare grounding conductor, O-Z Type CG, Burndy Type GAR or equal connector at fence post, and Burndy Type KS or equal tap connector at tension wire.
 - (2) At connections of grounding conductors to posts and tension wires, remove vinyl coating at contact surfaces before making connections and apply vinyl coating over finished connections to match original coating.
 - d. Railing, cable trough and metallic-deck structure at aerial track:
 - (1) In each abutment and pier, install 4/0 AWG insulated grounding conductor with one end connected to pile or one-inch diameter by 10-foot long ground rod, buried with top two feet below grade, with two-foot separation from concrete structure and three-foot pigtail on the top of pier or abutment for bonding and grounding of deck structure.
 - (2) Bond and ground deck structure, cable trough and hand railing to 4/0 AWG insulated grounding conductor installed at each abutment and pier using 4AWG insulated grounding conductor. For providing electrical continuity, where necessary, install flexible copper braided or leaf-type jumper or 4AWG insulated grounding conductor.
 5. In underground locations, bond and ground hand railing and metallic safety walk grating at each end and at approximate 50-foot intervals to nearest ground bus or sub-bus, using 6AWG insulated grounding conductor. For electrical continuity, where necessary, install flexible copper braided or leaf-type jumper or 6AWG insulated grounding conductor.
 6. Station entrance pylon (Type B): Provide multiple ground paths as follows:

- a. Bond and ground the pylon frame using 6AWG insulated grounding conductor to 5/8-inch diameter by 10-foot long ground rod driven so that top of rod is six inches below finished grade.
 - b. Bond and ground the pylon frame to equipment grounding conductor in branch circuit.
7. Handhole, manhole and junction box metallic body, cover frame and cover: Provide a minimum of two ground paths as follows:
- a. Bond and ground handhole, manhole and junction box metallic cover frame and metallic body to 5/8-inch diameter by 10-foot long ground rod driven with top of rod three inches above bottom of manhole, handhole and junction box using 6AWG insulated grounding conductor.
 - b. Provide a minimum of 6AWG insulated grounding conductor and a bronze or brass chain with 210-pound breaking strength in a 1/2-inch or 5/8-inch rubber hose to bond metallic cover to metallic cover frame. Length of cable, chain and hose as required to allow removal of cover adjacent to and clear of handhole and/or manhole opening.
 - c. When cable is spliced in handhole, manhole or junction box, bond metallic cover frame and body to equipment grounding conductor.
8. Exothermically weld or gas torch braze grounding and bonding connection to exposed metallic structure, metallic cable trough, galvanized steel fence, hand railing, metallic safety walk grating, map case and telephone enclosure, frame columns of shelter, pylon and diorama, and metallic cover, metallic cover frame and metallic body of handhole, manhole and junction box. Repair damaged galvanized coating in accordance with Division 2 Repair finish of shelter, map case and telephone enclosure and diorama frame to match existing finish.

3.02 BONDING FOR STRAY CURRENT AND CATHODIC PROTECTION:

- A. Reinforcing Steel At-Grade Sections:
 - 1. Bond reinforcing steel using 250 MCM, Class G, stranded bare conductor exothermically welded to steel straps as shown in accordance with Division 3.
- B. Floating-Slab Expansion Joints:
 - 1. Bond floating-slab expansion joints, using 1/0 AWG, Class G, stranded bare conductor exothermic welded to longitudinal bar.
- C. Metallic Pipe:
 - 1. Bond across joint for the following pipe, pipe fittings and pipe appurtenances, except those welded or soldered joints, using 2AWG insulated conductor as shown and in accordance with Section 15205.
 - a. Buried pipe, except soil pipe unless shown bonded.
 - b. Pressure pipe.
 - c. Pipe parallel to and within 20 feet of centerline of track.
 - 2. Do not bond District of Columbia, Department of Public Works (DCDPW), buried piping systems
- D. Permanent Metal Piles:
 - 1. Interconnect permanent metal piles, except those used in ground grid, using 4/0 AWG insulated conductor exothermically welded to piles. At each end of line of bonded piles, connect 4/0 AWG insulated conductor and terminate it in box inside line structure. Identify conductor termination using non-metallic tags or plastic labels attached to conductor with slip-free plastic lacing or nylon bundling strap.

- E. Drainage Cables in Tunnel, At-Grade and Aerial Sections:
 - 1. Between bonded reinforcing steel and negative switchboard in traction-power substation, install stray-current discharge cable in accordance with the following requirements:
 - a. Adjacent to each traction-power substation, install two 250 kcmil, Class G, stranded bare conductors, one end of each conductor welded to the reinforcing steel which has been bonded as specified herein, and the other end terminated in 12-inch by 18-inch by 4-inch junction box.
 - b. From the junction box, install two 250 kcmil insulated cables in FRE conduit to dc negative switchboard area of the traction-power substation for future connection by others.
- F. Separate reinforcing steel and other buried metallic structures, bonded for stray current and cathodic protection, from ground grid, grounding electrode, or exposed metallic structures grounded for personnel safety. Metallic contact or electrical bonding between two systems is prohibited.

3.03 FIELD QUALITY CONTROL:

- A. Test ground resistance of each ground grid after installation and each ground bus when connected to ground grid, using approved test procedure.
- B. Ground resistance not to exceed the following:
 - 1. Ground grid/bus in ac-switchboard rooms, chiller plants, and traction-power substations: Two ohms.
 - 2. Ground grid/bus in fan shafts, drainage-pumping stations, electrical rooms, dispatcher rooms, Bell system rooms, mechanical rooms and dc tie-breaker stations: Five ohms.
- C. To meet resistance requirements, install additional ground rods or use permanent metal piles as ground rods.
- D. Isolate permanent metal piles used for grounding from those bonded for stray-current and cathodic protection.
- E. Test metallic conduits and raceways, metallic enclosures for equipment, metallic cable troughs, fences, metallic hand railings, metallic safety walk gratings, metallic structures, metallic covers, cover frames and bodies of manholes, handholes and junction boxes, frames of shelters, pylons and dioramas, map case and telephone enclosures, and poles for mounting lighting fixtures for continuity to grounding system.
- F. Test resistance of connection between ground bus in train-control rooms/communications rooms and ground bus in associated ac-switchboard rooms, traction-power substations or dc tie-breaker stations for resistance not to exceed one ohm.
- G. Conduct tests in presence of Engineer.
- H. Inspect and test exothermic welds as follows:
 - 1. Inspect finished exothermic welds for visual characteristics that are consistent with a properly made connection in accordance with the manufacturer's instructions and

- recommendations. Remove welds that do not meet minimum visual requirements as acknowledged by the Engineer, and reweld after cleaning the area to be welded.
2. Test mechanical strength of exothermic weld by applying three sharp blows to the weld with a two-pound hammer using 15-inch strokes. Acceptable welds to sustain the blows without cracking the weld metal or the bond between the two connecting materials. Remove defective welds and reweld after cleaning the area to be welded.

END OF SECTION

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SECTION 16072

ELECTRICAL SUPPORTS AND SEISMIC RESTRAINTS

1.01 SUMMARY

- A. This Section includes the following:
1. Hangers and supports for electrical equipment and systems.
 2. Seismic restraints for electrical equipment and systems.
 3. Construction requirements for concrete bases.

1.02 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IBC: International Building Code.
- C. IMC: Intermediate metal conduit.
- D. NBC: National Building Code.
- E. OSHPD: Office of Statewide Health Planning and Development.
- F. RMC: Rigid metal conduit.
- G. SBC: Standard Building Code.
- H. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.
- I. UBC: Uniform Building Code.

1.03 SUBMITTALS

- A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.
1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 2. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Shop Drawings: Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a qualified professional engineer. Include the following:
1. Fabricated Supports: Representations of field-fabricated supports not detailed on Drawings.
 2. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Detail fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

- D. Welding certificates.
- E. Qualification Data: For professional engineer and testing agency.
- F. Field quality-control test reports.

1.04 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3 and in Division 16 Section "Electrical Supports and Seismic Restraints."
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.05 PROJECT CONDITIONS

- A. Site Class as Defined in the IBC: Per local requirements.
- B. S_s , Mapped Maximum Considered Earthquake Spectral Response at Short Periods: Per local requirements.
- C. S_1 , Mapped Maximum Considered Earthquake Spectral Response at 1-Second Period: Per local requirements.
- D. Assigned Seismic Use Group or Building Category as Defined in the IBC: Per local requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.
- B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.
 - 1. Available Manufacturers:
 - a. Cooper B-Line; a division of Cooper Industries.
 - b. ERICO International Corporation.
 - c. Allied Support Systems; Power-Strut Unit.
 - d. GS Metals Corp.
 - e. Michigan Hanger Co., Inc.; O-Strut Div.
 - f. National Pipe Hanger Corp.
 - g. Thomas & Betts Corporation.
 - h. Unistrut; Tyco International, Ltd.
 - i. Wesanco, Inc.
 - 2. Finishes:
 - a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
 - b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-3.
 - c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-3.
 - 3. Channel Dimensions: Selected for structural loading and applicable seismic

forces.

- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
1. Available Manufacturers:
 - a. Allied Support Systems; Aickinstrut Unit.
 - b. Cooper B-Line; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 4. Rated Strength: Selected to suit structural loading and applicable seismic forces.
- D. Raceway and Cable Supports: As described in NECA 1.
- E. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers:
 - (1) Hilti, Inc.
 - (2) ITW Construction Products.
 - (3) MKT Fastening, LLC
 - (4) Simpson Strong-Tie Co. Inc.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers:
 - (1) Cooper B-Line; a division of Cooper Industries.
 - (2) Empire Tool and Manufacturing Co., Inc
 - (3) Hilti, Inc.
 - (4) ITW Construction Products.
 - (5) MKT Fastening, LLC.
 - (6) Powers Fasteners.
 3. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.03 SEISMIC-RESTRAINT COMPONENTS

- A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Strength in tension, shear, and pullout force of

components used shall be at least five times the maximum seismic forces to which they will be subjected.

- B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.
- C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.
 - 1. Available Manufacturers:
 - a. Amber/Booth Company, Inc.
 - b. Loos & Co., Inc.
 - c. Mason Industries, Inc.
 - 2. Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.
 - 3. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.
 - 4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
 - 5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

2.04 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Miscellaneous Metal" for steel shapes and plates.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction
 - 2. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION

- A. Comply with NECA 1 for installation requirements, except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.

- D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 Section "Miscellaneous Metal" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.
- B. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so expansion anchors will be a minimum of 10 bolt diameters from edge of the base.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
 - 2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 6. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Structural Concrete."

3.05 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS

- A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to

wall.

- C. Restraint Cables: Provide slack within maximums recommended by manufacturer.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Make flexible connections in runs of raceways, cables, wire ways, cable trays, and bus ways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.07 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing: Test pullout resistance of seismic anchorage devices.
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Record test results.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.02 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.03 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.04 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
 - 1. Power Circuits: Black letters on an orange field.
 - 2. Legend: Indicate system or service and voltage, if applicable.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.02 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch-thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.
- E. Write-On Tags: Polyester tag 0.15 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.03 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.

2.04 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.05 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20

sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.06 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.07 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength: 50 lb, minimum.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.
 1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - (1) Primer: Exterior concrete and masonry primer.
 - (2) Finish Coats: Exterior semigloss acrylic enamel.
 2. Exterior Concrete Unit Masonry:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - (1) Block Filler: Concrete unit masonry block filler.
 - (2) Finish Coats: Exterior semigloss acrylic enamel.
 3. Exterior Ferrous Metal:
 - a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - (1) Primer: Exterior ferrous-metal primer.
 - (2) Finish Coats: Exterior semigloss alkyd enamel.
 4. Exterior Zinc-Coated Metal (except Raceways):
 - a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - (1) Primer: Exterior zinc-coated metal primer.
 - (2) Finish Coats: Exterior semigloss alkyd enamel.
 5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
 - a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - (1) Primer: Interior concrete and masonry primer.
 - (2) Finish Coats: Interior semigloss alkyd enamel.
 6. Interior Concrete Unit Masonry:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - (1) Block Filler: Concrete unit masonry block filler.
 - (2) Finish Coats: Interior semigloss acrylic enamel.
 7. Interior Gypsum Board:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - (1) Primer: Interior gypsum board primer.
 - (2) Finish Coats: Interior semigloss acrylic enamel.
 8. Interior Ferrous Metal:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - (1) Primer: Interior ferrous-metal primer.
 - (2) Finish Coats: Interior semigloss acrylic enamel.
 9. Interior Zinc-Coated Metal (except Raceways):
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

- (1) Primer: Interior zinc-coated metal primer.
- (2) Finish Coats: Interior semigloss acrylic enamel.

- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label.
- D. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
1. Fire Alarm System: Red.
 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 3. Combined Fire Alarm and Security System: Red and blue.
 4. Security System: Blue and yellow.
 5. Mechanical and Electrical Supervisory System: Green and blue.
 6. Telecommunication System: Green and yellow.
 7. Control Wiring: Green and red.
- E. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- F. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use write-on tags. Identify each ungrounded conductor according to source and circuit number.
- G. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and maintenance Manual.
- I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or

other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- K. Instruction Signs:
1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Stenciled legend 4 inches high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Electrical substations.
 - f. Emergency system boxes and enclosures.
 - g. Motor-control centers.
 - h. Disconnect switches.
 - i. Enclosed circuit breakers.
 - j. Motor starters.
 - k. Push-button stations.
 - l. Power transfer equipment.
 - m. Contactors.
 - n. Remote-controlled switches, dimmer modules, and control devices.
 - o. Battery inverter units.
 - p. Battery racks.
 - q. Power-generating units.
 - r. Voice and data cable terminal equipment.
 - s. Master clock and program equipment.
 - t. Intercommunication and call system master and staff stations.
 - u. Television/audio components, racks, and controls.
 - v. Fire-alarm control panel and annunciators.
 - w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
 - x. Monitoring and control equipment.
 - y. Uninterruptible power supply equipment.
 - z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.02 INSTALLATION

- A. Verify identity of each item before installing identification products.

- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Color-Coding for Phase Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- J. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION

SECTION 16118

FIBERGLASS CONDUIT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies the furnishing and installing of rigid non-metallic conduits, applicable to medium and low voltage, direct current cable installation work to be performed within the CMNT Shop under this contract.

1.02 RELATED SECTIONS

- A. Pertinent provisions of the following, also apply to the work of this Section, except as they may be modified herein, and are hereby made part of this Specification to the extent required:
1. Section 16120 - Wire, Cable and Busway.
 2. Section 16119 - Medium Voltage Cable.

1.03 QUALITY ASSURANCE

- A. Conform all manufacturing and work to these specifications and to the applicable requirements of the latest edition of the following codes, regulations and standards.
1. Local Building Codes
 2. National Electrical Code (NEC)
 3. National Fire Protection Association (NEPA)
 4. Underwriters Laboratories, Inc. (UL)
 5. Occupational Safety and Health Administration (OSHA)
 6. Institute of Electrical and Electronic Engineers (IEEE)
 7. American National Standards Institute (ANSI)
 8. National Electrical Manufacturers Association (NEMA)
- B. Comply with all other applicable laws, ordinance and requirements of the local agencies and utility companies having jurisdiction.
- C. In the event of any conflicts in the provisions stipulated in the referenced codes, regulations or standards and the specifications, the most stringent provision, as determined by the Project Manager, is to govern.

1.04 SUBMITTALS

- A. Submit manufacturer's data for conduit and fittings specified herein including, but not limited to, dimensions, electrical rating and identification.

PART 2- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
1. Non-Metallic Conduit
 - a. Canadian General Electric Company (CGE)
 - b. Champion Flame Shield, or,
 - c. Approved equal.

2.02 MATERIALS

- A. Rigid Fiberglass Conduit:
1. Heavy Wall (IPS size) rigid conduit of Fiberglass Reinforced polyester Epoxy (FRE) as manufactured by the pultrusion or filament wound process. At least 50% of the glass reinforcement is to be in the form of continuous strands. FRE conduit suitable for above ground surface mounted duct systems.
 - a. Conform exposed conduit and fittings installed above grade to NEMA Spec. TC-14A for filament wound reinforced thermosetting resin conduit.
 - b. Concrete encase conduit and fittings installed below grade and conform to NEMA Spec. TC-14A, as Listed and Labeled by UL, meeting the requirement of NEC Article 347 for Rigid Nonmetallic Conduit and its use.
 - c. The FRE conduit is to pass the UL 651 flame test and be certified by the manufacturer as such.
 2. Add UV degradation protection to all reinforcement containing materials by use of surface veiling, pigments, dyes or fillers.
 3. Make the pull box and fittings from fiberglass reinforced epoxy (FRE) or polyester compounds.
 4. Utilize in the installation, the bonding agent as recommended by the manufacturer to insure the integrity of the system.
 5. Fiberglass pull boxes, fittings and associated hardware items such as square tubing, threaded rods, nuts, etc., all are to be provided by the same manufacturer.
 6. Certify that the manufacturer's meet the NEMA specification applicable for area of conduit use, TC-14A for exposed or better. Each piece of conduit is to be labeled with the following information, marked clearly and durably every 10 ft or as recommended by the manufacturer:
 - a. Nominal size: (IPS).
 - b. Type: (Heavy Wall).
 - c. Manufacturer's name and trademark.
 - d. Material/resin designation: (i.e. Fiberglass polyester conduit).
 - e. NEMA specification number: (i.e. TC-14A).

2.03 GENERAL REQUIREMENTS

- A. Furnish all items of the materials, design, sizes and ratings shown on the drawings and herein specified.
- B. Furnish materials and equipment bearing evidence of UL approval where UL standards exist and such product listing is available.
- C. Method of fabrication, assembly and installation is optional unless otherwise specifically stated.
- D. Provide products that are free from defects impairing performance, durability, or appearance, and of the commercial quality best suited for the purpose shown on the drawings or specified herein.

PART 3 - EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. Install conduit and fitting according to National Electrical Code.

- B. Arrange conduit to maintain headroom and present a neat appearance.
- C. Route exposed conduit and conduit above accessible ceiling parallel and perpendicular to walls and adjacent piping.
- D. Maintain a minimum 6 inch clearance between conduit and piping. Maintain a minimum 12 inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
- E. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers or bolted split stamped galvanized hangers. Coordinate work to embed channel or spot inserts in concrete for supporting conduits, before the concrete is poured for new slabs or walls. Use appropriate anchors to attach conduit supports to existing structures.
- F. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- G. Do not fasten conduit with wire or perforated pipe straps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.
- H. Support the conduits in accordance with the criteria established in the National Electric Code.
- I. Unless otherwise shown on the drawings, size conduit for conductor type installed. 3/4-inch (19mm) is the minimum conduit size.

3.02 CONDUIT INSTALLATION

- A. Cut conduit square using a saw or pipe cutter; de-burr cut ends.
- B. Bring conduit to the shoulder of fittings and couplings and fasten securely.
- C. Use conduit hubs or sealing locknuts for fastening conduit to cast boxes, and for fastening conduit to sheet metal boxes in damp or wet locations.
- D. Install no more than the equivalent of three 90-degree bends between boxes.
- E. Use conduit bodies to make sharp changes in direction, as around beams.
- F. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.
- G. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.
- H. Use silicone sealant fill to fill the void space in conduit at the entrance and exit of the cables.
- I. Provide # 8 insulated conductor or suitable pull string in empty conduit, except sleeves and nipples.
- J. Install expansion joints where conduit crosses building expansion joints.
- K. Where conduit penetrates fire-rated walls and floors, seal opening around conduit with UL listed foamed silicone elastomer compound. Provide galvanized rigid conduit sleeve for all penetrations, cut sleeve flush with opening.

- L. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket.
- M. Maximum Size Conduit in Slabs Above Grade is 1-inch (25mm). Do not route conduits to cross each other in slabs above grade.

END OF SECTION

SECTION 16119

MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Specification covers the design, manufacture, testing, delivery and installation of 2,000 volt, copper conductors, ethylene-propylene rubber (EPR) insulated, low smoke cross linkpolyolefin (XLPO) jacketed power cable.
- B. Following sizes of dc cables, rated 2kV are used in this project.
 - 1. 1000 kCM between DC Switchboard, stinger contactors, and DC Stinger power bus conductor.
 - 2. # 1/0 AWG cables between DC Switchboard, car receptacle contactors, and car receptacle locations.
- C. Cables placed in subsurface ducts will be subject to wet, brackish conditions.
- D. The cable will be subjected to heavy currents cyclical in nature and to continual, intermittent applications of 3,000 volt dc voltage spikes.
 - 1. Furnish the cable in continuous lengths on non-returnable reels. Allow only one length on each reel. Afford reels complete protection to the cable during shipment and handling.
 - 2. Apply a watertight seal to each end of the cable to prevent entrance of moisture during shipment, installation and storage.
- E. The cable specifications described in this Section pertain only to the DC Stinger and car receptacle systems.

1.02 APPLICABLE STANDARDS

- A. The cable shall comply with the latest revisions of all applicable ANSI, ICEA, NEMA,ASTM, NESC and NEC Standards.
 - 1. ANSI, American National Standards Institute
 - 2. ICEA, Insulated Cable Engineers Association
 - 3. NEMA, National Electrical Manufacturers Association
 - 4. ASTM, American Society for Testing and Materials
 - 5. NESC, National Electrical Safety Code
 - 6. NEC, National Electrical Code

1.03 SUBMITTALS

- A. Submit the following technical data, for approval of the Authority Representative.
- B. Technical Data for 1000 KCM conductor. The Contractor is advised that it is essential that the characteristics of the cable be fully explained to meet the ratings described in paragraph 2.1, by furnishing the information required in the following tabulation. Failure to do so will subject the submittal to rejection as incomplete.

	<u>Item Description</u>	<u>Minimum Standard</u>
1.	Conductor Stranding:	[Class D Extra Flexible]
2.	Conductor Material:	[Copper]
3.	Conductor Coating:	[Tin-Coated]
4.	Insulation Material:	[EPR]
5.	Insulation Thickness (minimum):	[2.29 mm (90 mils)]

- | | | | |
|-----|---|--|---------------------|
| 6. | Maximum Copper Temperature: | [90°C] | |
| | a. Continuous: | [90° degrees Celsius] | |
| | b. Emergency: | [130° degrees Celsius] | |
| | c. Short Circuit: | [250° degrees Celsius] | |
| 7. | Minimum Installation Temperature: | [-20° degrees Celsius] | |
| 8. | Jacket Material: | [Lo Smoke XLPO] | |
| 9. | Jacket Thickness (minimum): | [1.65 mm (65 mils)] | |
| 10. | Physical Requirements: | | |
| | | <u>Insulation</u> | <u>Jacket</u> |
| | a. Tensile Strength (minimum): | [1200 psi] | [1700 psi] |
| | b. Elongation at Rupture (minimum): | [150%] | [150%] |
| | c. Set (maximum): | [50%] | [50%] |
| 11. | Aging Requirements: | | |
| | a. After Air Oven Test | [168 Hours] | [168 Hours] |
| | (Indicate Condition): | [121° C] | [100° C] |
| | Tensile Strength and | | |
| | Elongation at Rupture, | | |
| | Percent of Unaged Value: | [75%] [85%] | [75%][75%] |
| | b. After Oil Immersion | | |
| | Test (Jacket Only): | | |
| | Indicate Conditions: | [18 hrs/121°C/ASTM #2 Oil] | |
| | Tensile Strength and | | |
| | Elongation Percent | | |
| | of Unaged Value: | | |
| | (minimum) | [60%] | |
| | Elongation at Rupture, | | |
| | Percent of Unaged Value | | |
| | (minimum): | [50%] | |
| 12. | Accelerated Water Absorption: | | |
| | a. Electrical Method | | |
| | Increase in Capacitance: | | |
| | 1 to 14 Days: | [5.0%] | |
| | 7 to 14 Days: | [3.0%] | |
| | Stability Factor After | | |
| | 14 Days: | [1.0] | |
| | b. Gravimetric Method: | | |
| | Water Absorption in | | |
| | Milligrams per | | |
| | 645.16 Square millimeter: | [5.0] | [20.0] |
| 13. | Electrical Requirements (Insulation): | | |
| | a. AC Voltage Test: | [9.5 Kv] | |
| | b. DC Voltage Test: | [28.5 kV] | |
| | c. Insulation Resistance: | [K = 20,000] | |
| 14. | Cable Outside Diameter: | [36.2 mm (1.426 inch)] | |
| 15. | Allowable Minimum Bending Radius: | [305 mm, (12 inches)] | |
| 16. | Allowable Maximum Pulling Tension: | [1814 kg (4000 pounds)] | |
| 17. | Reel Data: | | |
| | a. Diameter: | [As recommended by Cable Manufacturer] | |
| | b. Width: | [As recommended by Cable Manufacturer] | |
| | c. Drum Diameter: | [As recommended by Cable Manufacturer] | |
| | d. Tare Weight: | [As recommended by Cable Manufacturer] | |
| | e. Arbor Diameter: | [76 mm (0.3")] | |
| 18. | Electrical Characteristics (Indicate Conditions): | | |
| | a. Resistance: | [.03543] ohms per km | |
| | b. Reactance (Inductive): | [.0919] ohms per km. | |
| | c. Impedance: | [.0985] ohms per km. | |
| 19. | Cable Weight: | [2.41 kg/m (3.582 #/ft)] | [5.2 MNT (11462 #)] |

C. Technical Data for #1/0 conductor. The Contractor is advised that it is essential that the characteristics of the cable be fully explained to meet the ratings described in paragraph 2.1, by furnishing the information required in the following tabulation. Failure to do so will subject the submittal to rejection as incomplete.

	<u>Item Description</u>	<u>Minimum Standard</u>		
1.	Conductor Stranding:	[Rope Lay Class K]		
2.	Conductor Material:	[Copper]		
3.	Conductor Coating:	[Tin-Coated]		
4.	Insulation Material:	[EPR]		
5.	Insulation Thickness (minimum):	[2.29 mm (90 mils)]		
6.	Maximum Copper Temperature:	[90°C]		
	a. Continuous:	[90° degrees Celsius]		
	b. Emergency:	[130° degrees Celsius]		
	c. Short Circuit:	[250° degrees Celsius]		
7.	Minimum Installation Temperature:	[-20° degrees Celsius]		
8.	Jacket Material:	[Lo Smoke XLPO]		
9.	Jacket Thickness (minimum):	[1.65 mm (65 mils)]		
10.	Physical Requirements:		<u>Insulation</u>	<u>Jacket</u>
	a. Tensile Strength (minimum):		[1200 psi]	[1700 psi]
	b. Elongation at Rupture (minimum):		[150%]	[150%]
	c. Set:		[50%]	[50%]
11.	Aging Requirements:			
	a. After Air Oven Test (Indicate Condition):		[168 Hours]	[168 Hours]
	Tensile Strength and Elongation at Rupture, Percent of Unaged Value:		[121° C]	[100° C]
	b. After Oil Immersion Test (Jacket Only):			
	Indicate Conditions:		[75%] [85%]	[75%] [75%]
	Tensile Strength, and Elongation Percent of Unaged Value (minimum):		[18 hrs/121°C/ASTM #2 Oil]	
	Elongation at Rupture, Percent of Unaged Value (minimum):		[60%]	
12.	Accelerated Water Absorption:		[50%]	
	a. Electrical Method:			
	Increase in Capacitance:			
	1 to 14 Days:		[5.0%]	
	7 to 14 Days:		[3.0%]	
	Stability Factor After 14 Days:		[1.0]	
	b. Gravimetric Method:			
	Water Absorption in Milligrams per 645.16 Square millimeter:		[5.0]	[20.0]
13.	Electrical Requirements (Insulation):			
	a. AC Voltage Test:		[9.5 kV]	
	b. DC Voltage Test:		[28.5 kV]	
	c. Insulation Resistance:		[K = 20,000]	
14.	Cable Outside Diameter:		[17 mm (.681 inch)]	
15.	Allowable Minimum Bending Radius:		[76 mm, (3 inches)]	
16.	Allowable Maximum Pulling Tension:		[1814 kg (4000 pounds)]	

17. Reel Data:
 - a. Diameter: [As recommended by Cable Manufacturer]
 - b. Width: [As recommended by Cable Manufacturer]
 - c. Drum Diameter: [As recommended by Cable Manufacturer]
 - d. Tare Weight: [As recommended by Cable Manufacturer]
 - e. Arbor Diameter: [As recommended by Cable Manufacturer]
18. Electrical Characteristics
(Indicate Conditions):
 - a. Resistance: [.033465 r/km (102 r/1000)] ohms per km.
 - b. Reactance (Inductive): [.0919] ohms per km.
 - c. Impedance:
19. Cable Weight: [.034704] ohms per km.

PART 2 - PRODUCTS

2.01 DC FEEDER CABLE:

- A. General: single conductor, type EPR, ethylene-propylene rubber, feeder cable for use with a 750 volt dc (nominal) traction power distribution system.
- B. Voltage Rating: 2000 Volts, withstand minimum voltage of 1000 Volts dc continuously; and sustain positive and negative voltage spikes of 3000 Volts concurrent with the continuous 750 Volts dc without damage to the cable nor reduction in cable lifetime.
- C. Temperature Rating:
 1. Normal operating conductor temperature: 90°Celsius wet and dry locations per NEMA WC70 continuous rating and 110°Celsius hot spot rating.
 2. Emergency operating conductor temperature: 130°Celsius per NEMA WC70 emergency overload rating is limited to not more than 100 hours per year and a maximum of 5 such 100 hour period in the anticipated cable life.
 3. Allowable conductor temperature reached under short circuit conditions 250°Celsius per NEMA WC70.
- D. Conductors:
 1. Annealed coated copper meeting the elongation, resistivity, finish and coating continuity requirement of ASTM B33 or B3, before stranding.
 2. Meet requirements for compressed Class D conductor per ASTM B-8 for conductors in conduit and cable tray. In addition, provide Class G extra-flexible stranded cable between DC stinger power takeoff conductor termination lug and the feeder cable as required to reduce transference of vibration to the rigid conduit system and to provide an ease of maintenance and installation.
- E. Insulation Jacket Covering:
 1. Composition: The insulation of flame retardant, EP (ethylene propylene) material. A protective jacket of low smoke, zero halogen thermosetting material Cross Link polyolefin (XLPO) shall be provided.
 2. Requirements: The insulation shall be provided with a jacket that is UL labeled "RHW-2", having minimum peel strength of the jacket from the insulation of 4 pounds per inch of width and have an insulation power factor of 2%.
- F. Identification:
 1. The cable shall carry throughout its length a color coded marker thread, as per NEMA requirements, for the purpose of manufacturer identification.
 2. Each length of cable shall be durably printed on the surface and repeated at intervals of 50mm or less with the following information.
 - a. Manufacturer's name
 - b. Cable size and type

- c. Year of manufacture
 - d. Insulation type
 - e. Voltage classification
 - f. Function
- G. Tests: Test and measurements of finished cable and material used in cable manufacturing shall be as prescribed in referenced NEMA Specifications.
- H. Acceptable Manufacturers (or equal):
- 1. The Okonite Company
 - 2. BICC
 - 3. AMERCABLE
 - 4. Rome Cable Corporation
 - 5. Triangle Conduit and Cable Co., Inc.
 - 6. Boston Insulated Wire

2.02 ARC AND FIREPROOFING TAPE

- A. The fireproofing tape material shall be a composite of a heat-resistant, flame-retardant, elastomeric compound permanently bonded to a flexible, conformable fabric backing. There shall be no asbestos, fiberglass or other potentially dangerous components in the tape.
- B. Thickness - The minimum thickness of this material shall be 50 mils (1.27mm).
- C. Retention of Strength after Exposure - At least 80% of the initial tensile strength shall be retained after exposure under the following conditions for 168 hours:
- 1. Distilled Water
 - 2. Salt Water
 - 3. Sewage
 - 4. Sunlight
- D. Cold Temperature Flexibility - The tape shall not crack when subjected to a 360 degree bend around a 1-inch (25mm) mandrel at 14 degrees F (-10 degrees Celsius).
- E. Arc Resistance - The tape shall withstand when wrapped about a 76mm diameter lead sleeve, exposure to heat created by an arc from 22mm electrodes, located 1-inch (25mm) from the sample, generated by not less than 195 nor greater than 210 amperes d-c, for a minimum of 30 seconds. The arc is blown magnetically against the lead tube until it melts at the arc contact point.
- F. Flame Resistance - Prepare the tape to withstand above, the flame created by an aerated transformer oil fire for a period of not less than ten (10) minutes before the lead tube begins to melt. Suspend the sample approximately 1-ft (.3048m) above the surface of the burning oil.
- G. Fireproofing tape shall be Quelpyre Arc and Fireproofing Tape by Quelcor, Inc. or Approved equal.

2.03 CABLE SPLICES AND TERMINATIONS

- A. Splice all dc cables by compression method or by Cadweld. Submit the proposed method of splicing for approval to the Authority Representative.
- B. Submit for approval, proposed splice and termination insulation systems and manufacturer's recommended installation procedures for each type.

2.04 CABLE TAGS

- A. Provide circuit identification tags and install them on cables at termination and splice locations. Select tags from Almetek, Tech Products or Approved equal. Secure tags to cables using nylon cable ties.

PART 3 - EXECUTION

3.01 TESTS

- A. Test the cable at the factory in accordance with applicable NEMA standards.
- B. Provide the Authority Representative with a minimum ten days written notice prior to the factory tests. The Authority Representative reserves the right to witness tests.
- C. Furnish five copies of certified test reports for approval by the Project Manager, prior to shipment of the cable.
- D. All 2 kV-insulated cables shall be field tested after installation by Step Voltage megger test procedure using a megger at 2500 Volts. Obtain the services of an independent testing agency to perform the testing requirements. Submit the name, address, telephone number, and qualifications of the proposed testing agency test procedure for approval at least(16) weeks prior to cable field commissioning tests. In addition, submit for approval the cable commissioning test procedure at least (8) weeks prior to the proposed testing date. Reject any cable exhibiting defects or non-compliance with these Specifications and assume responsibility for all cost incidental to the replacement of the Cable.

3.02 CABLE INSTALLATION

- A. Furnish and install cables as herein specified.
- B. Assume responsibility for all cable lengths and allow sufficient slack for connection to equipment. Seal cable ends immediately after cutting to prevent moisture from entering the cable.
- C. Where existing cable racks are unusable, provide new fiberglass cable racks.

3.03 ARC AND FIREPROOFING TAPE

- A. Wrap cables spirally, fabric side out with a single, half-lapped layer of the fireproofing tape with care taken to insure total coverage of exposed areas. Fasten the tape to the cable with the manufacturer's recommended typing cord.
- B. Wrap cables with the fireproofing tape wherever the cables are exposed, in pull boxes, and in any location where exposed in cable tray.

3.04 CABLE SPLICES AND TERMINATIONS

- A. No straight through inline splices in cables will be permitted except in pullboxes. Make splices, that are made in the pull boxes according to the manufacturer's recommendation, subject to the approval of the Authority Representative. Furnish the Project Manager with seven (7) copies of the manufacturer's recommendations.
- B. Provide compression splices on dc cables. Do the splicing in accordance with the manufacturers recommendation.
- C. Furnish and install heat-shrinkable insulation systems over all DC cable splices. When

applying heat to the heat shrinkable insulation, ensure ample heat, without burning, to effect a proper seal, in accordance with the manufacturer's recommendations. Acceptable heat shrinkable insulation sleeves shall be as manufactured by Raychem, 3M Inc., or approved equal.

- D. Schedule all splicing so that the Authority Representative may visually inspect and witness the procedure at each location.

3.05 TESTS

- A. Test all cables, unless directed otherwise by the Authority Representative, for insulation dielectric strength (meggered) and continuity as described herein and the results properly recorded and submit to the Authority Representative on graphs meeting ICEA standards.

END OF SECTION

THIS PAGE NOT USED

SECTION 16120

WIRE, CABLE AND BUSWAYS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing wire, cable and busways.
- B. Definitions:
 - 1. Cable: Cable having low smoke generating characteristics.
- C. Requirements for single-conductor cable and for multiple-conductor cable as stated except as otherwise specified.
- D. Related Work Specified Elsewhere:
 - 1. Grading, excavating and backfilling: Section 02320.
 - 2. Wire connection accessories: Section 16125.
 - 3. Raceways, boxes and cabinets: Section 16130.

1.02 QUALITY ASSURANCE:

- A. Qualifications: Select a manufacturer who is engaged in production of similar wire, cable and busways.
- B. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. National Electrical Code (NEC).
 - 3. Insulated Cable Engineers Association (ICEA): S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, S-81-570.
 - 4. IEEE: 1202-1991 IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies, 383-1974 IEEE Standard for Type Test of Class 1E Electrical Cables, Field Splices, and Connections for Nuclear Power Generating Stations.
 - 5. National Electrical Manufacturers Association (NEMA): BU1, WC70, WC71, WC74.
 - 6. American National Standards Institute (ANSI): C37.20.1, Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear; C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear; C37.20.3, Metal-Enclosed Interrupter Switchgear; Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
 - 7. UL: 44, Rubber-Insulated Wires and Cables Thermoset-Insulated Wires and Cables; 62, Flexible Cord and Fixture Wire; 857, Electric Busways and Associated Fittings; and 1581, Standard for Electrical Wires, Cables, and Flexible Cords.
 - 8. American Standards of Testing and Materials (ASTM): B3-95, Standard Specification for Soft or Annealed Copper Wire; B8-99, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; D471-98e1, Standard Test Method for Rubber Property-Effect of Liquids, E662-97, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
 - 9. ITS: Directory of ITS Listed Products

- C. Source Quality Control:
 - 1. Cable and busways: Listed or labeled per UL or ITS directory.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings.
- B. Samples:
 - 1. Smoke-density test sample for jacket material: Specified sample will become property of the Authority.
- C. Certification:
 - 1. Certified flame-retardancy test reports (VW-1, IEEE 383, and IEEE 1202, Article 18) and data for tests performed not more than 12 months prior to submittal, for materials which are identical to those of cable furnished. Include test reports with submittal of shop drawings.
 - 2. Submit smoke-density test reports and data for tests performed on the jacket material not more than 12 months prior to the submittal, for materials which are identical to those of the furnished cable. Include test reports with submittal of shop drawings.
 - 3. Certified test reports demonstrating that cable complies with specified requirements and those of referenced ICEA Standards. Submit test reports prior to cable shipments.
 - 4. Certificates from manufacturers verifying that products conform to specified requirements. Include certificate with submittal of shop drawings and with each cable shipment.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Mark each single-conductor cable, each multiple-conductor cable and each busway to show label per referenced UL or ITS directory, size, voltage, manufacturer and number of conductors or phases in accordance with NEC requirements.
- B. Ship each unit securely packaged and labeled for safe handling and shipment.
- C. Store products in a dry and secure facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements for Single-Conductor and Multiple-Conductor Cable:
 - 1. Type and size: As shown.
 - 2. Rated voltage: 600 volts.
 - 3. Conductors:
 - a. ASTM B3 or B8 annealed copper.
 - b. Size 10 AWG and smaller: Solid or Class B or Class C stranded.
 - c. Size 8 AWG and larger: Class B stranded.
 - 4. Standards: Except as modified, wires and cable complying with the following standards:

- a. Cross-linked polyethylene (XLPE) insulated cable: ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, S-81-570.
 - b. Other cable: ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, S-81-570.
5. Non-metallic jacket for single-conductor cable and an overall covering on multiple-conductor cable:
- a. Standard grade THNN/THWN at shop.
 - b. Jacket material free of PVC and PVC-based compounds.
 - (1) Tensile strength, minimum pounds per square inch: 1,800.
 - (2) Elongation at rupture, minimum percent: 150.
 - (3) Aging requirement: After 168 hours in air oven test at 100C, plus-or-minus one degree C:
 - (a) Tensile strength, minimum percentage of unaged value: 100.
 - (b) Elongation at rupture, minimum percentage of unaged value: 80.
 - (4) Oil immersion: 18 hours at 121C, plus-or-minus one degree C, ASTM D471, Table 1, No. 2 oil:
 - (a) Tensile strength, minimum percentage of unaged value: 80.
 - (b) Elongation at rupture, minimum percentage of unaged value: 80.
6. Applied voltage testing:
- a. Single-conductor cable and individual conductors of multiple-conductor cable to be given applied ac voltage dielectric-strength test, i.e., six-hour water-immersion test.
 - b. For single conductors of multiple-conductor cable, conduct tests prior to assembly as multiple-conductor cable.
 - c. Test procedures:
 - (1) Polyethylene-insulated conductors: In accordance with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692.
 - (2) Other conductors: In accordance with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, and S-81-570.

B. Single-Conductor Cable:

- 1. Insulated with ethylene-propylene-rubber with non-metallic jacket as specified. UL-Labeled as Type RHW-2.
- 2. Color coding: In accordance with paragraphs 200-6, 200-7 and 210-5 of the NEC.

C. Multiple-Conductor Cable:

- 1. Individual conductors:
 - a. Number of conductors: As shown.
 - b. Construction: Complying with one of the following:
 - (1) Insulated with ethylene-propylene-rubber, with or without non-metallic jacket.
 - (2) Insulated with composite compound of ethylene-propylene-rubber and polyethylene, without outer jacket.
 - (3) Insulated with filled cross-linked polyethylene without jacket.
 - c. Phase and neutral conductors: Individually insulated.
 - d. Neutral conductors: Same size as phase conductors.
 - e. Bare ground conductors: Sized in accordance with the NEC, unless otherwise shown.
 - f. UL Listed as Type RHW-2 or XHHW-2.

2. Conductors assembled with nonwicking, flame-retardant filler to form cable of circular cross section.
 3. Metallic sheath:
 - a. Provide one of the following:
 - (1) Size 1 AWG and larger:
 - (a) Interlocked aluminum-tape armor.
 - (b) Continuous corrugated aluminum sheath conforming to ICEA S-19-81, Table 4-26A.
 - (2) Size 2 AWG and smaller: As specified for 1 AWG and larger or continuous smooth aluminum sheath conforming to ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692.
 - b. Metallic covering not required for multiple-conductor TC cable with overall non-metallic jacket when installed in cable tray.
 4. Multiple-conductor cable provided with overall non-metallic jacket as specified.
 5. Cable UL-listed as follows:
 - a. Non-metallic-sheathed cable: Type TC, suitable for wet and dry locations.
 - b. Metallic-sheathed cable: Type MC, suitable for wet and dry locations.
 6. Color coding:
 - a. Power cables: In accordance with paragraphs 200-6, 200-7 and 210-5 of the NEC.
 - b. Control cables: In accordance with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692.
- D. Fixture Wire: UL 62, with the following additional requirements:
1. Type: SF-2 silicone-rubber insulated or as necessary to suit temperature rating of lighting fixture, minimum 90C.
 2. Conductor: Stranded copper conductor 16AWG or larger as shown.
- E. Bare Conductors: ASTM B3 or B8, annealed copper conductor; 8AWG and larger, Class B stranded, unless otherwise shown or specified.
- F. Busway (Busduct) and Fittings:
1. UL 857, NEMA BU1.
 2. Totally enclosed, three-phase, four-wire feeder busway system, as shown, with necessary fittings, hanging devices, accessories and provision for flange bolting over circuit breaker.
 3. Continuous current rating:
 - a. Secondary tie duct for use in combined substation: Sized in accordance with ANSI C37.20.1, C37.20.2, C37.20.3, and NEC.
 4. Voltage rating: 480/277 volts.
 5. Busway system braced to withstand minimum short-circuit current of 75,000 amperes symmetrical, unless otherwise shown.
 6. Maximum allowable temperature rise in busway at continuous full load above maximum ambient temperature of 40C: 55C.
 7. Housing: Nonventilated, fabricated from galvanized sheet steel. Removable gasketed cover provided at transformer connection for maintenance and test. Hardware galvanized or cadmium-plated.
 8. Joints:
 - a. Single-bolt pressure joint designed for optimum electrical contact and mechanical strength.
 - b. To permit safe testing of its tightness without de-energizing systems.
 - c. To permit removal of duct sections without disturbing adjacent pieces.
 - d. To permit making up joint from one side when busway is installed against wall or ceiling.

9. Busbars: Fabricated from 98-percent-conductivity copper and insulated over entire length except at joints and contact surface. Joints and contact surfaces tin-plated or silver-plated. Neutral bar same size as phase bar. Ground bar half size of phase bar.
10. Entire busway system polarized.
11. Expansion fittings provided where necessary.
12. Flexible connections, braided or laminated, provided for connecting bus conductor to transformer terminals.
13. Finish: Light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install type cable as specified.
- B. Install single-conductor cable in conduit, underfloor duct or wireway. Install UL Type TC multiple-conductor cable in cable trays only. Install UL Type MC multiple-conductor cable and ground cable on channel inserts, cable trays, racks, trench or trough using straps and fasteners as specified in Section 16130. Install UL Type MC multiple-conductor cable in conduit where shown or required. On walls or ceilings, fasten cable and bus duct directly to channel inserts, or use expansion-bolt anchors to attach to concrete and toggle bolts to attach to concrete masonry unit walls. Splice cable only when unavoidable.
- C. Install motor feeders, service connections and extensions in accordance with reference codes. Install motor feeder in 18-inch minimum length liquid-tight flexible conduit at motor conduit box.
- D. Use nylon straps to bundle and secure wire and cable located in panelboards, cabinets, switchboards, motor control centers and switchgear.
- E. Minimum bending radius 12 times outer diameter of cable. Where shown, use shorter bending radius as permitted by NEC, ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692, and cable manufacturer.
- F. To facilitate pulling cable, use listed per UL or ITS directory lubricant recommended by cable manufacturer.
- G. Use direct-burial cable only for stray current and cathodic protection.
- H. To install direct-burial cable, prepare trench of uniform width and free of sharp projections and rocks and place three-inch bed of sand. Do not pull cable directly into trench from stationary reel; unreel cable beside trench. Place cable on sand bed and backfill with three-inch deep sand cover. Fill remainder of trench with approved fill material and compact in accordance with Section 02320. Provide temporary supports in trench as necessary to prevent damage to insulation or jacket during installation.
- I. In damp and dusty indoor locations, tunnel areas, manholes and outdoor locations, seal cable at conduit termination using duct-sealing compound.

- J. Where shown or necessary, install cable-seal fitting specified in Section 16130 to prevent entry of water into electrical facilities. Where approved, use seal compound specified in Section 16130.

3.02 IDENTIFICATION:

- A. Identify cable terminations, feeders and power circuits using non-metallic fiberboard tags or plastic labels. Attach tags to cable with slip-free plastic lacing or nylon bundling straps. Use designation shown.

3.03 FIELD QUALITY CONTROL:

- A. Furnish equipment required to perform tests. Prior to insulation and high-potential tests, disconnect instruments and equipment which might be damaged during such tests. Conduct tests in presence of the Engineer.
- B. Submit test procedure for approval and perform approved tests including, but not limited to, the following:
1. Single-conductor cable and multiple-conductor cable:
 - a. Test continuity of cable conductors using ohmmeter.
 - b. Proof-test insulation resistance to ground and between insulated conductors for minimum of one minute using 1,000-volt megger. Insulation resistance: 200,000 ohms minimum.
 - c. When cable shows unsteady insulation resistance of less than 200,000 ohms, perform high-potential test at 80 percent of factory ac test voltage or as recommended by cable manufacturer.
 2. Busway:
 - a. Clean contact surfaces before making connections. For bolted connections, apply torque recommended by manufacturer.
 - b. Test resistance of busway connections. Resistance not to exceed value recommended by manufacturer.
 - c. Test insulation resistance to ground and between insulated busbars for minimum of one minute using 1,000-volt megger. Insulation resistance: One-megohm minimum. When busway shows insulation resistance of less than one-megohm minimum, perform high-potential test.
- C. Submit certified test reports.

END OF SECTION

SECTION 16121

DC STINGER SYSTEM AND CONTROLS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This Section covers specifications for furnishing all labor, materials, equipment, services, and tools necessary and required for electrical construction of the following traction power systems.
 - 1. 750 VDC Stinger system for traction power to married pairs for movement inside the shops.

1.02 RELATED SECTIONS

- A. Section 16119 - Medium Voltage Cable

1.03 QUALITY ASSURANCE

- A. Qualifications: Select a manufacturer who is regularly engaged in the repetitive production of stinger systems and controls equipment of the types and ratings described in these specifications. The equipment manufacturer shall have and maintain ISO 9001 or ISO 9002 certification.
- B. The work of this Section, including the products, shall satisfy the applicable requirements of the following standards and regulations of Jurisdictional Authorities:
 - 1. National Electrical Code (NFPA 70)
 - 2. ANSI/IEEE
 - 3. OSHA
 - 4. NEMA including WC70
- C. Inspections and Tests:
 - 1. The Authority Representative reserves the right to witness all tests and manufacturer inspections that the Authority Representative deems necessary.
 - 2. The Contractor and his supplier shall grant the Authority Representative free entry at all times while work under this Specification is being performed.
 - 3. The Contractor shall provide, free of cost, reasonable facilities to satisfy that materials and equipment are being furnished in accordance with these Specifications.\

1.04 SUBMITTALS

- A. Submittals for all stinger equipment components, materials, and systems shall be made as described in these Specifications.
- B. Prepare as-built drawings showing the complete layout of the 750 VDC stinger system and submit to the Authority prior to final acceptance of work.
- C. The Contractor shall include shop drawings, manufacturer's descriptive literature and published details with performance and capacity rating schedules on chart, for all product specified in Part 2 of this Section. Product shop drawings shall indicate fabrication detail and proposed layouts for shop or field fabrication. Include electrical wiring diagrams, details and all necessary dimensions from assembly and from installation.

- D. Operation and Maintenance Manuals
1. The Contractor shall include the following element in each manual; however not necessarily in the order listed:
 - a. Table of Contents.
 - b. Erection or installation instructions.
 - c. Start-up procedures.
 - d. Schedule of preventive maintenance requirements.
 - e. Detailed maintenance procedures and schedule for any routine periodic maintenance.
 - f. Detailed trouble shooting procedures.
 - g. Corrected and approved control and wiring diagrams.
 - h. Data sheet listing pertinent equipment or system information.
 - i. Color photographs (4"x 6") of the constructed and functional stinger system in detail. The photographs shall be bound in a suitable loose-leaf photograph album having individual transparent pages for insertion of the photographs.
 - j. Name, address, and telephone number for each major supplier/manufacturer of the equipment, where spare parts may be obtained for the equipment.
 2. The Contractor shall submit the final operation and maintenance manuals to the Authority Representative. These manuals shall be technically accurate and complete and shall represent the "As-Built" system, piece of equipment, or material. All illustrations, text, and tabular material shall be in final form; copies of all Shop Drawings submitted for approval shall be included for each major piece of equipment.
- E. Certification:
1. The Contractor shall furnish to the Authority Representative, the certified copies of the results of all tests and measurements made to determine the quality and serviceability of the manufactured equipment listed in this Specification Section, at no additional cost to WMATA.
 2. Certification shall include, as a minimum, the following items:
 - a. DC Stinger System
 3. DC Stinger System and Controls - System Integration
- F. Assume complete responsibility for the design, component and material selection, manufacturing, installation, testing, and operation of the DC Stinger power and controls as a system. Integrate the elements and assemblies described in Part 2 of this Specification Section, into a complete, operable, and WMATA-approved DC Stinger System.

PART 2 - PRODUCTS

2.01 DC STINGER (CONDUCTOR/COLLECTOR) SYSTEM

- A. General:
1. The conductor/collector system components shall be UL listed, and shall meet or exceed UL-94 for Combustibility (self-extinguishing characteristics).
 2. The conductor/collector system shall be protected against direct contact in accordance with "finger-safety standard" (UL-E99342). The conductor/collector system shall consist of standardized interchangeable units - track section, coupling sets, dead end caps, track hangers and power takeoff and control trolleys (including cables and cable support/relief assemblies).
 3. This application requires a system of sturdy mechanical design, able to withstand the everyday operating environment common to transit maintenance facilities and as found in areas of vehicle maintenance lifts.

4. The conductor/collector system shall be of sufficient size to conduct all intermittent peak current requirements and a conductor of a cross sectional area of sufficient size for required mechanical strength.
 5. No special tools should be required for installation.
 6. The conductor system shall consist of all necessary conductor sections, hanger supports, insulators, anchor supports, feeder assemblies, expansion joint assemblies, collector (trolley) assemblies and/or special components.
 7. The Contractor shall submit to the Authority Representative plan and details of the Stinger System for review and approval, prior to procurement and installation.
- B. Acceptable Manufacturers
1. Manufacturer shall be ISO 9002 certified. The following manufacturers are approved for manufacture of the DC Stingerpower and control system:
 - a. WAMPFLER Products, Inc. or approved equal
- C. Construction:
1. Internal air clearance or solid dielectrics sufficient to withstand 4500 volt transient potentials on the DC power bus.
 2. Electrical rating of 600 Amperes, 800 VDC nominal.
 3. Design shall maintain pressure tolerances between bus bars and collector trolley pickups without frequent adjustment.
 4. Construction shall allow for longitudinal thermal expansion movement between bus structure and other assembly supporting components or housings. The design shall provide a continuous track giving the control trolley and the power take-off trolley complete freedom of travel over the entire length without any binding.
 5. The design shall maintain the full current carrying capacity throughout the system structure.
- D. Power Conductor:
1. A one piece copper trolley trough of required shape and configuration, with a flat contact surface for the trolley collector assembly, and suitable for the voltage rating.
 2. A current carrying capacity of 1000 amperes based on a 30 degree C rise over a 40 degree C ambient air having sufficient thermal capacity to withstand 300% overload for intermittent duty cycles.
 3. Design utilizing a conductor-supported collector having sufficient mechanical strength to support and electrically feed a 1000 ampere (nominal) rated collector (trolley) assembly (based on a 30 degree C rise over a 40 degree C ambient air).
 4. The conductor hangers shall be cast of a high strength aluminum alloy with an outer nylon coating. Hanger design to provide free conductor movement to accommodate thermal expansion or contraction of the conductor.
 5. No drilling or welding of the conductor rail at time of erection shall be necessary, only bolted connections. Splice joint, anchors, expansion joints and all other required appurtenances shall be provided and shall be manufactured from the same material as the conductor rail.
 6. The electrical efficiency of the components, e.g. splice joints, feeders and expansion joints shall not be less than an equal length of conductor.
 7. The internal and external supporting insulators of fiberglass reinforced polyester compound shall have a flashover strength of four times nominal system voltage when tested per ANSI C29.1 (1988) Electrical Power Insulators, Test methods.
 8. The roof truss-supported Stinger system shall have the conductor rail supported at 8-ft intervals (maximum) between support members center to center.
- E. Stinger Power Collector Trolley:

1. Rated 1000 volts DC, 600 amperes capacity and compatible with the DC power conductor with 300% intermittent overload capacity.
2. The collector or trolley shall be of a captive type design in that the complete assembly shall be supported by and guided by sets of roller wheels within pairs of "C" channel mounted in tandem with the power conductor as required.
3. The trolley housing shall be of NEMA type 4 /IEC 1 P65 enclosure construction.
4. Contact with the power bus shall be by pairs of contact shoes that are spring-loaded and shall be adjusted to permit free longitudinal movement of the complete trolley assembly along the power conductor.
5. Provide horizontal and vertical guide wheels (ball bearing, rubber molded type) as an integral part of the trolley assembly. Supply support wheels designed to carry the dead and come-along dynamic weight of trolley; power cable, and stinger assembly, including pull-off force of stinger from the traveling vehicle shoe. Design shall prevent a 20 degree angle side pull-along force from creating abnormal pressure and shall maintain contact shoe alignment.
6. Collector assembly to accommodate one power conductor as indicated on the Drawings. Provide solderless type pressure cable connectors and insulate connections using heat-shrinkable sleeves as manufactured by Raychem, 3M Products, or approved equal.
7. The complete trolley assembly will consist of a captive trolley for the main conductor and two auxiliary support and movement rollers mounted to a common bracket held in alignment by the captive trolley.
8. The cable connection between the trolley assembly and the stinger cable will be such that the force required to move the trolley assembly longitudinally along the conductor will not be fully placed on the connection itself. Provide strain-relief Kellems grip connectors to support the power cable at the trolley.

F. Stinger Control Station Collector Trolley:

1. The control of the DC power stinger shall be provided by a separate 3-pole AC collector assembly, control trolley take-off system that shall be constructed in tandem with the DC power stinger assembly as shown on the Drawings.
2. (3) conductor, rated 600 VAC, 60 amperes capacity and compatible with the AC multi-conductor control cable.
3. The collector or trolley shall be of a captive type design in that the complete assembly shall be supported by and guided by sets of roller wheels within pairs of "C" channel mounted in tandem with the power conductor as shown on the Drawings.
4. The trolley housing shall be of NEMA type 4 /IEC 1P65 enclosure construction.
5. Contact with the AC control bus shall be by pairs of contact shoes that are spring-loaded and shall be adjusted to permit free longitudinal movement of the complete trolley assembly along the control conductors.
6. Provide horizontal and vertical guide wheels (ball bearing, rubber molded type) as an integral part of the trolley assembly. Supply support wheels designed to carry the dead and come-along dynamic weight of trolley, control cable, and control station pushbutton assembly. Design shall prevent a 20 degree angle side pull-along force from creating abnormal pressure and shall maintain contact shoe alignment.
7. Collector assembly to accommodate (3) control conductors as indicated on the Drawings. Provide solderless type pressure cable connectors or terminal strip .
8. The complete control trolley assembly will consist of a captive trolley for the control conductors (two control wires and a ground) and two auxiliary support and movement rollers mounted to a common bracket held in alignment by the captive trolley.
9. The cable connection between the trolley assembly and the control cable will be such that the force required to move the trolley assembly longitudinally along the conductor will not be fully placed on the connection itself. Provide strain-relief Kellems grip connectors to support the control cable at the trolley.

G. Stinger Assembly

1. The DC power stinger assembly shall be provided with power cable, and service power tip. The control of the DC power stinger shall be provided by a separate 3-pole AC collector assembly, control trolley take-off system that shall be constructed in tandem with the DC power stinger assembly as shown on the Drawings.
2. The design shall meet space restrictions of vehicle lifts and vehicle clearances for safe working procedures.
3. Connection of the power and control cables to the stinger power cable and to the control pushbutton station and collector trolleys shall be via strain relief Kellems grip connectors.
4. Stinger assembly shall be furnished with an extra flexible, rope lay, stranded (class K in accordance with ASTM B172) #4/0 AWG, coated, annealed copper power cable, having low smoke and low toxic silicon rubber insulation thickness rated for 2kV in accordance with NEMA WC70. Provide low smoke, zero halogen crosslinked modified polyolefin jacket.
5. Provide hook on stinger and cable-mounted hanger for storage to facilitate operator to return trolley to starting position for next vehicle movement.
6. Provide end-of-run shock absorber assembly for both the stinger power trolley and the stinger control trolley.
7. Provide one (1) stinger assembly for each mobile collector trolley assembly and one (1) control station assembly for each mobile collector trolley assembly. The stinger assemblies and control station assemblies shall be furnished by the manufacturer of the collector busway and trolley assembly.

H. Control Station Assembly

1. The control station assembly shall be provided with control cable, and pendant-mounted single pushbutton control station.
2. The design shall meet space restrictions of vehicle lifts and vehicle clearances for safe working procedures.
3. Connection of the power and control cables to the stinger power cable and to the control pushbutton station and collector trolleys shall be via strain relief Kellems grip connectors.
4. Stinger assembly shall be furnished with an extra flexible, rope lay, stranded (class K in accordance with ASTM B172) #4/0 AWG, coated, annealed copper power cable, having low smoke and low toxic silicon rubber insulation thickness rated for 2kV in accordance with NEMA WC70. Provide low smoke, zero halogen crosslinked modified polyolefin jacket.
5. Provide hook on stinger and cable-mounted hanger for storage to facilitate operator to return trolley to starting position for next vehicle movement.
6. Provide end-of-run shock absorber assembly for both the stinger power trolley and the stinger control trolley.
7. Provide one (1) stinger assembly for each mobile collector trolley assembly and one (1) control station assembly for each mobile collector trolley assembly. The stinger assemblies and control station assemblies shall be furnished by the manufacturer of the collector busway and trolley assembly.

I. Supporting Insulators:

1. The mechanical and electrical properties of the DC conductor supporting insulator and the external mounting insulators shall meet the following requirements:
 - a. tensile strength 7000 lbs.
 - b. cantilever strength 12000 inch lbs.
 - c. compression strength 65000 lbs.

d.	torsional strength	150 (+) ft.-lbs.
e.	arc resistance	190 seconds - ASTM D495
f.	tracking resistance	1200 min. - ASTM D2302
g.	flame resistance	ASTM D635 Self-Extinguishing Federal LP406b - 164/31
h.	creep distance	plate to plate - 2 7/8 inches (min) insert to insert 3 3/16 inches (min)
i.	dielectric strength	(a) dry - 40 kV minimum (b) wet - 19 kV minimum
j.	impulse	80 kV minimum - (1.5 x 40 wave)

J. Additional System Parameters

1. Operational safety of the stinger system shall require any personnel to be remote from the vehicle movement. It also requires that disengagement of the vehicle shoe clamp be accomplished as a NON-LOAD BREAK operation.
2. Trolley end stop bumper will permit "pull-off" of the stinger from the vehicle collector shoe and will stop trolley travelling at a speed of 5 mph without damage to trolley or overhead busway system (power and control conductors).

K. System Operation:

1. All stinger cable assemblies, control station cable assemblies, power and control system wiring, and auxiliary devices shall permit the following sequence of operation.
 - a. DC voltage to the service power tip is off.
 - b. To make a move, the operator places the stinger service power tip on the vehicle shoe
 - c. The operator then presses the control station momentary pushbutton and continues to press it. Immediately rotating red lights and horns will operate. After a preset time delay (15 seconds), associated DC contactor is energized, and DC traction power is available at the service tip and the vehicle will begin to move.
 - d. Movement is permitted to continue as long as the momentary pushbutton is pressed.
 - e. The control circuit "power on" function is disabled if any emergency (maintained) pushbutton stations are pressed.
 - f. At Brentwood Shop, only one (1) of the stinger systems can be operated at any given time
 - g. at Shady Grove Shop, only one (1) of the stinger systems can be operated at any given time
 - h. After the move is made, the stinger control station momentary pushbutton is released. DC supply power is removed. The stinger is stored on its cable hanger.

L. Control Stations

1. Cord-mounted pendant-type single pushbutton control stations shall have NEMA 4/4X stainless steel enclosure.
2. Flush head momentary pushbutton with 10 ampere rated contacts in accordance with NEMA A600.
3. Acceptable manufacturers shall be Allen-Bradley or approved equal.

M. Relays and Timers

1. All control relays and timers for the operation of the stinger system shall be of the heavy duty industrial type having screw type wire terminals or plug-in sockets. Provide sockets and all mounting hardware for the complete control system.
2. Acceptable Manufacturers

- a. Agastat
- b. Square D Co.
- c. ASCO
- d. Potter Brumfield
- e. Allen Bradley
- f. Approved equal.

N. Contactors

Contactors shall be normally open, magnetically held, single pole, load break with 8-hour enclosed rating of 1250 amperes inductive load at 1000 volts dc. Each contactor shall be provided with silver alloy, adjustable and readily replaceable contacts. The contactor shall have a minimum life under full load conditions of 100,000 cycles. Each pole shall be equipped with a current coil type magnetic blow-out which will provide directed control of the arc away from the current carrying contact surfaces. Each of the contactors shall be supplied with a minimum of two (2) N.O. auxiliary contacts and two (2) N.C. auxiliary contacts rated at 10 amperes. The short-circuit withstand capability shall be coordinated with the available peak-through current of the dc distribution system and shall be sufficiently large so that no damage to the contactor or its enclosure is done during the time it takes the feeder circuit fuse to clear the fault. The contactor shall be controlled with a 120V ac rated coil capable of remote control operation. An internally-mounted 120 volt ac toggle switch which shall disconnect the control power shall be provided. Each contactor shall be provided with a non-metallic NEMA 4 enclosure.

O. Warning Devices

- 1. Provide warning devices to indicate presence of 750 VDC in areas having controlled DC stinger power.
- 2. Provide a warning device circuit, driven by one of the N.O. auxiliary contacts on the stinger contactor, to provide an alarm if the stinger contactor fails to open.
- 3. All stinger areas shall be provided with rotating red lights for visual indication and warning horns for audible indication in the shop areas served by the stinger systems.

P. Spare Parts

- 1. The Contractor shall furnish spare components, parts and service tools as follows:
 - a. (1) - Stinger Power Trolley assembly, complete.
 - b. (1) - Stinger Control Trolley assembly, complete.
 - c. (2) - DC Stinger power cable assemblies, complete (service power tip furnished by WAMTA).
 - d. (2) - DC Stinger control cable assemblies, complete with control station.
- 2. All spare parts shall be packaged in manufacturer's standard cartons, properly labeled and delivered to a location designated by the Authority Representative that is within 20 miles of the Project's location.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Refer to wire and cable sizes or single line diagrams and control ladder diagrams for size and quantity of wires required for the installation.
- B. Clean installed products of this Specification Section where deposits of oil, grease, dirt, dust, mud or debris is present after installation.

- C. Follow the recommendations of the stinger equipment manufacturer that pertain to the start-up and operation of the DC stinger systems.

3.02 FIELD TEST FOR EQUIPMENT OPERATION

- A. Perform the following tests and submit certified test reports to the Authority Representative. Furnish, at no cost to WAMTA, all test equipment, materials, and labor required to perform the tests.
- B. Test performance and operation of the DC stinger system and DC contactor systems and operating procedures, to the satisfaction of the Authority Representative.
 - 1. Testing of controls shall consist of operating each control not fewer than five times.
 - 2. Testing of power circuits and operational procedure shall consist of energizing each stinger bus and provide actual traction power to a married-pair.

END OF SECTION

SECTION 16122

CONTACT RAIL CABLE CONNECTOR ASSEMBLIES FOR TRACTION POWER

PART 1. GENERAL

1.01 SUMMARY

- A. This section specified fabricating, testing and furnishing contact rail cable connector assemblies as specified.
- B. Related Sections
 - 1. Section 16123 - Contact Rail Insulator Assembly For Traction Power
 - 2. Section 16124 - Contact Rail Protection Cover For Traction Power
 - 3. Section 16126 - Contact Rail Anchor Assembly For Traction Power
 - 4. Section 16127 - Contact Rail System Installation For Traction Power
 - 5. Section 16128 - Wire and Cable For Traction Power
- C. Payment and Measurement:
 - 1. Cable Connector Assembly: Lump sum, no separate measurement.

1.02 REFERENCES

- A. Codes, regulations, references, standards and specifications:
 - 1. Does not apply.

1.03 QUALITY ASSURANCE

- A. Testing: Conduct specified testing at no additional cost to the Authority.
 - 1. Compression connectors:
 - a. Prototype testing:
 - 1) Prior to production, assemble three compression connectors on 1,000-KCMIL 2,000-volt cable for use as test connections.
 - 2) Electrical resistance test:
 - a) Procedure:
 - (1) Remove insulation from cable portion of test connectors.
 - (2) Measure resistance between the cable and connector tongue with digital low resistance ohmmeter.
 - (3) With a 10 amp test current, digital low resistance ohmmeter (Kelvin Bridge Type) measure resistance of equivalent length of 1,000-KCMIL 2,000-volt cable.
 - b) Acceptance criteria:
 - (1) Electrical resistance for connection equal to or less than that of equivalent length of 1,000-KCMIL 2,000-volt cable.
 - 3) Tension test:
 - a) Procedure:
 - (1) Subject test connections to sustained tension of 5,000 psi of the nominal conductor cross-sectional

- area for three hours.
 - (2) Retest for electrical resistance after three hours.
 - b) Acceptance criteria:
 - (1) No slipping of cable in connector.
 - (2) No deformation.
 - (3) No increase of electrical resistance beyond that specified.
 - 4) Production Testing:
 - a) After successful prototype testing, production may commence.
 - (1) Prior to delivery, randomly select one percent of each production lot and subject to specified electrical resistance and tension tests.
 - 5) Insulating covers:
 - a) Production testing:
 - (1) Procedure:
 - (a) Prior to delivery, randomly select one percent of each production lot of insulating covers and test insulation resistance at thinnest portion with 1,000-volt dc megohmmeter.
 - (2) Acceptance criteria:
 - (a) Insulation resistance: 1,000,000 ohms minimum.
 - (b) If one insulator cover of a lot fails insulation resistance test, entire lot will be rejected.

1.04 SUBMITTALS

Submit the following in accordance with the Division 1 and with the additional requirements specified for each.

- A. Shop Drawings: Fabrication of cable connector assemblies. Use of drawings for manufacture or fabrication prior to approval is not permitted.
- B. Certification:
 - 1. Certifications that all cable connector assemblies meet or exceed specified requirements.
 - 2. Test procedures.
 - 3. Certified test reports.
 - 4. Method of packaging: Submit prior to packaging and shipping.

PART 2: PRODUCT

2.01 MANUFACTURERS

- A. Cable Connector Assembly
 - 1. MAC Products, Inc. No. B-9180 or equal.
 - 2. SELCO Manufacturing Corp., No. 2610 or equal.

2.02 COMPONENTS

- A. Furnish cable connector assemblies in accordance with the following requirements:
 - 1. Lug: Compression type.
 - 2. Material: 98-percent pure copper. Tongue:
 - 3. Not less than 9/16-inch thick, with fourholes and drilled for 1/2-inch bolts on 1-3/4 inch centers.
 - 4. Complete with silicon-bronze flat washers, lock washers, nuts and bolts.

2.03 INSULATING COVER AND ACCESSORIES

- A. Furnish insulating cover and accessories in accordance with the following requirements:
 - 1. Type: Two-piece.
 - 2. Material: Glass-reinforced polyester.
 - 3. Thickness: Not less than 0.125-inch.
 - 4. Color: Orange.
 - 5. Watertight.
 - 6. Complete with neoprene gaskets, sealing collars and captive screw fasteners.
 - 7. Each assembly, except sealing collar, capable of easy disassembly.

2.04 FABRICATION

- A. Procedures and tooling to be recommended by the manufacturer and strictly complied with by the installer.

PART 3: EXECUTION - Not Used

END OF SECTION

THIS PAGE NOT USED

SECTION 16123

CONTACT RAIL INSULATOR ASSEMBLY FOR TRACTION POWER

PART 1 - GENERAL

1.01 SUMMARY

- A. This section specifies fabricating, testing and furnishing contact rail insulator assemblies as shown and specified.
- B. Related Sections:
 - 1. Section 16122 - Contact Rail Cable Connector Assemblies For Traction Power
 - 2. Section 16124 - Contact Rail Protection Cover Assemblies For Traction Power
 - 3. Section 16126 - Contact Rail Anchor Assembly For Traction Power
 - 4. Section 16127 - Contact Rail System Installation For Traction Power
 - 5. Section 16128 - Wire and Cable For Traction Power
- C. Payment and measurement:
 - 1. Compensation for work specified in this section will be made in the following manner:
 - a. Materials: Lump sum, no separate measurement.

1.02 REFERENCES

- A. Codes, regulations, references, standards and specifications.
 - 1. ASTM A47.
 - 2. ASTM A153.
 - 3. ASTM A164.
 - 4. ASTM D149.
 - 5. ASTM D229.
 - 6. ASTM D256.
 - 7. ASTM D495.
 - 8. ASTM D570.
 - 9. ASTM D638.
 - 10. ASTM D648.
 - 11. ASTM D695.
 - 12. ASTM D790.
 - 13. ASTM D2000
 - 14. ASTM D2303.
 - 15. ANSI B4.1.
 - 16. ANSI B18.2.1.
 - 17. ANSI B18.2.2.
 - 18. ANSI C29.1.
 - 19. ANSI C29.5.
 - 20. UL 94

1.03 QUALITY ASSURANCE

- A. Testing
 - 1. Perform specified testing by a nationally recognized independent testing laboratory at no additional cost to the Authority.

2. The Contractor shall notify the Authority Representative fourteen (14) days in advance of the commencement of testing, including preparation of the test equipment for testing. Testing shall be performed in the presence of the Authority Representative.

B. General testing

1. Randomly select a minimum of one percent of each production lot of 500 insulators of each type as test specimens.
2. Subject specimens to the following tests:
 - a. Electrical resistance test:
 - 1) Procedure:
 - a) Immerse each specimen in water at room temperature.
 - b) After 70 hours, remove and dry thoroughly.
 - c) Provide complete contact by use of wet clay pads on top and bottom of specimen.
 - d) Measure resistance to each specimen with 1,000-volt dc megohm meter or other approved device.
 - 2) Acceptance criteria:
 - a) Electrical resistance: Not less than eight megohms.
 - b) If one insulator of a lot fails, entire lot will be rejected.
 - b. Impulse withstand voltage test.
 - 1) Procedure: In accordance with ANSI C29.1.
 - 2) Acceptance criteria:
 - a) Dry withstand voltage: 30 kV at 60 Hertz for one minute.
 - b) Wet withstand voltage: 20 kV at 60 Hertz for ten seconds.
 - c) If one insulator of a lot fails, the entire lot will be rejected.
3. Insulators used as test specimens prohibited as part of quantity furnished.

C. Porcelain insulators:

1. Impulse flash-over voltage test:
 - a. Subject all insulators to routine flash-over test.
 - b. Procedure: In accordance with ANSI C29.1.
 - c. Acceptance criteria:
 - 1) Insulator and glazing to remain intact.
 - 2) If an insulator fails the flash-over test, it will be rejected.
2. Mechanical test:
 - a. Randomly select a minimum of one percent of each lot of 500 insulators as test specimens.
 - b. Procedure:
 - 1) Attach each insulator and mounting base to oak block.
 - 2) Mount each assembly on rigid foundation simulating service conditions.
 - 3) Place on top of each insulator one of the following type pads:
 - a) Lead: 1/4 inch thick
 - b) Canvas: 1/16 inch thick
 - 4) Attach to malleable iron cap a hardened steel disc 1/2 inch thick and equal in diameter to cap. Place both atop each insulator pad.
 - 5) Subject each test specimen to 10 blows of 15-pound spherical iron weight dropped from height of 36 inches.
 - c. Acceptance criteria:
 - 1) No cracks or fractures.

- 2) If 50 percent or more of specimens fail, entire kiln-lot represented by specimens tested will be rejected.
3. Porosity test:
 - a. From insulators destroyed in other tests, randomly select ten specimens.
 - b. Procedure: In accordance with ANSI C29.1.
 - c. Acceptance criteria:
 - 1) No evidence of penetration of dye into test specimen to an extent visible to the unaided eye.
 - 2) If one insulator of a lot fails, entire lot will be rejected.
4. Insulators used as test specimens prohibited as part of quantity furnished.
5. Verification:
 - a. Compatibility of components of porcelain insulator assemblies:
 - 1) Prior to shipment, randomly select a minimum of one percent of each production lot of 500 of each component.
 - 2) Assemble to ensure that components mate properly.
 - 3) If one assembly fails to meet compatibility requirements, entire lot will be rejected.

1.04 SUBMITTALS

- A. Shop Drawings:
 1. The Contractor shall submit for approval shop drawings for fabrication of the component and assemblies of the contact rail insulators, showing tolerances for all dimensions. No fabrication or manufacture shall be performed prior to drawing approval.
- B. Samples:
 1. One complete insulator assembly for each type.
- C. Documentation:
 1. Certification that all insulator assemblies furnished meet or exceed specified requirements.
 2. Detailed engineering data on materials used in the manufacture of insulator assemblies.
 3. Fabrication details.
 4. Name of proposed independent testing laboratory.
 5. Detailed description of quality control program. Work performed prior to approval is undertaken at the Contractor's risk.
 6. Calibration certificates for quality control testing equipment.
 7. Certified test reports. Submit no later than seven days after completion of tests.
 8. Method of packaging. Submit prior to packaging and shipping.

PART 2 - PRODUCT

2.01 MATERIALS

- A. Furnish porcelain contact rail insulator assemblies in accordance with the following requirements:
 1. General Requirements
 - a. New and undamaged.
 - b. Symmetrical

- c. Free of cracks, voids, air pockets, lamination, metallic substances or other defects rendering them unsuitable for intended service.
 - d. Meeting or exceeding acceptance criteria of specified tests.
 - e. Indelibly marked on underside with model number and identification of manufacturer.
 - f. Rated for a nominal voltage of 750 volts dc.
 - g. Minimum creepage distance over external surface of insulator from energized metal components to ground or to insulator fasteners: Eight inches minimum.
 - h. Resistant to weathering and sudden changes in atmospheric temperature from plus 150F to minus 20F.
 - i. Impervious to moisture, acid and alkali.
 - j. Suitable for use on wood ties and for direct fixation to concrete invert.
 - k. Color: Uniform gray matching sample available from the Authority Representative.
 - l. Designed for composite rail specified in Section 05661 with free-end-to-anchor distance of 500 feet and temperature range of plus 150F to minus 20F.
 - m. Compatible with protection cover assemblies specified in Section 16124, contact Rail Protection Cover Assembly.
2. Porcelain Insulators
- a. Design porcelain insulator assemblies as a system.
 - b. Manufacture components to tolerances ensuring that each component is compatible with all other components.
 - c. Insulators:
 - 1) Material:
 - a) Wet process porcelain, ANSI C29.5.
 - b) Close grained, homogenous and non-absorbent.
 - 2) Dimensions: As shown.
 - 3) Tolerances:
 - a) Variation of maximum dimension between top and bottom face: Plus or minus one percent.
 - b) Variation of diameter of holes from that shown: Plus or minus 1/8 inch.
 - c) Variation of other dimensions: Plus or minus one percent.
 - 4) Glazing:
 - a) Smooth, hard, firmly adherent coating of uniform thickness.
 - b) Continuous over entire surface except as shown.
 - c) Free of checks and bubbles which extend completely through glaze.
 - d) Thermal expansion properties equal to porcelain material used.
 - d. Other components:
 - 1) Malleable iron castings:
 - a) ASTM A47, Grade 32510.
 - b) Free from imperfections.
 - c) Finished surface: Smooth. Grinding to ensure accurate fit with adjoining parts is permitted.
 - d) Galvanized.
 - 2) Tolerances: ANSI B4.1.

- 3) Hardware:
 - a) Dimensions and type: As shown.
 - b) Bolts: Steel, chemical and mechanical requirements in accordance with ANSI B18.2.1, galvanized.
 - c) Nuts: Steel, ANSI B18.2.2, galvanized.
 - d) Neoprene cushions, rings and pads: ASTM D2000, 1BC415.
- 4) Galvanizing:
 - a) ASTM A153 or ASTM A164, Type GS.
 - b) Prior to coating perform the following:
 - (1) Shot blast finished parts in accordance with SSPC-SP-6, except maximum grit size to be SAE G-18, or pickle finished parts in diluted sulfuric acid.
 - (2) Thoroughly remove scale.
 - (3) Thoroughly clean with cold running water.
 - c) Immerse parts in solution of zinc chloride or hydrochloric acid.
 - d) Dry thoroughly.
 - e) Subject parts to zinc bath.

PART 3 - EXECUTION Not Used

END OF SECTION

THIS PAGE NOT USED

SECTION 16124

CONTACT RAIL PROTECTION COVER ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY

- A. This section specifies designing, fabricating, testing and furnishing contact rail protection cover assemblies, including expansion joint protection cover assemblies, as shown and specified. All protection cover assemblies shall be type B.
- B. Related Sections
 - 1. Section 05661 - Contact Rail and Appurtenances For Traction Power
 - 2. Section 16123 - Contact Rail Insulator Assembly For Traction Power
 - 3. Section 16126 - Contact Rail Anchor Assembly For Traction Power
 - 4. Section 16127 - Contact Rail System Installation For Traction Power
 - 5. Section 16128 - Wire and Cable For Traction Power
 - 6. Section 16294 - Contact Rail Heating System For Traction Power
- C. Payment and measurement:
 - 1. Compensation for work specified in this section will be made in the following manner:
 - a. Material - Lump sum, no separate measurement.

1.02 REFERENCES

- A. Codes, regulations, references, standards and specifications:
 - 1. ASTM - A123
 - 2. ASTM - A153
 - 3. ASTM - A313
 - 4. ASTM - A325
 - 5. ASTM - B633
 - 6. ASTM - D149
 - 7. ASTM - D229
 - 8. ASTM - D256
 - 9. ASTM - D570
 - 10. ASTM - D1499
 - 11. ASTM - E84
 - 12. ASTM - G23

1.03 SYSTEM DESCRIPTION

- A. Type B: is a top protection cover for installation in at-grade locations to accommodate the contact rail heating system.

1.04 SUBMITTALS

Submit the following for review in accordance with the Division 1 and with the additional requirements as specified for each:

- A. Shop Drawings:
 1. The Contractor shall in accordance with Division 1 submit for approval shop drawings showing the design and fabrication of contact rail protection cover assembly.

- B. Documentation:
 1. Certification that protection cover assemblies furnished meet or exceed specified requirements.
 2. Detailed engineering data on materials used in manufacture of protection covers.
 3. Fabrication details.
 4. Name of proposed testing laboratory.
 5. Detailed description of quality control Program. Work performed prior to approval is undertaken at the Contractor's risk.
 6. Calibration certificates for quality control testing equipment.
 7. Certified test reports. Submit no later than seven days after completion of tests.
 8. Method of packaging. Submit prior to packaging and shipping.

1.05 QUALITY ASSURANCE

- A. Testing: Have specified testing performed by a nationally recognized testing laboratory at no additional cost to the Authority. The Contractor shall notify the Authority Representative fourteen (14) days in advance of the commencement of testing, including preparation of the test equipment for testing. Testing shall be performed in the presence of the Authority Representative.
 1. Material testing: Prior to fabrication, furnish one test specimen for performance of the following tests:
 - a. Water absorption test:
 - 1) Procedure: Test in accordance with ASTM D570.
 - 2) Acceptance criteria: Maximum absorption rate not exceeding 0.50 percent in 24 hours.
 - b. Flammability tests:
 - 1) Flame resistance:
 - a) Procedure: Test in accordance with ASTM D229.
 - b) Acceptance criteria: Maximum burning time: ten seconds.
 - 2) Flame spread:
 - a) Procedure: Test in accordance with ASTM E84.
 - b) Acceptance criteria:
 - (1) Flame spread: UL-listed, Class A Incombustible with classification not exceeding 25.
 - (2) Chlorine content: Not exceeding that which will emit more than 10 ppm.
 - c. Dielectric test:
 - 1) Procedure: Test in accordance with ASTM D149, Short Time Method.
 - 2) Acceptance criteria: Not less than 250 volts per mil.
 2. Type testing: Prior to fabrication, furnish five rail protection cover assemblies with brackets set at widest spacing shown, as test specimens for performance of all specified tests on contact rail protection cover assemblies and specified mechanical load tests on expansion joint protection cover assemblies.
 - a. Mechanical load test:
 - 1) Procedure: Perform the following in the order given:



- a) Mount protection cover assembly on length or contact rail or approved equivalent.
- b) Static load test:
 - (1) Use 250-pound weight with bottom measuring six inches by twelve inches.
 - (2) Place weight on protection cover at point selected by Authority Representative.
 - (3) One cycle consists of applying weight to assembly for 30 seconds, removing it, and reapplying it 60 seconds later.
 - (4) Test duration: Fifty cycles.
- c) Impact resistance test:
 - (1) Use 250-pound weight with bottom measuring 18 inches square.
 - (2) Drop weight from height of 18 inches onto portion of protection cover directly above centerline of rail and directly above bracket.
 - (3) Subsequently, drop weight from height of 18 inches onto point on protection cover midway between two adjacent support brackets.
- 2) Acceptance criteria:
 - a) Maximum permissible deflection at centerline of rail: 1-½ inches, at all times.
 - b) No splits, cracks or breaks.
 - c) Permanent deformation: Not exceeding 1/8 inch.
 - d) No violation of clearance envelope shown.
- b. Insulation resistance test:
 - 1) Procedure:
 - a) Conduct after mechanical load test.
 - b) Measure resistance between a point in contact with rail and a point on surface of protection cover assembly with 1,000-volt dc megohm meter.
 - 2) Acceptance criteria:
 - a) Resistance: 1,000,000 ohms minimum.
- c. Longevity test:
 - 1) Procedure:
 - a) Expose test specimens to light and water in accordance with ASTM G23 and ASTM D1499.
 - b) Total exposure time: 3,600 hours.
 - c) With 1,000-volt dc megohm meter, test insulation resistance through thinnest portion of protection cover.
 - 2) Acceptance criteria:
 - a) No visible evidence of deterioration.
 - b) Resistance: 1,000,000 ohms minimum.
- d. Izod impact strength test:
 - 1) Procedure:
 - a) Perform after longevity test in accordance with ASTM D256, Method A.
 - 2) Acceptance criteria:
 - a) Average izod impact strength: Four foot-pounds per inch of width.
- e. Production testing:

- 1) General requirements:
 - a) Production testing specified constitutes minimum requirements.
 - b) All components subject to full or partial testing at the discretion of the Authority Representative.
 - c) Items used for testing not to be included in quantities furnished.
 - d) All facets of production testing, particularly location of facility and repair, capacity and calibration of test equipment, subject a approval.
 - e) Notify Authority Representative 14 calendar days prior to scheduled testing dates.
- 2) Procedure:
 - a) Select one percent of protection covers produced in such a way that each group of five specimens represents identifiable lots of 500 lengths of protection cover and 1500 support brackets.
 - b) Subject test specimens to specified mechanical load and resistance rests specified under type testing.
- 3) Acceptance criteria:
 - a) As specified for type testing for mechanical load and resistance.
 - b) If one protection cover assembly of a lot fails to meet requirements, test additional 10 specimens from same lot. If one assembly of additional specimens fails to meet specified requirements, entire lot will be rejected.

PART 2 -PRODUCTS

- A. Design: Design protection cover assembly to meet the following requirements:
 1. Prevention of accidental contact with energized rail components.
 2. Assurance of unimpeded passage of current collector mounted on transit vehicle.
 3. Resistance to sagging produced by intrinsic weight or external loads and forces.
 4. Ease of dismounting and remounting without disassembly of support bracket. Fasteners to be easily removable and reusable.
 5. Configuration:
 - a. Similar to configuration shown.
 - b. Cover not to be integral part of support bracket.
 - c. Basic geometry of cover, curved or chorded.
 - d. Fabricated in 10-foot lengths.
 - e. Continuous and uniform. Gaps at support brackets not exceeding 1/16 inch.
 - f. Support brackets at three-foot four-inch intervals, for Type B protection cover and as shown.
 - g. Arrangement of brackets at expansion joints as shown.
 - h. Assembly to lie within clearance envelope shown.
 6. Compatible with the composite contact rail specified in Section 05661.
- B. Material: Fabricate protection covers of material meeting the following requirements
 1. Glass-reinforced plastic.
 2. No separation or warpage under service conditions during 30-year life expectancy.
 3. Flame spread, flame resistance, chlorine content, water absorption and dielectric

- strength: In accordance with specified testing.
4. Outer surface coated with polyurethane paint, 1.5 mils minimum dry film thickness.
 5. Color: Gray, to match specimen available from the Authority Representative.

C. Support Brackets: Furnish support brackets meeting the following requirements:

1. Design: Two-piece consisting of bracket and clamp as shown.
 - a. Configuration: Compatible with protection cover and with composite contact rail specified in Section 05661.
2. Material: Same as that of protection cover.

D. Nuts, Bolts, and Miscellaneous Hardware:

1. Material
 - a. All nuts, bolts, and flat washers shall be manufactured in accordance with ASTM A325.
 - b. The dimensional data and type hardware for all nuts, bolts and miscellaneous parts shall be recommended by the manufacturer. All steel bolts, nuts, screws and washers shall be galvanized as specified.
 - c. Spring washers shall be manufactured in accordance with the requirements of ANSI B18.21.1.
 - d. Hair pin cotter pins shall conform to the requirements of ASTM A313, Stainless Steel 304.
2. Galvanizing:
 - a. All parts to be galvanized shall be galvanized after manufacture. Unless otherwise specified, parts to be galvanized shall be coated in accordance with the requirements of ASTM A123.
 - b. Bolts and miscellaneous hardware shown or specified to be galvanized shall be coated in accordance with ASTM A153 or alternate method in accordance with ASTM B633 Type I SC-2 for threaded items and SC-3 without threads.
 - c. Before galvanizing, the finished parts shall be pickled or sandblasted and the scale and adhering impurities removed. The pickling shall be done in properly diluted sulfuric acid, after which the parts shall be thoroughly cleaned in running cold water. Sandblasting shall meet or exceed Steel Structures Painting Council SSPC-SP-6, except that the maximum grit size shall be SAE No. G-18. The parts shall then be immersed in a solution of zinc chloride or hydrochloric acid. Immediately following thorough drying, the parts shall be dipped into the zinc bath before corrosion starts again.

PART 3: EXECUTION- Not Used

END OF SECTION

THIS PAGE NOT USED

SECTION 16125

WIRE CONNECTION ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing wire-connection accessories, such as connectors, terminal lugs and fittings, bundling straps, insulating tape and resin.

1.02 QUALITY ASSURANCE:

- A. Qualifications: Select a manufacturer who is engaged in production of similar wire connection accessories.
- B. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
 2. National Electrical Code (NEC).
 3. UL: 486A, Wire Connectors and Soldering Lugs for Use With Copper Conductors.
 4. American Standards of Testing and Materials (ASTM): D149-97a, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies; D257-99, Standard Test Methods for DC Resistance or Conductance of Insulating Materials; D412-98a, Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension; D570-98, Standard Test Method for Water Absorption of Plastics; D638-00, Standard Test Method for Tensile Properties of Plastic; D696-98, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 C and 30 C with a Vitreous Silica Dilatometer; D792-00, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement; D1000-99, Standard Test Method for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications; D1518-85(1998)e1, Standard Test Method for Thermal Transmittance of Textile Materials; D5034-95, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test); D5035-95, Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method); D2240-00, Standard Test Method for Rubber Property-Durometer Hardness; and G21-96, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 5. American National Standards Institute (ANSI): C119.1, Sealed Insulated Underground Connector System 600V
 6. ITS: Directory of ITS Listed Products.
- C. Source Quality Control:
1. Connectors, terminal lugs and fittings listed, per referenced UL or ITS directory.
 2. Factory testing: Submit certified copies of test report for cable splice and tap-insulation/sealing kits as specified.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings.
- B. Certification.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Mark each item in accordance with applicable reference standard.
- B. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage.
- C. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Connectors, Terminal Lugs and Fittings:
 - 1. In accordance with UL 486A.
 - 2. For 10AWG and smaller conductor cable: Tin-plated copper pressure connectors with nonflammable, self-extinguishing insulation grip with temperature rating equal to that of conductor insulation.
 - 3. For 8AWG to 4/0 AWG conductor cable: Tin-plated copper compression connectors and terminal lugs with nylon insulating sleeve for insulation grip.
 - 4. For 250 Kcmil and larger conductor cable: Long-barrel, double-compression tin-plated copper connectors and terminal lugs with two-hole pad.
 - 5. For multiple-conductor cable: Watertight aluminum fittings with stainless-steel pressure ring and set screws or compression cone for grounding of aluminum sheath of MC cable.
- B. Bundling Straps:
 - 1. Self-locking steel barb on one end, with tapered strap of self-extinguishing nylon, temperature rating minus 40F to plus 185F.
 - 2. For outdoor use: Ultraviolet-resistant.
- C. Insulating Tape:
 - 1. Plastic tape: Vinyl plastic tape with rubber-based pressure-sensitive adhesive, pliable at zero degree F with the following minimum properties when tested in accordance with ASTM D1000-99:
 - a. Thickness: 8.5 mils.
 - b. Breaking strength: 20 pounds per inch width.
 - c. Elongation: 200 percent.
 - d. Dielectric breakdown: 10,000 volts.
 - e. Insulation resistance, indirect method of electrolytic corrosion: 1,000,000 megohms.
 - 2. Rubber tape: Silicone-rubber tape with silicone pressure-sensitive adhesive, with the following minimum properties when tested in accordance with ASTM D1000-99:
 - a. Thickness: 12 mils.
 - b. Breaking strength: 13 pounds per inch width.
 - c. Elongation: 525 percent.
 - d. Dielectric breakdown: 13,000 volts.
 - e. Insulation resistance, indirect method of electrolytic corrosion: 1,000,000 megohms.

3. Arcproof tape: Flexible, coated one side with flame-retardant flexible elastomer, self-extinguishing, non-combustible, with the following minimum properties:
 - a. Thickness, ASTM D1000: 30 mils.
 - b. Breaking strength, ASTM D5034-95 and D5035-95: 50 pounds per inch width.
 - c. Thermal conductivity, ASTM D1518-85: 0.0478 BTU per hour per square foot per degree F.
 - d. Electrical arc resistance: Withstand 200 amperes arc for 30 seconds.
4. Glass tape: Woven-glass fabric tape with pressure-sensitive thermosetting adhesive, with the following minimum properties when tested in accordance with ASTM D1000-99:
 - a. Nominal width: 3/4 inch.
 - b. Thickness: Seven mils.
 - c. Breaking strength: 170 pounds per inch width.
 - d. Elongation: Five percent.
 - e. Dielectric breakdown: 2,500 volts.
 - f. Insulation resistance, indirect method of electrolytic corrosion: 5,000 megohms.

D. Epoxy Resin: Suitable for insulating and moisture sealing cable splices, with the following minimum properties:

1. Dielectric strength, ASTM D149-97a: 400 volts per mil.
2. Volume resistance, ASTM D257-99: 2.8×10^{15} ohm per centimeter cube at 30C.
3. Water absorption, ASTM D570-98:
 - a. 0.193 percent in 24 hours at 23C.
 - b. 0.62 percent in 24 hours at 53C.
4. Tensile strength, ASTM D638-00: 8,000 psi.
5. Elongation, ASTM D638-00: 2.4 percent.
6. Coefficient of expansion, ASTM D696-98: 6.8×10^{-5} inch per inch per degree C.

E. Cable splice and tap-insulation/sealing kit: Suitable for use on 600-volt, 90C cables, material compatible with cable insulation and jacket, meeting the seal test requirements of ANSI C119.1.

1. Heat-shrinkable tubing or wraparound heat-shrinkable sleeve: approved per referenced UL or ITS directory, flame-retardant, corrosion-resistant thick-wall tubing with factory-applied sealant for field insulation on in-line splices and taps or wraparound-type sleeve for retrofit installation on existing splices and taps to provide a watertight seal and insulating encapsulation, with the following additional requirements:
 - a. Material: Cross-linked polyolefin.
 - b. Shrink ratio: 3 to 1 minimum.
 - c. Physical properties:
 - (1) Ultimate tensile strength: 2,350 psi, ASTM D412-98a.
 - (2) Ultimate elongation: 350 percent, ASTM D412-98a.
 - (3) Hardness, Shore D: 42, ASTM D2240-00.
 - (4) Water absorption: 0.050 percent, ASTM D570-98, Method 6.1.
 - (5) Specific gravity: 1.28, ASTM D792-00.
 - d. Electrical properties:
 - (1) Dielectric strength: 450 volts per mil, ASTM D412-98a.
 - (2) Volume resistivity: 1×10^{14} ohm cm, ASTM D257-99.
 - e. Thermal properties:
 - (1) Continuous operating temp.: -55C to +135C.
 - (2) Air oven aging (14 days at 175C):
 - (a) Tensile strength: 2,680 psi.
 - (b) Elongation: 375 percent.

- (3) Low temp. flexibility (4 hours at -55C): No cracking when flexed.
- (4) Heat shock (4 hours at 250C): No cracking, flowing or dripping.
- f. Chemical properties:
 - (1) Corrosivity: Non-corrosive.
 - (2) Fungus resistance: Non-nutrient, ASTM G21-96.
 - (3) Flammability: Self-extinguishing.
 - (4)

PART 3 - EXECUTION

3.01 SPLICES AND TERMINATIONS:

- A. Make wire and cable splices in outlet, junction or pull boxes, in cable troughs or in equipment cabinets. Splices in conduit are prohibited.
- B. Secure connectors or terminal lugs to conductor so as to engage all strands equally.
- C. Do not rupture insulation nor expose bare conductors.
- D. Install compression connectors and terminal lugs using tools and pressure recommended by manufacturer. Indent mark connectors and terminal lugs with number of die used for installation.
- E. Apply anti-corrosion joint compound to connectors, terminal lugs and bolting pads before installation.
- F. Wrap ½-lapped layer of arcproof tape, glass tape overall on cable splices installed in air tunnels, ducts and shafts.
- G. Install terminal fittings on multiple-conductor cable in accordance with manufacturer's recommendation. Completely seal cable from moisture.
- H. On cable splices, taps and terminations in manhole handhole and outdoor junction and pull boxes, cover connectors with electrical putty, wrapped with three layers of plastic tape or final layer of rubber tape and then install watertight encapsulation as follows and under the supervision of kit manufacturer's representative or using a factory-certified installation technician, proficient in field installation of heat-shrinkable sealing kits.
 - 1. Use heat-shrinkable tubing for encapsulation of new splices, taps and terminations.
 - 2. Use wraparound-type heat-shrinkable sleeve for encapsulation of existing splices, taps and terminations.

3.02 CATHODIC PROTECTION SPLICES AND TERMINATIONS:

- A. For splices made in aboveground cable, use compression connectors covered with electrical putty, wrapped with three layers of plastic tape and final layer of rubber tape.
- B. Install compression terminal lugs using tools and pressure recommended by manufacturer. Indent mark terminal lugs with number of die used for installation.
- C. For splices made in direct-burial cable, use thermit weld sealed with cast epoxy-resin encapsulation.

3.03 INSPECTION:

- A. Have splices in direct-burial cable for stray current and cathodic protection inspected by the Engineer before backfilling.
- B. Have splices and taps in manholes, handholes and outdoor junction and pull boxes inspected by the Engineer or the manufacturer's representative, when available.

END OF SECTION

THIS PAGE NOT USED

SECTION 16126

CONTACT RAIL ANCHOR ASSEMBLY FOR TRACTION POWER

PART 1 - GENERAL

1.01 SUMMARY

- A. This section specified fabricating, testing and furnishing contact rail cable connector assemblies as shown and specified.
- B. Related Sections:
 - 1. Section 16122 - Contact Rail Cable Connector Assemblies For Traction Power
 - 2. Section 16123 - Contact Rail Insulator Assembly For Traction Power
 - 3. Section 16124 - Contact Rail Protection Cover Assembly For Traction Power
 - 4. Section 16126 - Contact Rail System Installation For Traction Power
 - 5. Section 16128 - Wire and Cable For Traction Power
- C. Payment and Measurement Basis:
 - 1. Compensation for work specified in this section
 - a. Contact Rail Anchor Assemblies, Furnish, Fabricate and Deliver: Lump Sum.

1.02 REFERENCES

- A. Codes, Regulations, Standards and Specifications:
 - 1. Society of Automotive Engineers (SAE):
 - a. SAE G18.
 - 2. American Society for Testing and Materials (ASTM):
 - a. ASTM A27.
 - b. ASTM A36.
 - c. ASTM A47.
 - d. ASTM A48.
 - e. ASTM A123.
 - f. ASTM A153.
 - g. ASTM A283.
 - h. ASTM A325.
 - i. ASTM A489.
 - j. ASTM A681.
 - k. ASTM B134.
 - l. ASTM B633.
 - m. ASTM D570.
 - n. ASTM D638.
 - 3. American National Standards Institutes (ANSI):
 - a. ANSI B4.1.
 - b. ANSI B46.1.
 - c. ANSI B18.8.1.
 - d. ANSI B18.21.1.
 - 4. Steel Structures Painting Council (SSPC):
 - a. SSPC-SP-6.

1.03 SUBMITTALS

Submit the following for approval in accordance with the Division 1 and with additional requirements as specified for each:

- A. Shop Drawings
 - 1. The Contractor shall submit shop drawings to be used for fabrication of the components and assemblies of the contact rail anchors.
- B. Certification
 - 1. Certification that contact rail anchor assemblies furnished meet or exceed specified requirements and are compatible with the contact rail.
 - 2. Certified test reports for specified factory testing.

1.04 QUALITY ASSURANCE

- A. Testing
 - 1. Production Testing
 - a. Prior to delivery two anchor assemblies of each production lot shall be randomly selected to be used as test specimens.
 - b. Perform the tests in the following sequence in accordance with the referenced codes and standards.
 - 1) Tension test:
 - a) Tension test shall be in accordance with ASTM D638 using a temperature range of plus 40C to minus 17C.
 - b) The minimum acceptable tensile strength shall be 60,000 psi.
 - 2) The impact-resistance test:
 - a) The impact-resistance test shall be conducted within the temperature range of plus 21C to minus 17C.
 - b) The strain insulator rod shall be mounted as a simple beam with 21 inches between supports.
 - c) A 50-pound weight shall be dropped from a height of 12 inches so that it impacts at a midpoint on the rod. Repeat the test three times. No fractures shall occur on the rod.
 - 3) Water-absorption test:
 - a) Water-absorption test shall be performed in accordance with ASTM D570 over a 48-hour period using a temperature range of 20C to 40C.
 - b) Weight gain shall not exceed 0.15 percent of the original weight.
 - 4) DC-resistance test:
 - a) Following the specified water-absorption test, one eight-inch length of 5/8-inch diameter strain insulator rod shall undergo a dc-resistance test. The rod shall show a resistance of not less than eight megohms measured between the end surfaces of the rod.
 - 5) Dielectric test:
 - a) A dielectric test shall be performed on the same rod used in the resistance test.
 - b) The strain insulator rod shall be capable of withstanding an ac potential of 15,000 volts, 60 Hertz applied to the rod surface for three minutes without insulation breakdown or damage.
 - c) If one test specimen of a lot fails to meet specified test requirements, the entire production lot shall be rejected.

- 6) Strain Insulator Rod Testing
 - a) After the rods are assembled to the clevis ends using a resin compound or similar approved adhesive and allowed to cure for 24 hours, proof load test each assembly to 15,000 pounds. No physical damage shall be allowed at the conclusion of testing.

B. For Codes, Regulation, References, Standards and Specifications, refer to Article 1.02.

PART 2 - PRODUCTS

2.01 COMPONENTS

- A. Contact Rail Anchors
 1. Cast Parts
 - a. The contact rail anchor cast parts shall be free of cracks, blemishes, scale, machining flaws, excessive shrinkage or other defects rendering them unsuitable for their intended service. They shall be finished to a true and homogeneous surface and if necessary ground to ensure accurate fit with contiguous parts.
 - b. Steel used in the fabrication shall be medium steel manufactured by the open-hearth, basic-oxygen or electric furnace process, ASTM A27, Grade 65-35, fully annealed and tempered. Malleable iron shall be ASTM-A47, Grade 32510 and gray iron shall be ASTM A48 Class 40C.
 2. Rolled Steel Parts
 - a. Rolled steel parts shall be manufactured by the open-hearth, basic-oxygen or electric-furnace process and shall be in accordance with ASTM A36, ASTM A681 and ASTM A283, Grade C.
 - b. Parts shall be free from cracks, flaws, seams, blisters, imperfect edges and other defects rendering them unsuitable for their intended service. The surface roughness shall not exceed 125 micro inches as prescribed by ANSI B46.1
 3. Tolerances
 - a. All tolerances shall be in accordance with ANSI B4.1.
 4. Galvanizing
 - a. Parts to be galvanized shall be prepared by first pickling in diluted sulfuric acid and cleaning in cold running water. The parts shall then be shot blasted in accordance with SSPC - SP6, maximum grit size SAE G18, followed by immersion in a solution of zinc chloride or hydrochloric acid. After drying, hot-dip galvanize the parts in accordance with ASTM A123, unless otherwise specified. Nuts, bolts, washers, clevis pins and eye bolts shall be galvanized in accordance with ASTM A153 or ASTM B633 Type I SC-2.
 5. Strain Insulator Rods
 - a. The strain insulator rods shall be fabricated from 5/8-inch diameter reinforced plastic consisting of 60 to 65-percent glass fiber uniformly impregnated with 35 to 40-percent thermosetting p
 6. Miscellaneous Hardware
 - a. Nuts, bolts and miscellaneous hardware shall be of the type, material and dimensions as shown. The parts shall be galvanized as specified and manufactured as follow:
 - b. Nuts, bolts and flat washers: ASTM A325.
 - 1) Spring washers: ANSI B18.21.1.
 - 2) Cotter pins: ASTM B134 and ANSI B18.8.1.
 - 3) Eye bolts: ASTM A489.

PART 3 - EXECUTION - Not Used.

END OF SECTION

THIS PAGE NOT USED

SECTION 16127

CONTACT RAIL SYSTEM INSTALLATION FOR TRACTION POWER

PART 1-GENERAL

1.01 SUMMARY

- A. This section specifies the requirements for installation of an operable contact rail system consisting of composite contact rail and all appurtenances including protection equipment and furnishing of ancillary material as specified.
- B. Related Sections:
1. Section 05661 - Contact Rail and Appurtenances For Traction Power
 2. Section 16122 - Contact Rail Cable Connector Assemblies For Traction Power
 3. Section 16123 - Contact Rail Insulator Assemblies For Traction Power
 4. Section 16124 - Contact Rail Protection Cover Assemblies For Traction Power
 5. Section 16126 - Contact Rail Anchor Assemblies For Traction Power
 6. Section 16128 - Wire and Cable For Traction Power
 7. Section 16294 - Contact Rail Heating System For Traction Power
- C. Payment and Measurement
1. Compensation for work specified in this section will be made in the following manner:
 - a. Contact rail system, install: Lump Sum.
 2. Measurement of work specified in this section will be made in the following manner:
 - a. Contact rail system, install: linear foot measured to nearest 0.5 foot along center line of contact rail including end approaches, excluding gaps to include:
 - 1) Insulators, install: includes furnishing and installing insulators, shims and drive spikes.
 - 2) Composite contact rail, install: includes furnishing and installing of composite contact rail, bending rail, attachment of splice joints and installation of anchors, and end approaches.
 - 3) Cable connector assembly, install: includes preparation and installation of 1,000 KCMIL power cable as required and installation of compression connectors and insulating covers.
 - 4) Composite contact rail terminal lugs, install: includes preparation and installation of extra-flexible, 427-strand, power cable as required and installation of the terminal lugs on the composite contact rail.
 - 5) Protection cover, install: includes furnishing and installation of protection cover, support brackets, expansion joint protection cover assemblies and hardware.

1.02 REFERENCES

- A. Code, regulations, references standards and specifications
1. ASTM - D1248
 2. UL
 3. AREMA

1.03 SUBMITTALS

Submit the following for approval in accordance with the Division 1 and with additional requirements

specified for each:

- A. Shop drawings: shims for contact rail height adjustment.
- B. Documentation:
 - 1. The method of bending and tolerances to be allowed for contact rail.
 - 2. The method of brushing, cleaning, and grinding for removing local surface irregularities
- C. Certification:
 - 1. Wire pulling lubricants to be non-injurious to insulation of wire.

1.04 QUALITY ASSURANCE

- A. Testing
 - 1. Electrical resistance of the installed composite rail not to be greater than 0.002 ohms per 1,000 feet at 20 degree centigrade.
 - 2. Sample compression cable connector assemblies will be tested to sustain tension of 5,000 psi for three hours. At the end of three hours, there shall be no slipping of the cable in the connector, deforming or loosening of the connection or increase in the electrical resistance beyond that is specified.
 - 3. Terminal lugs for composite contact rail shall be tested as specified for cable connector assembly compression connections.
- B. For codes, regulations, reference standards and specifications, refer to Article 1.02 above.

PART 2: PRODUCTS

- A. The components furnished under this section shall be as follows:
 - 1. The top surface of each insulator rail clip shall be thoroughly coated with a non-conductive lubricant, Dow-Corning 44 (heavy) grease, or equal, to reduce strain on the insulators caused by the movement of the contact rail.
 - 2. Timber drive spikes to secure insulator to timber ties for ballasted track installment shall be ½ inch in diameter and 6-1/2 inches long. Two spikes will be required for each insulator. Timber drive spikes shall be in accordance with AREMA Plan.
 - 3. Shims as required, up to 1/4 inch shall be used under the insulator for further height adjustment. Shims shall be supplied by the Contractor at no additional cost to the Authority.
 - 4. Shims for contact rail height adjustment shall be 1/8 inches thick high density polyethylene, ASTM D1248, Type III, Class C, Cat. 5, and shall provide full bearing of the insulator on the grout pad in all positions of adjustment. Shims shall be designed to stay in place even if bolts are loose.
 - 5. Shim material may be manufactured without carbon black but shall meet all other requirements.
 - 6. The contact rail anchors shall be secured to the trackbed with 11/16-inch by 6-inch washer-head drive spikes in ballasted track. Drive spikes shall be in accordance with AREMA Plan.
 - 7. All jumper cable installed in conduit at crossovers, transitions and other special track work shall be standard duty, 127-strand, or extra flexible 427-strand power cable.
 - 8. Contact rail connection cable shall be extra flexible 427-strand, power cable. Its length and points of connection to the contact rail shall be as shown and in accordance with contraction requirements of the contact rail.

3.0 EXECUTION

A. Insulator Assemblies

1. Insulators shall be installed as shown and specified.
 - a. The insulators shall be centered and secured in place and shimmed if necessary.
 - b. Insulators shall be installed on the contact rail ties as shown. The distance between insulators shall not exceed ten feet.
 - c. All injurious substances falling on the insulators shall be immediately removed to prevent damage. Upon completion of the work, all insulators shall be inspected and thoroughly cleaned. All insulators chipped, broken or otherwise defective after installation shall be replaced before final acceptance at no additional cost to the Authority.
2. Ballasted Track Installation
 - a. The insulator shall be located to permit positioning the contact rail with respect to the gauge line of the near running rail within the specified tolerances.
 - b. The insulators shall be secured to the contact rail ties by two 1/2-inch diameter by 6-1/2-inch long timber drive spikes per insulator. The ends of ties under insulators shall be adzed or shimmed as necessary to compensate for warped ties. Contact rail ties shall be bored in the field to receive the drive spikes. Position holes to ensure that each insulator is centered across width of tie. The holes shall be 3/8-inch in diameter and six inches deep and treated with pentachlorophenol oil or creosote immediately after boring. The drive spikes shall be started vertically and driven straight. Drive spikes bent during installation shall be withdrawn and new drive spikes driven. Drive spikes shall be driven firmly to the top of the insulator base. Uneven tightening of spikes to adjust rail locating is prohibited

B. Contact Rail:

1. The centerline of the contact rail shall be located as shown on drawings. The contact rail shall be installed to rest evenly and uniformly on all insulator assemblies.
2. No length of contact rail less than 25 feet in length shall be used, except at locations shown, unless otherwise approved. Cuts shall be made only as required to ensure that the end of a run of contact rail falls within the specified tolerances. Cuts shall be made straight and perpendicular to the longitudinal axis of the contact rail. Contact rail for curve radii of less than 400 feet shall be bent to the appropriate curve prior to installation. Contact rail for curve radii greater than 400 feet may also be bent prior to installation to facilitate handling. The method of bending and tolerances to be allowed shall be submitted for approval.
 - a. Ballasted Track Installation: The required relative height of contact rail with respect to the top of running rail for timber ties shall be obtained by using shims under the insulator if necessary. Shims necessary for height adjustment shall be supplied by the Contractor at no additional cost to the Authority.
 - b. If further height adjustment is required, additional shims as required up to 1/4 inch shall be used under the insulator.
 - c. Shims shall be installed with tabs facing the direction of train traffic and a 3 inch finish nail tacked into the timber tie directly adjacent to the insulator base to prevent shims from vibrating out.
3. End Approaches: The end of contact rail sections shall be terminated with end approaches, installed as shown on drawings. They shall be assembled to the contact rail to ensure a smooth running surface. The allowable longitudinal location tolerance shall be plus or minus six inches except at special track work locations where the distance measured from the nearest point of switch shall be as calculated from dimensions shown with a tolerance of minus zero and plus one foot.

4. Splice Joints for Composite Contact Rail: Composite contact rail splice joint shall be installed as specified by the manufacturer of the composite contact rail and approved. Splice joints shall be installed to provide one foot clearance from contact rail insulators. The contractor shall demonstrate that the installed composite rail has an electrical resistance not greater than 0.002 ohms per 1,000 feet at 20 degrees C.
 5. Splice joints may be installed over insulators if the manufacturer demonstrates to the satisfaction of the Authority Representative that designed and furnished joint bars will not come in contact with insulator ears.
- C. Contact Rail Surface Preparation: After installation of the contact rail to the specified tolerances, but prior to its final acceptance, the Contact rail shall be brushed or otherwise cleaned to remove rust and scale from the head of the contact rail. Such brushing or cleaning shall not remove in excess of 0.002 inch from any surface of the rails, except that additional brushing, cleaning or grinding shall be performed as necessary to remove local surface irregularities. The method of brushing, cleaning and grinding shall be submitted for approval prior to use.
- D. Expansion Joints: The relatively short lengths of contact rail associated with this contract do not require expansion joints.
- E. Protection Cover Assembly: The protection cover assembly shall be installed entirely within the clearance envelope shown and in accordance with the manufacturer's recommendations:
1. At end approaches the protection cover shall be maintained at the uniform height above the top of the contact rail and shall not drop with the end approach.
 2. On curve radii under 500 feet, the protection cover may be cut into lengths a minimum of five feet long to conform as closely as possible to the arc of the curve. The protection cover shall lie within the clearance envelope at all times.
 3. For underground installation, protection cover support brackets shall be installed at five-foot intervals maximum; one bracket joining ends of protection cover sections and one at the midpoint of each 10-foot section.
 4. For at-grade installation, protection cover support brackets shall be installed at three foot, four inch intervals maximum; one bracket joining ends of protection cover sections and one at each third point of a 10-foot section.
 5. Additional protection cover brackets shall be installed where necessary. The maximum middle ordinate of a length shall be $\frac{1}{2}$ inch. At contact rail expansion joints, an expansion joint protection cover assembly shall be installed as shown. Contractor shall fabricate expansion joint protection covers from the protection covers as shown. Contractor shall install protection cover support brackets so as to avoid compression fasteners and splice joints in the composite contact rail.
- F. Electric Cabling and Connections
1. Materials shall be furnished and installed by the Contractor, including the cable connector assemblies, extra-flex 1,000 KCMIL cables, and connections to the contact rail.
 - a. All cabling shall be continuous without splices between terminations.
 - b. Cables shall not be bent, either permanently or during installation, to radii less than 10 times the outer diameters, except where shorter radii are approved for conditions making the specified radius impractical. The Contractor shall provide suitable installation equipment to prevent cutting and abrasions of conduit and cable during installation. Any conduit stub-ups broken or damaged shall be repaired as shown. Rod and swab conduits so as to remove water, cement and other foreign matter. Wire pulling lubricants, if used, shall conform to applicable UL requirements. The lubricant shall be

certified by the manufacturer to be non-injurious to such insulation. Pull-lines shall be made of nylon, polyester, polyethylene or other suitable nonmetallic material. Pull-lines shall be attached to cables by means of either woven basket grips or pulling eyes attached directly to the conductors. Only one cable shall be installed per conduit. Pulling tensions on both the conductors and their insulations and jackets shall not exceed the maximum tensions recommended by the cable manufacturer

2. Cable Installed in Conduit: All jumper cable installed in conduit at crossovers, transitions and other special track work shall be standard duty, 127-strand, or extra flexible 427-strand power cable. After installation, all cables shall be tested in accordance with Section 16128. Conduit ends shall be sealed using existing conduit sealing bushings, OZ Gedney Type CSBE-400p-1 or equal, as shown.

G. Cable Connector Assemblies

1. Qualifications for Performing Compression Connections: Prior to installation, the Contractor shall have prepared, under the direction of each foreman who will supervise a crew performing compression connections, two compression assemblies. The test compression assemblies shall be made using the methods and equipment the Contractor proposes to use for the installation. The electrical resistance of the completed connection, when measured between the distal end of cable and the connector tongue, shall not be greater than the resistance of an equivalent length of uncut cable.
2. Installation of Compression Connectors: Compression connectors shall be attached to the cable with the manufacturer's recommended tooling. When bolting tongues together, a lockwasher shall be installed under the head of each bolt and under each nut. All bolted connections shall be tightened with torque wrenches to a uniform torque of 450 inch pounds.
3. Installation of Terminal Lugs for Composite Contact Rail: Cable connections to the composite contact rail shall be one-hole, tin-plated, copper compression connectors. Prior to assembly of the terminal lugs to the composite contact rail, mating surfaces shall receive a liberal coating of oxide-inhibiting paste, NO-OX-ID, Dearborn Chemical, or equal. The oxide-inhibiting paste shall also be applied to all interfaces of the compression fasteners. The methods and equipment used to fasten the terminal lugs to the composite contact rail shall be as recommended by the manufacturer of the rail. Compression fasteners bent or improperly installed shall be replaced. Compression fasteners shall be installed in existing compression fastener holes used to hold the aluminum extrusion in place. Existing steel compression fasteners shall be removed and new fasteners installed to hold the terminal lugs.

END OF SECTION

THIS PAGE NOT USED

SECTION 16128

WIRE AND CABLE FOR TRACTION POWER

PART 1. GENERAL

1.01 SUMMARY

- A. This section specifies furnishing, installing and testing wire and cable.
- B. Compensation for work specified in this section will be made in the following manner and in accordance with the Unit Price Schedule:
 - 1. Wire and Cable Materials: Lump Sum.
 - 2. Installation: Lump Sum.
- C. Related sections include:
 - 1. Section 16294 - Contact Rail Heating System For Traction Power
 - 2. Section 16341 - Metal-Enclosed DC Switchgear For Traction Power

1.02 REFERENCES

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. NEC.
 - 3. ICEA: WC70, T-33 - 655.
 - 4. IEEE: 383.
 - 5. NEMA: WC70.
 - 6. ASTM: B3, B8, D471, B173, E662.
 - 7. UL: 44, 224, 1581, 1569, 1685

1.03 SUBMITTALS

Submit the following for approval in accordance with the Special Conditions and with the additional requirements as specified for each:

- A. Shop Drawings: Submit shop drawings for each type of cable in accordance with Section 16051.
- B. Samples: Specified smoke-density test sample will become property of the Authority.
- C. Certification:
 - 1. Certified flame retardancy test reports and data for tests performed not more than 12 months prior to submittal, for materials which are identical to those of cable furnished.
 - 2. Submit smoke-density test reports and data from tests performed not more than 12 months prior to the submittal for materials which are identical to those of the furnished cable.
 - 3. Certified test reports demonstrating that cable complies with specified requirements and those of referenced ICEA and NEMA Standards.
 - 4. Certificates from manufacturers verifying that products conform to specified requirements. Include certificate with submittal of shop drawings and with each cable

shipment.

1.04 QUALITY ASSURANCE

- A. Qualifications: Select a manufacturer who is regularly engaged in production of similar wire and cable, particularly to Railway or Transit industry in USA.
- B. For Codes, Regulations, Reference Standards and Specifications, refer to Article 1.02.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Mark each single-conductor cable and each multiple-conductor cable to show UL label, size, voltage, manufacturer and number of conductors or phases in accordance with NEC requirements.
- B. Ship each unit securely packaged and labeled for safe handling and shipment.
- C. Store products in a dry and secure facility.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General Requirements for Single-Conductor and Multiple-Conductor Cable:
 - 1. Type and size: Type I cable having low smoke - generating characteristics.
 - 2. Conductors: Type I cable having low smoke generating characteristics.
 - a. ASTM B3 or ASTM B8 annealed copper.
 - b. Size 10 AWG and smaller: Solid or Class B or Class C stranded.
 - c. Size 8 AWG and larger: Class B stranded, unless otherwise specified.
 - d. Other constructions as specified.
 - 3. Standards: Except as modified, wires and cable complying with the following standards: ICEA/NEMA WC70.
 - 4. Nonmetallic jacket for single-conductor cable and individual conductors of multiple-conductor cable and as overall covering on multiple-conductor cable:
 - a. Cross-linked polyolefin.
 - 5. Cross-linked polyolefin complying with the following physical requirements. Properties tested in accordance with ICEA/NEMA WC70. Jacket material free of PVC and PVC-based compounds.
 - 1) Tensile strength, minimum pounds per square inch: 1,800.
 - 2) Elongation at rupture, minimum percent: 150.
 - 3) Aging requirement: After 168 hours in air oven test at 100C, plus or minus 1 degree C:
 - a) Tensile strength, minimum percentage of unaged value: 100.
 - b) Elongation at rupture, minimum percentage of unaged value: 80.
 - 4) Oil immersion: 18 hours at 121degree C, plus or minus one degree C, ASTM D471, Table 1, No. 2 oil:
 - a) Tensile strength, minimum percentage of unaged value: 80.
 - b) Elongation at rupture, minimum percentage of unaged value: 80.

- 5) Jacket materials other than cross-linked polyolefin complying with ICEA/NEMA WC70. Jacket material free of PVC and PVC-based compounds.
 6. Flame retardancy: Single-conductor and multiple-conductor cable demonstrating flame retardancy in accordance with IEEE-383. Not required for medium voltage cable.
 - a. Single-conductor cable and individual conductors of multiple-conductor cable passing vertical flame test. Cable size for testing: 14 AWG.
 - b. Single-conductor cable, Size 1/0 AWG and larger, passing vertical tray flame test, using ribbon gas burner in accordance with UL 44. Cable size for testing: 1/0 AWG.
 - c. Multiple-conductor cable passing vertical tray flame test, using ribbon gas burner. Cable size for testing: 7/C or 9/C with 12 AWG or 14 AWG conductors.
 7. Applied Voltage testing:
 - a. Single-conductor cable and individual conductors of multiple-conductor cable to be given applied ac voltage dielectric strength test, i.e., six-hour water immersion test.
 - b. For single conductors of multiple-conductor cable, conduct tests prior to assembly as multiple-conductor cable
 - c. Test procedures per applicable ICEA/NEMA standards.
- B. Smoke generation: Single-and-multiple-conductor cable jacket materials demonstrating low-smoke generation when tested in accordance with ASTM E662 by independent, nationally recognized testing agency.
1. Conduct tests on specimens of overall jacket material for multiple-conductor cable and of jacket material for single-conductor cable.
 2. Prepare slab specimens for each material .100 inch, plus-or-minus .005-inch thick, identical to those of finished cables and meeting minimum physical requirements specified.
 3. Prior to testing, submit six-inch square portion of each specimen. Tag sample with manufacture's jacket or insulation identification code or number.
 4. Test values not to exceed the following:
 - a. Flaming mode:
 - 1) Uncorrected maximum specific optical density during first four minutes of test: 150.
 - 2) Uncorrected maximum specific optical density for entire 20-minute test: 300.
 - b. Nonflaming mode:
 - 1) Uncorrected maximum specific optical density during first four minutes of test: 150.
 - 2) Uncorrected maximum specific optical density for entire 20-minute test: 300.
- C. 2000-Volt Single-Conductor Cable:
1. Rated voltage: 2000 volts.
 2. Conductor:
 - a. Extra-flexible, 1000 KCMIL cable, Class G stranded for power feeder between cable connector assembly and contact rail.
 - b. Standard 1000 KCMIL cable, Class D stranded for traction power feeder installed in conduit and cable tray.

- c. Standard 500 KCMIL cable, Class D stranded for traction power feeder installed in conduit and cable tray.
 - d. 6 AWG cable for connecting DC surge arrestor to ground.
 - 3. Insulation: Ethylene-propylene rubber, ICEA Type II, 90 degree C, suitable for dry and wet locations.
 - 4. Jacket: Overall nonmetallic jacket of T-33-655 thermoset type II or cross-linked polyolefin.
 - 5. UL labeling: Type RHW-2.
 - 6. Additional requirements:
 - a. Insulation power factor: Two percent maximum.
 - b. Bond jacked to insulation to prevent moisture pockets. Minimum peel strength of the jacket from insulation: Four pounds per inch width for cross-linked polyolefin, and 10 pound per inch for heavy-duty neoprene.
- D. 600-Volt, Single-Conductor Cable:
 - 1. Rated voltage: 600 volts.
 - 2. Insulated with jacketed ethylene-propylene-rubber with nonmetallic jacket UL-labeled Type RHW or unjacketed filled cross-linked polyethylene, UL-labeled Type XHHW-2 or RHW-2.
 - 3. Color coding: In accordance with paragraphs 200-6, 200-7 and 210-5 of the NEC.
- E. Bare Conductor: ASTM B3, annealed copper conductor; 8 AWG and larger, Class B stranded.
- F. Cable Pulling Calculations:
 - 1. The Contractor shall perform pulling calculations in accordance with the cable manufacturer's recommendations, and these specifications. The calculations shall be made by an Electrical Engineer registered in the State of Maryland or the District of Columbia (depending on location) and bear the seal and signature of the engineer who is responsible for the calculations. Calculations shall be made for all conductors when installed in conduit under the following conditions:
 - a. The conduit run exceeds 100 feet vertically;
 - b. The conduit run exceeds 300 feet horizontally; and
 - c. The conduit run contains a total of over 180 degrees of bend.
 - 2. The Contractor shall also provide calculations for any additional run under any condition when requested by the Authority Representative. The calculations shall establish that the Contractor's cable installation can be implemented without damage to any wire or cable.
 - 3. For pulling calculations, consideration shall be given to the following parameters - fill, coefficient of friction, clearance configuration, jam ratio of the cables and conduit, weight correction factor, bend radii, training of cables on entering and existing the conduits, maximum allowable tension, sidewall load, the method of attaching the conductors to the pulling equipment, and weight of the cables. These factors shall be calculated for each pull as required. The contractor shall not exceed the maximum allowable values of sidewall pressure, pulling strain on conductors or sheath, limits of pulling device, and pulling tension.
 - 4. In general, the Contractor shall not exceed the following guidelines:
 - a. The maximum pulling strain on the cable with a pulling eye attached to the conductors is a function of the conductor area as follows: $TM = 0.008 \times n \times CM.$, where TM = Maximum tension (lbs), n = number of conductors, CM = area of each conductor circular miles.
 - b. When a basket-weave grip is used in lieu of a pulling eye, the maximum

tension shall not exceed the value calculated for the pulling eye method or 1000 lbs per grip, whichever is less.

- c. The sidewall pressure loads shall not exceed 300 lb/ft of bend radius, or the Wire and Cable Manufacturer's recommendation, which ever is less.
 - d. The jam ratio shall not fall between 2.8 and 3.2.
 - e. The coefficient of the friction for the cables with lubrication shall be taken to be 0.5.
5. Cable pulling calculations shall be submitted to the Authority Representative for approval. Cable shall not be installed until the contractor receives approval from the Authority Representative for the pulling calculations and cable installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all wiring continuous, without splices, between terminations, except as otherwise noted.
- B. Install single-conductor cable in conduit or cable tray as necessary. On walls or ceilings, fasten cable directly to channel inserts, or use expansion bolt anchors to attach to concrete and toggle bolts to attach to concrete masonry walls.
- C. Use nylon straps to bundle and secure wire and cable located in panelboards, cabinets, switchboards, switchgear and control panels.
- D. Minimum bending radius 12 times outer diameter of cable. Where shown, use shorter bending radius as permitted by NEC, ICEA, and cable manufacturer.
- E. To facilitate pulling cable, use UL-listed lubricant recommended by cable manufacturer.
- F. Use polyethylene or other suitable nonmetallic rope for pulling cable. Attach to cable by means of either woven basket grips or pulling eyes attached directly to the conductors.
- G. In damp and dusty indoor locations, manholes and outdoor locations, seal cable at conduit termination using duct sealing compound.
- H. Where shown or necessary, install cable seal fittings to prevent entry of water into electrical facilities.
- I. The splicing of power and control cables is not permitted in ductbanks, cable troughs or cable trenches. However, if permitted by the Authority Representative, make watertight splices as approved.
- J. The Contractor shall hook up 1000 KCMIL and 500 KCMIL traction power cables at switchgear end and trackside (negative and positive rails) when directed by the Authority Representative.
- K. All 1000 KCMIL and 500 KCMIL cables shall be secured at every rung on the cable tray with tie wraps.
- L. Identify cable terminations, feeders, power and control circuits using the following:
 - 1. Cable Tags: Stainless steel tags punched with conduit or cable number or

- identification as appropriate.
2. Wire Labels: Sleeve-type, heat shrinkable, flame retardant Raychem TMS product line, Type XPE or equal and conforming to UL 224. Wire identification same as corresponding terminal block identification unless otherwise shown. The labels on 1000 KCMIL and 500 KCMIL cable shall be clear, heat shrinkable with 1/2" height yellow lettering stamped on inside. The labels shall have reference of substation or tie breaker station breaker Supervisory control ID number and cable sequence in the branch of the feeder (e.g. BRK. 32-A) at both ends.
 3. Attach tags to cable with slip-free plastic lacing or nylon bundling straps. Use designation shown.

3.02 FIELD QUALITY CONTROL

- A. Furnish equipment required to perform tests. Prior to insulation and high potential tests, disconnect instruments and equipment which might be damaged during such tests. Conduct tests in presence of the Authority Representative. Schedule all tests through the Authority Representative and provide a minimum 48 hours notice.
- B. Submit test procedure for approval and perform approved tests. Do not perform tests without approved test procedure. Schedule all tests through the Authority Representative. Tests include but not limited to the following:
 1. 600-volt single-conductor cable:
 - a. Test continuity of conductors using ohmmeter.
 - b. Disconnect cable under test at both ends. Proof-test insulation resistance between each cable and the conduit in which the cable runs. While conducting the test, all other cables installed in the same conduit with the cable under test shall be connected to ground at one end. Insulation resistance shall be measured with a 1000-volt megger for minimum of one minute between the cable under test and the ground. Insulation resistance: One megohm minimum corrected to 15.6 degree C.
 - c. When cable shows insulation resistance of less than one megohm, perform high potential test at 80 percent of factory dc test voltage or as recommended by cable manufacturer. A gradual decrease of leakage current with time indicates an acceptable cable installation.
 2. 2000-volt single-conductor cable:
 - a. Test continuity of conductors using ohmmeter.
 - b. Proof-test insulation resistance to ground of the cable under test for a minimum of one minute using a 2500-volt three-terminal megger. Insulation resistance: 500 megohms, minimum, corrected to 15.6 degree C. Testing shall be done prior to termination of the cables at the two ends. Terminal lugs shall be installed prior to cable testing. Testing procedure shall be as follows:
 - 1) Proof-test the system insulation resistance to ground of the cable under test using step-voltage testing method.
 - 2) Insulation resistance: 500 megohms, corrected to 15.6 degree C. Testing shall be done after all cables have been installed and lugged.
 - 3) Isolate all cables at trackside and in the switchgear.
 - 4) Secure each cable under test and connect the positive test lead of the megger to one end of the cable under test. Connect the megger ground lead to the station ground busbar.
 - 5) Apply a 1000-volt dc test voltage to the cable for one minute and

- record the end test reading on the data sheet.
- 6) If the megger reading is greater than or equal to 500 megohms, proceed with testing the next cable in the test plan. If the test value is lower than 500 megohms, proceed with the step-voltage test as described below.
 - 7) Step-voltage test:
 - a) Examine and clean cable termination for presence of moisture or contamination.
 - b) Make a second megger test at 1000 volts dc for one minute and record end test reading on data sheet. If reading is less than 500 megohms, proceed with step (c) below, otherwise record new test reading on data sheet with comments depicting corrective action and proceed with testing next cable in the test plan.
 - c) Increase the megger test voltage in increments of 500 volts starting at 1500 volts dc up to 2500 volts dc and perform one minute insulation resistance measurement tests. Record end test readings on data sheet for each incremental test.
 - d) Compare insulation test readings at all levels of test voltage. A decrease of insulation resistance from the 1000 volts dc test voltage to the 2500 volts dc test voltage indicates the cable insulation has incipient weakness and the cable shall be replaced at no cost to the Authority.
 - 8) Repeat the above procedures for all the positive and negative traction power cables.

END OF SECTION

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SECTION 16129
2000 VOLT SHIELDED CABLE

PART 1. GENERAL

1.01 SUMMARY

- A. This section specifies furnishing, installing and testing shielded, low-smoke, halogen-free, low toxicity, single conductor 2000V cable, with standard and "extra-flexible" stranding. Size as shown on the contract drawings or as specified.
- B. Compensation for work specified in this section will be made in accordance with the Unit Price Schedule.
- C. Related sections include:
 - 1. Section 16128 - Wire and Cable For Traction Power
 - 2. Section 16341 - Metal-Enclosed DC Switchgear For Traction Power

1.02 REFERENCES

- A. Pertinent provisions of the current edition of the following listed Codes, Regulations, Reference Standards and Specifications shall apply to the work of this Section, except as they may be modified herein, and are hereby made a part of this Specification to the extent required. In instances of conflict, the more stringent requirement will take precedence.
 - 1. Codes and regulations of the jurisdictional authorities.
 - 2. NEC.
 - 3. ICEA: S-95-658, S-96-659, S-93-639, T-26-465, T-27-581, T-28-562, T-33-655.
 - 4. IEEE: 383.
 - 5. NEMA: WC53, WC54, WC70, WC71, WC74.
 - 6. ASTM: B3, B8, B173, D412, D471, D572, D573, E662.
 - 7. UL: 44, 224, 1072, 1581, 1685
 - 8. MIL: C-24643

1.03 SUBMITTALS

Submit the following for approval in accordance with the Special Conditions and with the additional requirements as specified for each:

- A. Shop Drawings: Submit shop drawings for each type of cable.
- B. Samples: Specified smoke-density test sample will become property of the Authority.
- C. Certification
 - 1. Certified flame retardancy test reports and data for tests performed not more than 12 months prior to submittal, for materials which are identical to those of the furnished cable.
 - 2. Submit smoke-density test reports and data from tests performed not more than 12 months prior to the submittal for materials that are identical to those of the furnished cable.
 - 3. Certified test reports demonstrating that cable complies with specified requirements and those of referenced ICEA and NEMA Standards.

4. Certificates from manufacturer and the Underwriters Laboratories Inc.(UL Listing) verifying that products conform to specified requirements. Include certificates with submittal of shop drawings and with each cable shipment.

1.04 QUALITY ASSURANCE

- A. Qualifications: Select a manufacturer who is regularly engaged in production of similar wire and cable, particularly to Railway or Transit industry in USA. The manufacturer must have in place a quality system in accordance with ISO 9001 or 9002 and be registered by an independent registration organization.
- B. For Codes, Regulations, Reference Standards and Specifications, refer to Article 1.02.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Mark each single-conductor cable to show UL Listing, size, voltage, manufacturer, etc. in accordance with NEC, ICEA/NEMA and UL requirements.
- B. Ship each unit securely packaged and labeled for safe handling and shipment.
- C. Store products in a dry and secure facility.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General Requirements for Single-Conductor Shielded Cable:
1. Type and rating: Type II shielded, low smoke, halogen free, low toxicity 2000 Volt jacketed cable.
 2. Conductors:
 - a. ASTM and ICEA standards.
 - b. Standard 1000kcmil, 127 strand Class D tinned copper.
 - c. Extra-flexible 1000kcmil, 427 strand Class G tinned copper.
 - d. Other constructions, as specified or shown on the contract drawings.
 - e. Cable suitable for dry and wet locations and hostile environmental conditions associated with underground heavy rail transit systems.
 3. Standards: Except as modified, cable shall comply with the Article 1.02.
 4. Conductor insulation: Low smoke, halogen free, low toxicity Ethylene-Propylene Rubber (EPR), ICEA Type II, and have the following properties:
 - a. The low smoke, halogen free, low toxicity EPR insulation shall be capable of withstanding operating copper conductor temperature of 90 degrees C continuous, 130 degrees C emergency overload for standard prescribed periods and 250 degrees C for short circuits. The insulation shall be highly moisture resistant, shall be free-stripping and leave the surface of the conductor clean. An opaque mylar separator may be used between the conductor and the insulation to ease stripping. Any additional tapes (e.g., flame-retardant fiberglass over the tinned copper tape, etc.) deemed necessary by the manufacturer shall be clearly noted.
 - b. Insulation thickness:
 - 1) Minimum average thickness of the EPR insulation wall over the conductor: 90 mils (0.090 inches).

- 2) Minimum average thickness of the supplemental EPR insulation wall over the shield: 80 mils (0.080 inches).

The minimum point thickness for both layers of insulation shall not be less than 90% of the minimum average thickness.

- c. The EPR insulation will have the following physical and electrical characteristics when tested in strict accordance with Article 1.02 standards:

- 1) Tensile strength (minimum): 1200 PSI .
- 2) Elongation (minimum): 150 percent.
- 3) Tensile stress at 100 percent elongation (minimum): 500 PSI.
- 4) When air oven tested for 168 hours at 121 degrees C \pm 1 degree C:
 - a) Tensile strength: 75 percent
 - b) Elongation: 75 percent.
- 5) When Hot Creep tested after conditioning at 150 degrees C \pm 2 degrees C:
 - a) Elongation (maximum): 50 percent
 - b) Set (maximum): 5 percent.
- 6) Electrical properties after water immersion at 75 degrees C \pm 1 degree C:
 - a) Permittivity after 24 hours (maximum): 6.0
 - b) One to 14 days immersion (maximum increase in capacitance): 5 percent
 - c) Seven to 14 days immersion (maximum increase in capacitance): 3 percent
 - d) Stability factor after 4 days (maximum): 1.0,
- OR -
Stability factor difference (maximum) 1 - 14 days: 0.5
- 7) Insulation resistance constant at 15.6 degrees C (minimum): 10,000 meg/1000 feet.

5. Shield:

- a. The shield shall consist of a continuous layer of tin-coated copper tape at least 5 mils (0.005 inches) thick. The tape shall be a minimum width of 0.75 inches and be applied with an overlap of at least 0.25 inches or 25 % of its width.
- b. The tape shall be free from burrs and shall be applied in such a manner that electrical continuity or contiguity will not be distorted or disrupted during normal installation bending. Joints in tapes shall be made electrically continuous by welding, soldering or brazing. Butted tapes shall not be permitted.

Note: Reminder: Apply supplemental EPR over shield before non metallic jacket. See 2.01 A.4.b.2), above.

6. Nonmetallic jacket for single-conductor cable:

- a. Cross-linked polyolefin (XLPO) Thermoset Type II complying with the following physical requirements. Minimum average wall thickness shall be 0.095 inches, minimum thickness at any point 0.080 inches. Properties tested in accordance with ASTM, ICEA, UL, IEEE and MIL specifications, refer to Article 1.02. Jacket material shall be low-smoke, halogen-free, low toxicity, fire retardant. Bond jacket to insulation to prevent moisture pockets between the jacket and insulation. The minimum peel strength of

the jacket from insulation shall be four pounds per inch width.

- 1) Tensile strength, minimum pounds per square inch: 1,600.
 - 2) Elongation at rupture, minimum percent: 150.
 - 3) Aging requirement: After 168 hours in air oven test at 121degrees C \pm 1 degree C:
 - a) Tensile strength, minimum percentage of unaged value: 85.
 - b) Elongation at rupture, minimum percentage of unaged value: 75.
 - 4) When Hot Creep tested after conditioning at 150 degrees C \pm 2 degrees C:
 - a) Elongation (maximum): 100 percent
 - b) Set (maximum): 10 percent.
 - 5) Cold Bend Temperature: minus 25 degrees C.
 - 6) Gravimetric Method - Water Absorption (maximum): 50 mg/in².
 - 7) When oil immersion tested for 18 hours at 121 degrees C \pm 1 degree C:
 - a) Tensile strength: 50 percent
 - b) Elongation: 50 percent.
 - 8) Smoke density, 100 mil slab: Prepare 100 mil (0.100 inches), plus-or-minus 0.005 inches, thick slab specimens for each material identical to those of finished cables and meeting minimum physical requirements specified. Prior to testing, submit six-inch square portion of each specimen. Tag sample with manufacture's jacket or insulation identification code or number. Allowable maximum limits when tested per ASTM E662 by independent, nationally recognized testing agency:
 - a) Flaming mode:
Uncorrected maximum specific optical density during first four minutes of test D_{s4}: 150
Uncorrected maximum specific optical density for entire 20-minute test, D_m: 300
 - b) Nonflaming mode:
Uncorrected maximum specific optical density during first four minutes of test, D_{s4}: 150
Uncorrected maximum specific optical density for entire 20-minute test, D_m: 300
7. The completed cable (including insulation and jacket) will be tested in accordance with ASTM, UL and MIL standards by an independent, nationally recognized testing agency. The combustion requirements and characteristics are:
- a. Acid gas equivalent (maximum): 2 percent
 - b. Halogen content: 0.2 percent
 - c. Flame retardancy: All 2000-volt shielded power cables shall be flame-retardant and shall pass the vertical tray flame test as described in the IEEE - 383, ICEA S-95-658, T-30-520 and UL-1581, 1685. Cable size for testing shall be a minimum 250 kcmil.
8. Applied Voltage testing:
- a. All 2000-volt shielded cable to be given applied AC voltage dielectric strength test, i.e., six-hour water-immersion test.
 - b. Test procedures:

Conductor shall be immersed in water for a minimum of six hours before test. Shielded cables shall be tested from conductor to shield, and tested from shield to water at 11.0 kV AC. Test in accordance with methods outlined in appropriate sections of ICEA, NEMA and UL standards.

B. Cable Pulling Calculations

The Contractor shall perform pulling calculations in accordance with the cable manufacturer's recommendations, and these specifications. The calculations shall be made by an Electrical Engineer registered in the State of Maryland or the District of Columbia (depending on location) and bear the seal and signature of the engineer who is responsible for the calculations. Calculations shall be made for all conductors when installed in conduit under the following conditions:

1. The conduit run exceeds 100 feet vertically;
2. The conduit run exceeds 300 feet horizontally; and
3. The conduit run contains a total of over 180 degrees of bend.

The Contractor shall also provide calculations for any additional run under any condition when requested by the Authority Representative. The calculations shall establish that the Contractor's cable installation can be implemented without damage to any wire or cable.

For pulling calculations, consideration shall be given to the following parameters - fill, coefficient of friction, clearance configuration, jam ratio of the cables and conduit, weight correction factor, bend radii, training of cables on entering and existing the conduits, maximum allowable tension, sidewall load, the method of attaching the conductors to the pulling equipment, and weight of the cables. These factors shall be calculated for each pull as required. The contractor shall not exceed the maximum allowable values of sidewall pressure, pulling strain on conductors or sheath, limits of pulling device, and pulling tension.

In general, the Contractor shall not exceed the following guidelines:

1. The maximum pulling strain on the cable with a pulling eye attached to the conductors is a function of the conductor area as follows: $TM = 0.008 \times n \times CM.$, where TM = Maximum tension (lbs), n = number of conductors, CM = area of each conductor circular mils.
2. When a basket-weave grip is used in lieu of a pulling eye, the maximum tension shall not exceed the value calculated for the pulling eye method or 1000 lbs per grip, whichever is less.
3. The sidewall pressure loads shall not exceed 300 lb/ft of bend radius, or the Wire and Cable Manufacturer's recommendation, which ever is less.
4. The jam ratio shall not fall between 2.8 and 3.2.
5. The coefficient of the friction for the cables with lubrication shall be taken to be 0.5

Cable pulling calculations shall be submitted to the Authority Representative for approval. Cable shall not be installed until the contractor receives approval from the Authority Representative for the pulling calculations and cable installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all cable continuous, without splices, between terminations, except as otherwise noted.
- B. Install single-conductor cable in conduit or cable tray as necessary. On walls or ceilings, fasten cable directly to channel inserts, or use expansion bolt anchors to attach to concrete and toggle bolts to attach to concrete masonry walls.

- C. Minimum bending radius 12 times outer diameter of cable. Where shown, use shorter bending radius as permitted by NEC, and/or appropriate sections of ICEA/NEMA standards and cable manufacturer.
- D. To facilitate pulling cable, use UL-listed lubricant recommended by cable manufacturer.
- E. Use polyethylene or other suitable nonmetallic material for the line to pull the cable. The pulling line should be adequately sized to safely pull the cable into the raceway. The pulling line should be high strength, low stretch and abrasion resistant. Attach to cable by means of either woven basket grips or pulling eyes attached directly to the conductors.
- F. In damp and dusty indoor locations, manholes and outdoor locations, seal cable at conduit termination using duct sealing compound.
- G. Where shown or necessary, install cable seal fitting to prevent entry of water into electrical facilities.
- J. The splicing of power cables is not permitted in ductbanks, cable troughs or cable trenches. However, if permitted by the Authority Representative, make watertight splices as approved.
- K. The Contractor shall hook up 1000 KCMIL traction power cables at switchgear end and trackside (negative and positive rails) when directed by the Authority Representative.
- L. All 1000 KCMIL cables shall be secured at every rung on the cable tray with tie wraps.
- M. Identify cable terminations, feeders, power and control circuits using the following:
 - 1. Cable Tags: Non-ferrous tags or pressure sensitive labels, stamped or printed with cable number or identification as appropriate.
 - 2. Labels: The labels on 1000 KCMIL cable shall be clear, heat shrinkable with ½" height yellow lettering stamped on inside. The labels shall have reference of substation or tie breaker station breaker Supervisory control ID number and cable sequence in the branch of the feeder (e.g. BRK. 32-A) at both ends.
 - 3. Attach tags to cable with slip-free plastic lacing or nylon bundling straps.

3.02 FIELD QUALITY CONTROL

- A. Furnish equipment required to perform tests. Prior to insulation and high potential tests, disconnect instruments and equipment that might be damaged during such tests. Conduct tests in presence of the Authority Representative. Schedule all tests through the Authority Representative and provide a minimum 48 hours notice.
- B. Submit test procedure for approval and perform approved tests. Do not perform tests without approved test procedure. Schedule all tests through the Authority Representative. Tests include but not limited to the following:
 - 1. 2000-volt single-conductor shielded cable:
 - a. Test continuity of conductors using ohmmeter.
 - b. Proof-test insulation resistance to shield or to ground of the cable under test for a minimum of one minute using a 2500-volt three-terminal megger. Insulation resistance: 500 megohms, minimum, corrected to 15.6 degrees C. Testing shall be done prior to termination of the cables at the two ends. Terminal lugs shall be installed prior to cable testing. Testing procedure shall be as follows:
 - 1) For shielded cables, proof-test insulation resistance between conductor and the metallic shield. While conducting the test, the metal shield shall be tied to ground. For unshielded cables, proof-

test the system insulation resistance to ground of the cable. The step-voltage testing method shall be used.

- 2) Testing shall be done after all cables have been installed and lugged. Isolate all cables at trackside and in the switchgear.
- 3) Secure each cable under test and connect the positive test lead of the megger to one end of the cable under test. Connect the megger ground lead to the station ground busbar and/or cable shield, as appropriate.
- 4) Apply a 1000-volt dc test voltage to the cable for one minute and record the end test reading on the data sheet.
- 5) If the megger reading is greater than or equal to 500 megohms, proceed with testing the next cable in the test plan. If the test value is lower than 500 megohms, proceed with the step-voltage test as described below.
- 6) Step-voltage test:
 - a) Examine and clean cable termination for presence of moisture or contamination.
 - b) Make a second megger test at 1000 volts dc for one minute and record end test reading on data sheet. If reading is less than 500 megohms, proceed with step (c) below, otherwise record new test reading on data sheet with comments depicting corrective action and proceed with testing next cable in the test plan.
 - c) Increase the megger test voltage in increments of 500 volts starting at 1500 volts dc up to 2500 volts dc and perform one minute insulation resistance measurement tests. Record end test readings on data sheet for each incremental test.
 - d) Compare insulation test readings at all levels of test voltage. A decrease of insulation resistance from the 1000 volts dc test voltage to the 2500 volts dc test voltage indicates the cable insulation has incipient weakness and the cable shall be replaced at no cost to the Authority.
- 7) Repeat the above procedures for all the positive and negative traction power cables.

END OF SECTION

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SECTION 16130

RACEWAYS, BOXES AND CABINETS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing conduit, raceways, cable trays, boxes and cabinets to form raceway and support system for power, communication and control cables.
- B. Related Work Specified Elsewhere:
 - 1. Underground electrical and communications distribution systems: Section 02585.
 - 2. Concrete formwork: Section 03100.
 - 3. Cast-in-place structural concrete: Section 03300.
 - 4. Structural precast concrete: Section 03400.
 - 5. Grounding and bonding: Section 16060.
 - 6. Fire stopping: Section 07841.

1.02 QUALITY ASSURANCE:

- A. Qualifications: Select a manufacturer who is engaged in production of similar raceways, boxes and cabinets.
- B. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. National Electrical Code (NEC).
 - 3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum); VE 1, Metallic Cable Tray Systems.
 - 4. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc Coated; C80.5, Aluminum Rigid Conduit - (ARC); and Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
 - 5. UL: 5, Surface Metal Raceways and Fittings; 6, Rigid Metal Conduit; 50, Enclosures for Electrical Equipment; 94, Test for Flammability of Plastic Materials for Parts in Devices and Appliances; 360, Liquid Tight Flexible Steel Conduit; 514A, Metallic Outlet Boxes; 514B, Fittings for Conduit and Outlet Boxes; 514C, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers; 884, Underfloor Raceways and Fittings; and 1684, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
 - 6. Federal Specifications (FS): FF-S-325C, FF-S-760, TT-S-227.
 - 7. American Standards of Testing and Materials (ASTM): A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings; A123/A123M-00, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; A185-97, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement; A276-00a, Standard Specification for Stainless Steel Bars and Shapes; A507-00, Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled; A532/A532M-93a(1999)e1, Standard Specification for Abrasion-Resistant Cast Irons; A536-84(1999)e1, Standard Specification for Ductile Iron Castings; A615/A615M-00, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; A653/A653M-00, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; B138-96, Standard Specification for Manganese Bronze Rod, Bar and Shapes; B455-96, Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes; B584-00, Standard Specification for Copper Alloy Sand

Castings for General Applications; B633-98, Standard Specification for Electro deposited Coatings of Zinc on Iron and Steel; C109/C109M-99, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens); C173-94ae1, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; C231-97e1, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method; D149-97a, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies; D495-99, Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation; D570-98, Standard Test Method for Water Absorption of Plastics; D638-00, Standard Test Method for Tensile Properties of Plastics; D648-00a, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position; and D790-00, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

8. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges (SSHB).
 9. ITS: Directory of ITS listed products.
- C. The following items to be listed or labeled per referenced UL or ITS directory:
1. Conduit and fittings.
 2. Surface raceways and fittings.
 3. Underfloor raceways and fittings.
 4. Boxes.
 5. Cabinets.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings.
- B. Certification.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Mark each item in accordance with applicable reference standard.
- B. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- C. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements for Conduit, Raceways, Cable Trays, Boxes, Cabinets and Fittings:
 1. Size: As shown, minimum conduit size 3/4 inch.
 2. Materials:
 - a. Steel sheet: ASTM A507-00.
 - b. Zinc-coated steel sheet: ASTM A653/A653M-00.
 - c. Cast iron: ASTM A532/532M-93a(1999)e1.

- d. Ductile iron: ASTM A536-84(1999)e1.
 - e. Malleable iron: ASTM A47/A47M-99.
 - f. Bronze extrusion: ASTM B455-96, Alloy C38500.
 - g. Bronze casting: ASTM B584-00, Alloy C83600.
 - h. Rigid fiberglass reinforced epoxy: UL 1684.
 - i. Stainless steel: ASTM A276-00a, Type 304.
3. Zinc coating:
- a. Hot-dip galvanizing: ASTM A123/A123M-00.
 - b. Electro galvanizing: ASTM B633-98.
- B. Galvanized-Steel Rigid Conduit and Fittings: UL 6 and ANSI C80.1, zinc coating tested in accordance with reference test in appendix.
- C. Aluminum Rigid Conduit and Fittings:
- 1. ANSI C80.5 and UL 6.
- D. Liquid-Tight Flexible Conduit and Fittings:
- 1. Applicable requirements of UL 360.
 - 2. Flexible galvanized-steel core with extruded liquid-tight neoprene or PVC jacket overall.
 - 3. Sizes up to 1-1/4 inch provided with continuous copper bonding conductor, spiral wound between convolutions.
 - 4. Sizes 1-1/2 inch and above provided with separate grounding conductor.
- E. Conduit Expansion Fittings and Expansion and Deflection Fittings:
- 1. Materials:
 - a. For galvanized-steel rigid conduit:
 - (1) Expansion fittings: Steel or malleable iron, hot-dip galvanized.
 - (2) Expansion/deflection fittings: Bronze or ductile iron end couplings, neoprene sleeve and stainless steel clamping bands.
 - 2. Conduit expansion fitting: Weatherproof.
 - 3. Conduit expansion and deflection fitting: Watertight.
 - 4. Metallic fittings equipped with bonding jumper cable to provide electrical continuity.
- F. Conduit Connector Fittings:
- 1. UL 514B, material and finish similar to that of conduit with which they are to be used.
 - 2. For enclosures, cabinets, boxes and gutters in electrical rooms and aboveground indoor locations: Threaded nylon-insulated bushing and locknuts.
 - 3. For enclosure, cabinets, boxes and gutters with hub in outdoor, tunnel and underground locations, except electrical rooms: Threaded watertight hub fitting with gasket.
 - 4. For enclosure having punched or formed knockout for conduit entry in outdoor and underground locations, except electrical rooms: Threaded watertight fitting with gasket, nylon-insulated throat and sealing locknut.
- G. Conduit and Cable-Seal Fittings:
- 1. Conduit seal:
 - a. To provide watertight seal between concrete and conduit where it penetrates wall, floor or ceiling.
 - b. Size as shown or necessary.

- c. Materials: Body and pressure clamp of malleable or cast iron with a neoprene sealing grommet and PVC-coated or galvanized-steel pressure rings, oversized sleeve of FRE or galvanized steel.
 - d. Seal between conduit and concrete to withstand pressure from 50-foot head of water without leakage.
2. Cable seal:
- a. To provide watertight seal between cable and conduit for use with single-conductor or multiple-conductor cable as necessary.
 - b. Size as necessary, drilled to accommodate cable.
 - c. Pressure discs of PVC-coated steel and sealing ring of neoprene.
 - d. Seal between cable and conduit to withstand water pressure of 50 psi without leakage.
3. Seal compound:
- a. FS TT-S-227, two-component, fast-setting, polymeric sealing compound to provide watertight seal between concrete and conduit, between cable and conduit.
 - b. Pour-type for horizontal and gun-grade for vertical or overhead application.
 - c. When cured, sealant to have rubber-like flexibility allowing minimum movement of conduit and cable in temperature range of minus 40F to plus 150F without loss of watertight seal.
 - d. Pot life: 15 minutes.
 - e. Minimum ambient temperature for application: 35F.
 - f. Initial cure: 15 minutes.
 - g. Final cure: Seven days.
 - h. Hardness, Durometer A: 20-35.
 - i. Seal between conduit and concrete to withstand pressure from 50-foot head of water without leakage.
 - j. Seal between conduit and single-conductor or multiple-conductor cable to withstand water pressure of 70 psi without leakage.
 - k. Fox Industries, Type FX-571G or approved equal.
- H. Conduit and Cable Supports:
1. Retaining straps and fasteners: FS FF-S-760, with the following additional requirements:
- a. Type, style and size: As necessary.
 - b. Material and finish: Stainless steel, Type 304, or approved equal.
 - c. For separating conduit from masonry surface: Hot-dip galvanized malleable-iron spacer assembled with Style A strap.
 - d. For vertical run of metallic-sheath cable: Basket-weave cable support.
 - e. For fastening conduit or cable to channel inserts: Stainless steel, Type 304, or approved equal.
2. Multiple pipe hangers (trapeze-type): Consisting of two or more hanger rods, horizontal member, U-bolt clamp and other attachment necessary for securing hanger rods and conduit, with the following additional requirements:
- a. Material and finish: Stainless steel, Type 304, or approved equal.
 - b. Hanger rod: Not smaller than 3/8-inch diameter, threaded for sufficient distance at each end to permit at least 1-1/2 inches of adjustment.
 - c. Horizontal member: Channel, 1-1/2 inches square or 1-5/8 inches square by 12 gauge or heavier. Weld two or more channels together for greater strength if necessary.
 - d. Design: Capable of supporting load equal to sum of weights of conduit, cable and hanger plus 200 pounds. At design load, stress at root of thread on

hanger rod 9,500-psi maximum; stress in horizontal member 12,500-psi maximum.

3. Channel inserts:
 - a. Size and shape as shown, 12 gauge or heavier stainless steel, Type 304, or approved equal, with 7/8-inch wide slot.
 - b. For surface mounting: Channel inserts with 9/16-inch base slot, eight inches on center with minimum pullout-load rating of 1,000 pounds per linear foot.
 4. Spot inserts: Rated 800 pounds with safety factor of five, fabricated from steel galvanized after fabrication, covered to prevent entrance of concrete during installation.
- I. Surface Raceways and Fittings: UL 5, fabricated from galvanized steel.
- J. Underfloor Raceways and Fittings:
1. UL 884.
 2. Size: As shown.
 3. Fabricated from steel 14 gauge or heavier steel sheet.
 4. Finish: Corrosion-resistant coating listed per referenced UL or ITS directory.
- K. Boxes and Cabinets:
1. Outlet boxes:
 - a. UL 514A, capable of accommodating conduit as shown.
 - b. Material and finish:
 - (1) Steel, malleable iron, cast iron or ductile iron.
 - (2) Hot-dip galvanized or electro galvanized after fabrication.
 - c. For aboveground indoor locations and electrical rooms: Punched or formed knockouts.
 - d. For outdoor and underground locations, except electrical rooms:
 - (1) Threaded-conduit entrance hub.
 - (2) Threaded watertight fitting with gasket, nylon-insulated throat and sealing locknuts for enclosures having punched or formed knockouts for conduit entry.
 - e. For wall receptacles and switches, single or double devices: Outlet boxes 4-11/16 inch square by 1-1/2 inch deep.
 - f. For floor receptacles: Watertight cast-iron outlet boxes, four inches diameter, of suitable depth and complete with the following:
 - (1) Adjustment screws for final leveling.
 - (2) Bronze floor plate with flush-mounted screw plug, without exposed fastener, M32 finish.
 - (3) Screw plug attached to outlet-box assembly by chain or other means, M32 finish.
 - (4) Bronze floor plate flange, five inches in diameter, extending beyond box 1/2-inch above finished floor, M32 finish.
 - (5) One special screw-plug removal tool with every 10 receptacles.
 - g. For recessed wall-mounted receptacles: Watertight cast-iron outlet box, three-inch diameter, of suitable depth and complete with the following:
 - (1) Bronze faceplate with flush-mounted screw plug, without exposed fasteners, M32 finish.
 - (2) Screw plug attached to outlet-box assembly by chain or other approved means, M32 finish.
 - (3) Bronze faceplate flange, five inches in diameter, extending beyond box, M32 finish.
 - (4) One special screw-plug removal tool with every 10 receptacles.
 2. Junction and pull boxes:

- a. Internal volume up to 100 cubic inches, metallic boxes: UL 514A, non-metallic boxes: UL514C; internal volume above 100 cubic inches, UL 50.
- b. Flush-mounted or surface-mounted as shown.
- c. Size: Suitable to accommodate conduit, raceways, ducts, number of cables and splices shown.
- d. Material and finish:
 - (1) Metallic boxes:
 - (a) Steel, malleable iron, cast iron or ductile iron.
 - (b) Hot-dip galvanized or electro galvanized after fabrication.
 - (2) Non-metallic boxes:
 - (a) Precast concrete: Compressive strength 3,500 psi; air entrainment six-percent minimum, ASTM C173-94ae1 or C231-97e1; Section 03300 and Section 03400 and in accordance with the following:
 - i. Box: Concrete formed with closed bottom and sides and recess at top of box or at edge of cover to provide mating surfaces to prevent lateral movement of flush-mounted cover. Knockouts provided to accommodate conduits as shown.
 - ii. Cover:
 - 1. Material same as for box. Use of metallic cover and cover frame prohibited.
 - 2. Metro Type "B" logo with 3-1/8 inch by 4-inch envelope and service designation recessed in center of cover.
 - 3. Non-protruding provisions provided for lifting.
 - iii. Reinforcement:
 - 1. Sidewalk and landscape locations: Welded wire fabric, ASTM A185-97.
 - 2. Areas subject to vehicular traffic: Deformed steel bars, ASTM A615/A615M-00.
 - iv. Loading:
 - 1. Sidewalk and landscape locations: AASHTO 's SSHB H15-44.
 - 2. Areas subject to vehicular traffic: AASHTO's SSHB H20-44.
 - 3. Hardware: Stainless steel.
 - 4. Size: As shown or next available larger size.
 - (b) Composite material: Sand and gravel bound together with a polymer and reinforced with continuous woven glass strands and in accordance with the following:

Physical Properties	Values	Method
Compressive strength	11,000 psi	ASTM C109
Tensile strength	1,700 psi	ASTM D638
Flexural strength	7,500 psi	ASTM D790

Water Absorption (24 hours)	0.5 percent	ASTM D570
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- i. Box: Gray-color material formed with closed bottom and sides and flange with recess at top of box to accommodate flush-mounted cover.
 - ii. Cover:
 - 1. Material same as for box.
 - 2. Skid-resistant top surface with minimum 0.5 coefficient of friction.
 - 3. Metro Type "B" logo with 3-1/8 inch by 4-inch envelope and service designation recessed in center of cover.
 - 4. Secured to box with bolts.
 - 5. Non-protruding provisions provided for lifting.
 - iii. Loading:
 - 1. Sidewalk and landscape locations: AASHTO's SSHB H15-44.
 - 2. Areas subject to vehicular traffic: AASHTO's SSHB H20-44.
 - iv. Hardware: Stainless steel.
 - v. Size: As shown or next available larger size.
- (c) Molded fiberglass-reinforced polyester 1/8-inch thickness, minimum, and in accordance with the following requirements:

Physical Properties	Values	Method
Flexural strength	17,000 psi	ASTM D790
Deflection temperature	400F	ASTM D648
Water absorption (24 hours)	0.5 percent	ASTM D570
Tensile strength	6,500 psi	ASTM D638
Specific gravity	1.8	ASTM D794
Flammability	94-5V	UL 94
Dielectric strength	400 volts per mil	ASTM D149
Arc resistance	180 seconds	ASTM D495

- i. Ultraviolet protection: Fiberglass material containing ultraviolet-inhibitor, or coated with

- polyurethane paint, 1.5 mils minimum dry-film thickness on both inside and outside surfaces.
 - ii. Color: Fiberglass material, gray inside and outside.
 - (d) Molded polyvinyl chloride 1/8-inch thickness, minimum.
 - e. For aboveground indoor locations and electrical rooms: Punched or formed knockouts.
 - f. For outdoor and underground locations, except electrical rooms:
 - (1) Threaded conduit entrance hub.
 - (2) Threaded watertight fitting with gasket, nylon-insulated throat and sealing locknuts for boxes having punched or formed knockouts for conduit entry.
 - 3. Cabinets:
 - a. UL 50, fabricated from galvanized steel.
 - b. Surface-mounted, unless otherwise shown.
 - c. Backplate of reinforced steel for mounting interior components and to ensure rigid support and accurate alignment.
 - d. Provision for cabinet grounding.
 - e. Provide latch and handle in accordance with UL 50; screw fastenings will not be accepted in lieu of latch.
 - f. Finish: Metallic surface thoroughly cleaned, degreased, primed with zinc primer and coated after fabrication with light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.
- L. Cable Trays:
- 1. NEMA VE1, ventilated-steel ladder-type.
 - 2. Dimensions: Three inches inside depth; nine inches rung spacing unless otherwise shown.
 - 3. Maximum load rating: 50 pounds per linear foot with safety factor of 1.5 at 12-foot support span.
 - 4. Bend radius:
 - a. For incoming service cable: As required by power company.
 - b. For all other cable: 24 inches or as necessary and approved.
 - 5. Finish: Cable trays, fittings and accessories hot-dip galvanized or electro galvanized after fabrication.
- M. Expansion Bolt Anchors: FS FF-S-325C Group II, stainless steel, Type 304, or approved equal.
- N. Data-Transmission System (DTS) Cabinet:
- 1. Wall-mounted, single-door, NEMA 250 Type 12, with panel, Hoffman Engineering Company, as shown, or approved equal.
 - 2. Enclosure: Formed of minimum 14-gauge steel, seams continuously welded and ground, without openings or knockouts, with threaded-conduit entrance hubs, lugs for mounting enclosure and collar studs for mounting panel. Rolled lip formed on all sides of door opening. Enclosure and door reinforced when size exceeds 30 inches square. Size as shown.
 - 3. Door: Formed of minimum 14-gauge steel, with rolled lip along top and sides to mate with enclosure. Fitted with removable print pocket. Closed-cell neoprene gasket attached with oil-resistant adhesive and steel retaining clips.
 - 4. Hardware: Corrosion-resistant steel continuous piano hinge with removable pin. Hasp and staple for padlocking.
 - 5. Panel: Formed of 12-gauge steel.

6. Finish: Galvanized enclosure, door, panel and latch mechanism. Prepared for painting by manufacturer's standard method in accordance with the following:
 - a. Outside: Phosphatized, primed and finished with two coats of light-gray enamel or epoxy coating, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.
 - b. Inside including panel: Two coats of white enamel or epoxy coating.
 7. Breather drain: One 1/2-inch diameter, Crouse-Hinds Catalog No. ECD11, or approved equal.
 8. Grounding stud: Manganese bronze, ASTM B138-96, Alloy No. 675 hard, 3/8-inch high; Evedur GSI, American Brass Company or approved equal.
 9. Terminations: Assembly rail and modular terminals, Weidmuller Terminations, Incorporated or approved equal.
 - a. Terminal: Modular test terminal, Melamine plastic, screw-clamp connections, with socket screws; Type SAKC4, Catalog No. 3406.2 or approved equal, with the following additional requirements:
 - (1) Amperes: 25.
 - (2) Volts: 300.
 - (3) Wire-gauge range: 22AWG to 12AWG.
 - (4) Thickness: 0.256 inch.
 - (5) Listed per referenced UL or ITS directory.
 - (6) Standard accessories; compatible with terminal, with the following additional requirements:
 - (a) End section: Type AP, No. 1179.2 or approved equal.
 - (b) End bracket: Type EWK1, No. 2061.6 or approved equal.
 - (c) Test plug: Type PS, No. 1804.0 or approved equal.
 - (d) Cross-connection combination: QB25, No. 91455.D or approved equal.
 - (e) Disconnect plug for SAKC4 terminal: Type TST, No. 3399.0 or approved equal.
 - b. Assembly rail: Type TS32 steel standard section compatible with terminals, with fixing slots, Catalog No. 1228.0 and standard rail-mounting screws or approved equal.
 - c. Marking tags: Dekafix 6.5-FS or approved equal, consecutive vertical, Number 4682.6 or Number 5766.6 as approved. Consecutive numbering conforming to that of DTS box.
 - d. Group marking carrier with paper marking strip and transparent cover.
 - (1) Type SCHAT5, Catalog No. 2924.6 or approved equal.
 - (2) Type ESO5, Catalog No. 2937.0 or approved equal.
 - (3) SST5, Catalog No. 2940.0 or approved equal.
- O. Fiberglass Conduit and Fittings:
1. Rigid fiberglass reinforced epoxy conduit, UL 1684, IPS (Iron Pipe Size) based conduit.
 2. Conduit shall be manufactured by using filament winding process with minimum fiberglass content of 65 percent by weight and no fillers.
 3. IPS based conduit with nominal wall thickness of 0.09 inches for five-inch nominal conduit size.
 4. Conduits, elbows and fittings manufactured from the same material and using the same manufacturing process.
 5. Conduit sections formed with integral bell and spigot type couplings. Rubber sealing gasket at bell end is prohibited.
 6. Conduits, elbows and fittings provided with protection from exposure to sunlight by pigmentation uniformly dispersed through resin material.

7. Adhesive as recommended by conduit manufacturer.
8. Conduits, elbows and fittings are specified for use throughout a temperature range of -40°F to 230°F, and they are to be protected from exposure to sunlight by pigmentation uniformly dispersed through the resin material.
9. Conduits, elbows and fittings shall be suitable for encasement in concrete below grade and conform to UL 1684, and listed and labeled by UL meeting the requirements of NEC Article 347 for Rigid Nonmetallic Conduit and its use.
10. Each piece of the straight length conduit and each piece of the elbow and other bend made from and for use with such conduit is to be labeled with the following information, mark clearly legible and durable every 10 feet or as recommended by the manufacturer.
 - a. "Reinforced Thermosetting Resin Conduit", "RTRC"; "Fiberglass Reinforced Epoxy Conduit", "FREC"; or equivalent, as applicable.
 - b. Normal Size: (IPS)
 - c. Manufacturer's name and trademark.
 - d. Temperature range for conduit application.
 - e. "Above Ground", "AG", "Below Ground", "BG", or equivalent wording, as applicable.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Use size, type, general routing, location of conduit, raceways, boxes and cabinets as shown and specified.
2. Install metallic raceway, fittings, boxes and cabinets free from contact with reinforcing steel.
3. Where aluminum is placed in contact with dissimilar metal or with concrete, separate contact surfaces by means of gasket, nonabsorptive tape or coating to prevent corrosion.
4. Make metallic conduit, raceways, ducts and cable trays, electrically and mechanically continuous and ground them in accordance with Section 16060.
5. Install FRE conduit where conduit runs are embedded in concrete and where conduit is shown as direct-burial.

B. Conduit:

1. Run exposed conduit parallel to building lines.
2. Install exposed conduit to avoid interference with other work.
3. Traction-power substations, tie-breaker stations, ac-switchboard, electrical, train-control, communication and mechanical rooms: Where shown or where necessary to prevent seepage of subsoil or water into such areas, seal where conduits in contact with concrete and seal cable inside conduit using cable seal or sealing compound in accordance with the following requirements:
 - a. Where shown and as necessary, install cable seal and conduit seal in accordance with the manufacturer's recommendations.
 - b. Use sealing compound where approved and in accordance with manufacturer's recommendations, with the following additional requirements:
 - (1) Before applying sealing compound, prime concrete, conduit and cable surface using primer recommended by manufacturer.
 - (2) Pour or inject compound to prevent voids inside seal and to keep cable centered in conduit.

- (3) Use FRE sleeve for conduit seal installed on traction-power, train-control and communication conduit.
- c. For 13.8 kv incoming-service cable, install cable seal in traction-power substation, ac-switchboard rooms and utility company manholes adjacent to WMATA facilities. Coordinate the work with utility company representative.
- d. In empty conduit installed for future use, install blank cable seal inside conduit to prevent seepage of water.
- e. All conduits free of water before conduit seals are installed.
- 4. Apply lead-free conductive anti-seize compound to threaded-conduit joints.
- 5. In outdoor and underground locations, except electrical rooms, use threaded-conduit hub to attach conduit to equipment enclosure. Use watertight conduit fitting with gasket, nylon-insulated throat and sealing locknuts for attachment of conduit to enclosure having punched or formed knockout.
- 6. In aboveground indoor locations and electrical rooms, use locknut and nylon-insulated bushing to attach conduit to enclosure.
- 7. Install suitable caps or plugs in empty conduit for future extension. Leave approved nylon or polyester pull line in each conduit.
- 8. Thread and ream ends of field-cut conduit to remove rough edges. Use bushing at conduit entrance to boxes, cabinets and equipment enclosures.
- 9. Bends:
 - a. Unless otherwise shown or specified, install conduit bends in accordance with reference codes.
 - b. Install bends in buried conduit in accordance with the following:

Size of Conduit (in inches)	Minimum Radius of Factory-Bend (in inches)	Minimum Radius of Field-Bend (in inches)
3	18	24
4	24	30
5	48	48
6	48	48

- c. Total bends in each conduit run for traction-power cable: 225 degrees maximum.
- d. Bend conduit so that field-made bend is free from cuts, dents and other surface damage.
- 10. Support conduit during construction to prevent distortion and to ensure independent support.
- 11. Support horizontal conduit with one-hole pipe straps or individual pipe hangers.
- 12. Secure conduit supported on multiple-hangers (trapeze) or channel inserts by fasteners suitable for such purpose.
- 13. Where conduit is attached to masonry surface, use malleable-iron spacers with Style A pipe straps.
- 14. Support and secure vertical conduit spanning open areas at intervals not exceeding 10 feet.
- 15. Support conduit above suspended ceiling using applicable specified methods.
- 16. Install conduit so as to drain moisture to nearest outlet or pull box.

17. Use minimum of 18-inch long liquid-tight flexible-conduit connection for equipment enclosure subject to vibration.
18. Do not use wire for support of conduit and cable.
19. Install expansion fitting in exposed conduit runs longer than 300 feet and where shown. Install expansion/deflection fittings where embedded conduits cross structural expansion joints. Where embedded conduits cross a structural contraction joint, paint the external surface of conduit with linseed oil or other compatible bond breaker for two feet on each side of contraction joint.
20. Buried FRE conduit: Install in accordance with the following requirements in addition to those specified elsewhere:
 - a. Arrange conduit to cross each expansion joint at right angle to joint.
 - b. Prevent concrete and other materials from obstructing the conduit. Pack outlets, pull boxes and junction boxes and cap conduit ends prior to pouring concrete.
 - c. Use Tight Lock Joint method to join conduit sections for providing water tightness and pull out strength.
 - d. Provide compatible conduit supports and spacers to maintain position of conduit during placement of concrete.
 - e. Install buried non-metallic conduit for cable over 600 volts in accordance with reference code.
 - f. Waterproof conduit connections.
 - g. Rod and swab conduit after installation so as to remove water, cement and other foreign matter; cap conduit ends. If obstructions cannot be removed or if condition exists which may result in damage to cable, replace conduit.
 - h. Leave approved nylon or polyester pull-line in each conduit.
21. Use metallic conduit or above ground FRE conduit in exposed locations.
22. Conduit installed in outdoor location: Waterproof conduit connection.
23. Use IPS FRE conduit for all concrete-encased applications except as follows:
 - a. Use FRE conduit with minimum wall thickness of 0.95 inch for train control conduit direct buried without concrete encasement where shown.
 - b. Install conduits encased in concrete ductbanks, associated manholes and handholes outside the structural work in accordance with Section 02585.

C. Channel Inserts and Spot Inserts:

1. Surface-mount channel inserts as shown.

D. Surface Raceways:

1. Install as shown.

E. Underfloor Raceways:

1. Install underfloor raceways as specified in Section 03100. Align and level raceways accurately. Hold raceways in place during placing of concrete.

F. Outlet, Junction and Pull Boxes:

1. Mount outlet boxes as shown.
2. Arrange front of box or attached plaster cover flush with finished wall or ceiling.
3. Keep number of knock-outs to minimum.
4. Clean boxes thoroughly after installation and correct damage to boxes and to finish.
5. Install covers on boxes mounted on walls and ceilings.
6. Measure height of wall-mounted outlet box from finished floor to horizontal centerline of cover plate.
7. Fasten floor boxes securely in place.

8. Install junction and pull boxes so that covers are readily accessible.
 9. Do not install boxes above suspended ceilings except where ceilings are removable or definite provision is made for access to boxes.
 10. Use stainless steel (Type 304) mounting channels, retaining straps and fasteners, pipe hangers for conduits and cables; expansion bolt anchors, junction boxes, outlet boxes, cover plates for receptacles, enclosures for load centers in tunnel environment which includes vent and fan shafts and under platform areas.
 11. Use non-metallic boxes as follows:
 - a. Buried with cover flush-mounted with finish grade: Precast concrete or composite material junction and pull boxes within AASHTO load designations as specified.
 - b. For indoor and outdoor locations not subject to pedestrian or vehicular traffic: Molded fiberglass-reinforced polyester junction and pull boxes.
 - c. For outdoor locations but not for burial: Molded polyvinyl chloride junction and pull boxes.
 12. For indoor locations as minimum use NEMA -1 enclosures.
- G. Cabinets:
1. Fasten cabinet securely using expansion bolts, toggle bolts or mounting ears.
 2. Touch-up damaged painted finish.
- H. Cable Trays:
1. Install cable trays neatly, adequately supported and as shown.
 2. For incoming-service cable from power company, install cable tray as approved by the power company.
- I. Use expansion-bolt anchors to secure equipment to concrete surfaces.
- J. Attachments to Prestressed-Concrete Girders:
1. Attach pipes, conduits, boxes or similar items to prestressed girders by welding to embedded plates or bolting to embedded fittings. Drilling into prestressed girders is prohibited, except for track fasteners and appurtenances as shown.
- K. DTS Cabinet and Terminals:
1. Install as shown.
- L. Car Wash Areas:
1. Use PVC-coated galvanized steel conduit.

3.02 FILLING OF OPENINGS:

- A. Where conduit and raceway pass through fire-rated walls, ceilings or floors, provide seals to prevent passage of fire and fumes and to maintain integrity of fire-rated structure in accordance with Section 07841.
- B. Where openings are provided for passage of conduit and raceways in walls, ceilings or floors, use fire-resistant fibrous-glass safing or similar material to seal unused openings to prevent passage of fire and fumes in accordance with Section 07841.
- C. Close unused openings or spaces in floors, walls and ceilings. Plug or cap unused conduit and sleeves.

3.03 IDENTIFICATION:

- A. At end of each run, use stainless steel or aluminum tags, minimum 1-1/2 inch diameter, with stamped markings, minimum 1/4-inch high lettering, and tag holders attached to conduit using a stainless steel band with worm screw clamping device to establish identification of conduits and raceways in accordance with designations shown. Where conduits are terminated flush with concrete structure, install three-ply laminated phenolic plate, engraved through black face to white core and attached adjacent to conduits' entrance by means of non-metallic screws. Engrave conduits' designations within circles arranged in pattern similar to that of conduits.
- B. Identify by red painted color code and by marking EMERGENCY SYSTEM on all boxes and enclosures for emergency circuits to identify them as part of an emergency system in accordance with the NEC.

3.04 FIELD QUALITY CONTROL:

- A. Arrange with the Engineer for inspection and approval of embedded conduit and boxes prior to concrete placement.
- B. Arrange with the Engineer for inspection by electrical utility company representative of incoming-service conduit prior to placing concrete.
- C. Test metallic conduit and boxes for electrical continuity. Conduct tests in presence of Engineer.
- D. Test not less than 0.5 percent of total installed channel inserts and spot inserts as directed for compliance with specified pullout-load rating. Replace and retest inserts which fail. Conduct tests in presence of Engineer.
- E. Arrange with the Engineer for inspection and approval of direct-buried conduits for future train control circuits prior to backfilling.

END OF SECTION

SECTION 16131

DC PEDESTAL AND WALL MOUNTED CONTACTOR SYSTEM

PART 1- GENERAL

1.01 DESCRIPTION

- A. This Section covers specification of the pedestal and wall mounted, enclosed DC contactor system that supplies 750 VDC to the vehicles for on-board testing and operation of non-traction power related loads.
- B. The DC contactor units shall be provided at required locations.
- C. Without limiting and/or restricting the volume of Work or the component details, the following sub-assemblies shall be included in the DC contactor system.
 - 1. 750 VDC contactor assembly including power and control circuits
 - 2. 750 VDC power cable with spring clip connector.
 - 3. Hanger-mount for storage of power cable.
 - 4. Floor-mounted galvanized steel channel support pedestal.
- D. Provide the 750 VDC contactor system as an integrated system, including all feeder conduits and feeder cables from the DC Switchboard Room, miscellaneous conduit support materials, and all labor, tools, and equipment.

1.02 RELATED SECTIONS

- A. Section 16119 - Medium Voltage Cable
- B. Section 16118 - Fiberglass Conduit

1.03 QUALITY ASSURANCE

- A. The work of this Section shall satisfy the applicable requirements of the following standards and regulations of jurisdictional authorities.
 - 1. National Electrical Code (NFPA 70)
 - 2. American National Standards Institute (ANSI)
 - 3. Occupational Safety and Health Administration (OSHA)
 - 4. Institute of Electrical and Electronic Engineers (IEEE)
 - 5. National Electrical Manufacturers Association (NEMA)
- B. All other applicable laws, ordinance and requirements of the local agencies and utility companies having jurisdiction.
- C. In the event of any conflicts in the provisions stipulated in the referenced codes, regulations or standards and the specifications, the most stringent provision, as determined by the Authority Representative is to govern.

1.04 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements set forth in General Requirements.
- B. Submit manufacturer's data for conduit and fittings specified herein including, but not limited to, dimensions, electrical rating and identification.

- C. Prior to final acceptance of work, submit a drawing or drawings showing the complete layout of the 750 VDC Contactor System.
- D. Operations and Maintenance Manual
 - 1. Contractor shall include the following elements in each manual, however, not necessarily in the order listed.
 - a. Table of Contents
 - b. Erection or installation instructions
 - c. Start-up procedures.
 - d. Detailed trouble-shooting procedures
 - e. Corrected and approved control and wiring diagrams.
 - f. Detailed layout and component arrangement drawing for the enclosed DC contactor.
 - g. Bill of Material for the major components (enclosure, relays, control devices, power cord, spring clip connector, etc.) The Bill of Material shall include manufacturer, catalog numbers, essential descriptive information about the component, address of manufacturers, and telephone numbers.
 - h. Color photographs (4"x6") of the constructed and functional DC contactor system in detail. The photographs shall be bound in a suitable loose-leaf photograph album having individual transparent pages for insertion of the photographs.
 - 2. Contractor shall submit the final operation and maintenance manuals to the Authority Representative. These manuals shall be technically accurate and complete, and shall represent the "as-built" system, piece of equipment or material. All illustrations, text, and tabular material shall be in final form: copies of all Shop Drawings submitted for approval shall be included for each major piece of equipment.
- E. Certification: Contractor shall furnish to the Authority Representative, the certified copies of the results of all tests and measurements made to determine the quality and serviceability of the manufactured equipment listed in this specification Section, at no additional cost to WMATA.
- F. DC Contactor System and Controls - System Integration: Assume complete responsibility for the design, component and material selection, manufacturing, installation, testing and operation of the DC Contactor power and controls as a system, into a complete, operable, and WMATA approved DC Contactor System.

PART 2 - PRODUCTS

2.01 DC CONTACTOR ASSEMBLY

- A. 150 Amp, 800 Volts, DC, electrically operated contactor, 120 Volts AC operated solenoid. Provide 120 VAC from external source for control circuit operation. Control relays shall be as manufactured by General Electric Company, Allen-Bradley, ASCO, or approved equal.
- B. Internal air clearances or solid dielectrics sufficient to withstand 4500 volt transient potentials on the circuit.
- C. Acceptable Manufacturer's:
 - 1. Microelectronica Scientifica; Model LTC-250-M-ADA.
 - 2. General Electric Company
 - 3. Westinghouse
 - 4. Approved Equal

2.02 POWER CABLE

- A. 1/C # 1/0 extra flexible Class K copper stranded conductor with low smoke, zero halogen silicon rubber insulation, rated 2 kV.
- B. Power cable shall be 30 feet long. Power cable shall be equipped with a spring-loaded clamp and protective 2kV insulated boot over clip.

2.03 ENCLOSURE - DC CONTACTOR

- A. Provide a Fiberglass, NEMA type 4X wall-mounted enclosure having the following minimum dimensional characteristics: 20.19" high 16.25" wide, and 12.00" deep. (Provide internal mounting panel, (17" high x 13" wide). Provide a larger enclosure if required by the contactor manufacturer for its equipment and circuit arrangement.
- B. Provide wireway to guide 1/0 AWG conductors within the enclosure.
- C. Acceptable Manufacturer's:
 - 1. Hoffman Engineering Co. A-20H1612GQRLP with A-20P16 Panel.
 - 2. Approval Equal.

2.04 CONTROL AND INDICATION

- A. Key Operated "ON" Pushbutton 2-position, cylinder lock momentary (oil tight) pushbutton with key removable in "LOCK" position only.
 - 1. Allen Bradley 800T-EI 1 A or equal, with extra large legend plate.
- B. "OFF" non-illuminated extended head oil tight pushbutton, red color, Form B contact block.
 - 1. Allen Bradley 800MR-N26 or equal. with extra large legend plate.
 - 2. "ON" Pilot Light, oil tight, red lens, push-to-test, full voltage 120 Volt LED, with extra large legend plate.
 - a. Allen Bradley 800T-QTH 1 OR or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install the DC contactor system in accordance with the manufacturer's recommended procedures.

3.02 FIELD TEST FOR EQUIPMENT OPERATION

- A. Perform a continuity test and megger test on the power circuit.
- B. Provide function testing of the control and power circuits with complete 120 VAC control and 750 VDC power.
- C. Contractor shall coordinate the interconnection between the DC Contactor System and the DC switchboard power and control circuits. Contractor shall be responsible for final connections to the DC switchgear and the associated commissioning, and final acceptance of the DC Contactor System by WMATA.

END OF SECTION

THIS PAGE NOT USED

SECTION 16145

WIRING AND CONTROL DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing switches, cover plates, limit switches, occupancy sensors, receptacles, plugs, magnetic contactors, automatic transfer switches, photoelectric controls and time switches.
- B. Related Work Specified Elsewhere:
 - 1. Wire connection accessories: Section 16125.
 - 2. Grounding and bonding: Section 16060.
 - 3. Raceways, boxes and cabinets: Section 16130.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. National Electrical Code (NEC).
 - 3. National Electrical Manufacturers Association (NEMA):WD1, General Color Requirements for Wiring Devices; KS1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; ICS 12, Profiles of Networked Industrial Devices--Part 1: General Rules; NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 4. American National Standards Institute (ANSI): Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
 - 5. UL: 98, Enclosed and Dead-Front Switches; 198D, Class K Fuses; 198E, Class R Fuses; 508, Industrial Control Equipment; 773, Plug-In Locking-Type Photocontrols for Use With Area Lighting; 1008, Transfer Switch Equipment.
 - 6. American Standards of Testing and Materials (ASTM): A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings; A276-00a, Standard Specification for Stainless Steel Bars and Shapes; and A507-00, Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled.
 - 7. ITS: Directory of ITS Listed Products
- B. Source Quality Control:
 - 1. Following items listed per referenced UL or ITS directory:
 - a. Snap switches.
 - b. Disconnect switches.
 - c. Receptacles and plugs.
 - d. Automatic transfer switch.
 - e. Lighting contactor.
 - f. Photoelectric control.
 - g. Time switch.
 - h. Occupancy sensor.

- C. Qualifications: Select a manufacturer who is regularly engaged in the production of automatic transfer switches.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings.
- B. Certification:
 - 1. Certified test reports of factory tests performed on each automatic transfer-switch unit in accordance with reference standards.
 - 2. Furnish certificate from manufacturer verifying that automatic transfer switches conform to specified requirements. Include certificate with submittal of shop drawings.
- C. Documentation for Automatic Transfer Switch:
 - 1. Submit field test plan within 60 days after award with accompanying documentation in the form of test data recording sheets and list of proposed test equipment for approval prior to testing.
 - 2. Submit certified copies of test data, dated and clearly identified within two weeks after completion of testing.
- D. Operation and Maintenance Manuals for Automatic Transfer Switch.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Mark each item in accordance with applicable reference standard.
- B. Ship each unit securely packaged and labeled for safe handling and to avoid damage
- C. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Snap Switches:
 - 1. NEMA WD1, specification grade.
 - 2. Rating:
 - a. Twenty amperes at 120-277 volts ac.
 - b. Horsepower-rated when used as disconnecting device for motor circuit.
 - 3. Body and base: Fully enclosed, brown, fire-resistant, non-absorptive thermosetting urea or nylon.
 - 4. Contacts: Silver alloy.
 - 5. Mounting yoke: Corrosion-resistant metal with plaster ears.
 - 6. Poles: Single-pole, double-pole, three-way or four-way as shown.
- B. Disconnect (Safety) Switches:
 - 1. UL 98, NEMA KS1, heavy-duty, fusible or non-fusible as shown.
 - 2. Voltage rating: 240 volts ac, 480 volts ac or 250 volts dc as shown and as necessary.

3. Number of poles and current rating: As shown and as necessary.
4. Fuses:
 - a. UL 198D.
 - b. For fused disconnect switch associated with motor load: UL Class RK5 with time delay or as shown.
 - c. For fused disconnect switch associated with other loads: UL Class RK1 or as shown.
 - d. Current rating: As shown.
5. Enclosure: (NEMA 250)
 - a. Type:
 - (1) For aboveground indoor locations and electrical rooms: Type 1.
 - (2) For outdoor locations: Type 3R.
 - b. Materials:
 - (1) Steel sheet: ASTM A507-00.
 - (2) Malleable iron: ASTM A47/A47M-99.
 - c. Finish: Metallic surface cleaned, degreased, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.
6. Quick-make/quick-break switching mechanism with operating handle external to enclosure with positions labeled ON/OFF and capable of being padlocked in OFF position, defeatable interlock to prevent opening of enclosure door when switch is closed.

C. Receptacles and Plugs:

1. NEMA WD1, specification grade.
2. Rating: 20 amperes at 125 or 250 volts as shown.
3. Base and body: Brown, fire-resistant, non-absorptive thermosetting urea or nylon.
4. Receptacles:
 - a. Outlet: Single or duplex as shown.
 - b. Mounting yoke: Corrosion-resistant metal with plaster ears.
 - c. Configuration:

Rating	NEMA Configuration
Two-pole, three-wire, 20 amps, 125 volts	5-20 R
Two-pole, three-wire, 20 amps, 250 volts	6-20 R

- d. For use in restroom; water service room; locker room; wash rooms; elevator machine room, pit and hoistway; and outdoor locations: Equipped with solid-state ground-fault circuit interrupter with five-milliampere trip level.
5. Plugs:
 - a. Configuration and design: As follows unless otherwise shown:

Rating		NEMA Configuration
Two-pole, three-wire, 20 amps, 125 volts	Urea or neoprene with cord grip	5-20 P
Two-pole, three-wire, 20 amps, 250 volts	Armored cap with cord grip	6-20 P

D. Cover Plates:

1. Wall plates:
 - a. NEMA WD1, suitable for specified receptacles and switches, size suitable for recess-mounted or surface-mounted associated outlet box, stainless steel, ASTM A276-00a, Type 304, or approved equal.
 - b. For above ground indoor service areas and electrical rooms: Steel, stainless steel or aluminum plate, as standard with the manufacturer.
 - c. For receptacles in outdoor and underground locations, except electrical rooms: Stainless steel, ASTM A276-00a, Type 304, wall plate with gasketed spring-loaded hinged cover.
2. Floor plates: Section 16130.

E. Automatic transfer switch: UL-1008, electromechanical, in surface-mounted enclosure as shown, with the following additional requirements:

1. Operating and electrical characteristics:
 - a. Capable of transferring load automatically from normal source to alternate source when the voltage drops to 85 percent of rated voltage on any phase for set time. Operating point adjustable over range of 80 to 90 percent of rated voltage and time-delay adjustable over range from zero to five minutes in increments of at least eight steps.
 - b. Capable of transferring load automatically from alternate source to normal source when normal source returns to 90 percent of rated voltage for set time. Operating point adjustable over range of 85 to 100 percent of rated voltage and time-delay adjustable over range from zero to five minutes in increments of at least eight steps.
 - c. Capable of transferring load automatically from normal source to alternate source when normal source failure is simulated by integral test switch.
 - d. Rating:
 - (1) Number of poles: Three or four.
 - (2) Voltage rating: 480-volt, three-phase, three-wire or 480Y/277-volt, three-phase, four-wire, 60 Hertz system as shown.
 - (3) Current rating: As shown and rated 100 percent.
 - (4) Transfer time: Ten cycles maximum on 60-Hertz base after initiation signal.
 - (5) Short-circuit current rating, rms symmetrical amperes: 14,000; 22,000; 25,000; 30,000; 35,000; or 50,000 as required and shown.
 - (6) Capacity to close into available short-circuit current or let-through current of fuses without functional degrading.

- e. Solid-state control panel for sensing and control logic with accuracy of plus-or-minus two percent on voltage and frequency settings over a temperature range of minus 20 degrees to plus 70 degrees.
- 2. Design and construction features:
 - a. Mechanically held, electrically operated, double-throw switch.
 - b. Electrical and mechanical interlock to prevent maintained neutral position.
 - c. Designed to break-before-make on transfer and retransfer.
 - d. Equipped with renewable silver-alloy contact.
 - e. Neutral bus or terminal provided on 480Y/277-volt, three-phase, four-wire unit to allow interconnection of neutral conductors.
 - f. Pilot lights on door to indicate switch position as follows:
 - (1) On normal source: Green light.
 - (2) On alternate source: Red light.
 - g. Pilot lights on door to indicate:
 - (1) Normal source available: Green or white light.
 - (2) Alternate source available: Red or white light.
 - h. Contacts opened by single solenoid, motor operator or stored energy mechanism.
 - i. Handle provided to permit manual operation of automatic transfer switch for maintenance purposes.
 - j. Power conductors made of silver-plated copper bus.
 - k. Equipment ground lug provided.
- 3. Enclosure:
 - a. Type:
 - (1) For aboveground indoor locations and electrical rooms: NEMA Type1.
 - b. Door: Hinged with handle and latch.
 - c. Material: Steel.
 - d. Finish: Metallic surface thoroughly cleaned, degreased, primed with zinc primer and finished with gray enamel, ANSI Z55.1, Color No. 61; two mils minimum DFT.

F. Lighting Contactors:

- 1. NEMA ICS 2, UL 508, electrically held, equipped with silver-alloy contacts, designed to control incandescent, tungsten, halogen, fluorescent, high-intensity discharge lamp load.
- 2. Number of poles: As shown.
- 3. Continuous current rating: As shown.
- 4. Line and load voltage: 480-volt or 208-volt three-phase or 277-volt or 120-volt single-phase as shown.
- 5. Control coil rated 120 volts.
- 6. 480-volt or 277-volt to 120-volt control transformer fused on secondary and primary as required.
- 7. Control:
 - a. Heavy-duty, three-position selector switch with positions labeled HAND/OFF/AUTO for lights controlled by photo-electric cell.
 - b. ON-OFF push button for indoor lights.
- 8. Enclosure: NEMA 250, Type 1; fabricated from steel, cleaned, degreased, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.

- G. Photoelectric Control:
1. UL 773, designed to respond to natural daylight with 15-second inherent delay to prevent functioning due to sudden bright light such as vehicle lights or lightning and to operate in ambient temperature from minus 50C to plus 60C.
 2. Adjust to turn lights ON at two plus-or-minus one foot-candles, unless otherwise specified. ON to OFF ratio: One to three.
 3. Rating: 1,800VA at 120 volts or 277 volts, 60 Hertz, as shown.
 4. Contacts:
 - a. For control of outdoor lights: SPST, NC contact.
 5. Cells: Hermetically sealed.
 6. Enclosure: Weatherproof and tamper proof aluminum or non-metallic enclosure equipped with locking receptacles when mounted on fixture or designed for mounting on outlet box as shown and as necessary.
- H. Limit Switches:
1. NEMA ICS 2, industrial-control.
 2. Suitable for mounting in folding-gate cabinet. Switch contacts closed when cabinet door is fully closed and latched. Switch contacts opened when respective cabinet door is not fully closed.
 3. Voltage rating: 120 volts ac.
 4. Current rating: 10-amperes continuous.
 5. Enclosure: NEMA 250, Type 13.
 6. Actuator: Lever-operated and adjustable, with spring return.
 7. Mounting: Plug-in type with receptacle tapped for conduit size as shown.
 8. Contacts: Single-pole double-throw; one NO, one NC; snap action.
- I. Time Switch:
1. Seven-day and 24-hour calibration for each day time switch, listed per referenced UL or ITS directory, heavy-duty type suitable for controlling type of lighting fixtures shown.
 2. Type: As shown, with contacts capable of switching continuous load of 20 or 40 amperes per pole at 277 volts as necessary.
 3. Seven-day, 24-hour dial with day and night zones and 24-hour calibration for each hour clearly marked.
 4. Providing up to four automatic ON/OFF operations each day.
 5. Removable ON/OFF trippers designed for minimum ON period of one hour and minimum two-hour period between one OFF operation and next ON operation.
 6. Provision for manual ON and OFF operation of switch by hand without disturbing weekly preset schedule.
 7. Provision for omitting operation of switch on selected days.
 8. Spring-driven reserve power suitable for operation of switch for 16 hours minimum after failure of power. On restoration of power, switch transfers to synchronous motor drive and automatically rewinds spring.
 9. Terminals designed to accommodate up to 8AWG conductor cable.
 10. Operation at 480/277Y or 208Y/120 volts, 60 Hertz as shown and within temperature range of zero degree F to plus 140F.
 11. Enclosure:
 - a. NEMA 250, Type 1, steel, surface-mounted.
 - b. Hinged flush front door with catches and spring-loaded door pull.
 - c. Finish: Metallic surfaces cleaned and degreased, primed with zinc primer and finished with one coat of light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.

- J. Occupancy Sensor:
1. UL 508, passive infra-red motion detector designed for wall mounting over single-gang outlet box, minimum radio frequency interference and use with incandescent and fluorescent lighting fixtures and electronic ballasts.
 2. Voltage rating: 120-277 volts ac.
 3. Switching capacity:
 - a. 120-volt operation: 800 watts minimum.
 - b. 277-volt operation: 1,500 watts minimum.
 4. Coverage area: 1,000 square feet.
 5. Detection zone:
 - a. Horizontal: 180 degrees.
 - b. Vertical: 5 degrees.
 6. Ambient light sensing: Photocell for preventing operation of lights at ambient light levels above an adjustable setting.
 7. Adjustments: Adjustable settings for time delay, sensitivity and light level concealed by tamper proof cover. Time delay adjustable from 10 seconds to 15 minutes after motion stops.
 8. Operating mode: OFF/AUTO.
 9. Detection indicator: LED.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install switches, limit switches, occupancy sensors, receptacles, automatic transfer switches, lighting contactor, photoelectric controls and time switches as shown and in accordance with referenced codes and standards in Article 1.02, and manufacturer's instructions.
- B. Install cover plate on switch and receptacle.
- C. Install cover plate with gasketed spring-loaded cover, on each receptacle in outdoor and underground locations except electrical rooms.
- D. Ground disconnect switch, time switches, automatic transfer switches, receptacles, snap switches, photoelectric controls and lighting-contactor enclosures in accordance with Section 16060.
- E. Make power cable connections to snap switches, plugs, time switches, occupancy sensors, photoelectric controls, receptacles, automatic transfer switches and lighting contactors by means of integral mechanical connectors. If such items are not furnished with integral mechanical connectors, make connections using compression connectors in accordance with Section 16125.
- F. Make power cable connections to snap switches and receptacles using their side screw wiring connection terminals.
- G. Apply matching touch-up paint as necessary.

3.02 FIELD QUALITY CONTROL:

- A. Furnish necessary test equipment and perform the following in the presence of the Engineer, in accordance with approved procedures:

1. Test time switches, receptacles and contactors for connection in accordance with wiring diagram.
 2. Test equipment enclosure for continuity to grounding system.
 3. Check tightness of cable connections of snap switches, receptacles, time switches, occupancy sensors, disconnect switches, automatic transfer switches, lighting contactors, photoelectric controls and limit switches.
 4. Test operations of circuits and controls of switches, occupancy sensors, receptacles and contactors.
 5. Automatic transfer switches:
 - a. Test switches for connection in accordance with wiring diagrams.
 - b. Calibrate and set voltage-sensing device for each source and time delay for transfer and retransfer as follows and as approved:
 - (1) Automatic transfer switches for fan shafts and drainage pumping stations: Time delay setting for transfer equal to total of 30 seconds for each connected motor or additional time as required.
 - (2) Time delay setting for retransfer equal to or greater than time delay setting for transfer.
 - c. Perform automatic transfer of load in accordance with the following requirements:
 - (1) With power available on both the normal and alternate sources, initiate automatic transfer from the normal source to the alternate source by opening the disconnect switch or circuit breaker on the line side of the automatic transfer switch for the normal source. Check that the switch position changes to the alternate source and remains connected to the alternate source.
 - (2) With power available on the alternate source and the switch connected to the alternate source, initiate automatic transfer to the normal source by closing the disconnect switch or circuit breaker on the line side of the automatic transfer switch for the normal source. Check that the switch position changes to the normal source and remains connected to the normal source.
 - (3) If testing indicates failure to comply with specified requirements, modify settings for the automatic transfer switch so that the specified requirements are met. Conduct additional tests witnessed by the Engineer to prove compliance with specified requirements.
- B. Submit certified test reports for compliance with field quality control requirements.

END OF SECTION

SECTION 16225

MOTORS

PART 1 - GENERAL

1.01 DESCRIPTIONS:

- A. This section specifies providing motors.
- B. Related Work Specified Elsewhere:
 - 1. Grounding and bonding: Section 16060.
 - 2. Wire connection accessories: Section 16125.
 - 3. Raceways, boxes and cabinets: Section 16130.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. IEEE: 85, 112.
 - 4. NEMA: MG1.
 - 5. ANSI: Z55.1.
 - 6. ASTM: A582.
 - 7. OSHA: 1910.95.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Outline dimensions.
 - 2. Cross section showing internal construction and weight.
 - 3. Connection diagram.
- B. Certification.
- C. Operation and Maintenance Manuals.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship each motor securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Store motors in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. Motors:
 - 1. NEMA MG1, squirrel-cage, induction-type, unless otherwise shown.

2. Rating:
 - a. Horsepower: As shown.
 - b. Voltage and frequency:
 - (1) Motors, 1/2 HP and smaller: 115-volt, single-phase, 60 Hertz.
 - (2) Above 1/2 HP: 460-volt, three-phase, 60 Hertz, unless otherwise specified or shown.
 - (3) For motors in air-conditioning units:
 - (a) For units up to and including 10,000 BTUH: 115-volt, single-phase, 60 Hertz.
 - (b) For units from over 10,000 BTUH up to and including 36,000 BTUH: 208-volt, single-phase, 60 Hertz.
 - (c) For units over 36,000 BTUH: 460-volt, three-phase, 60 Hertz.
 - c. RPM: As shown.
 - d. Time rating: Continuous, unless otherwise shown.
 - e. Nominal full-load efficiency: Premium Efficiency when tested in accordance with NEMA MG1 and IEEE 112.
3. Design:
 - a. Single-phase motors: Design N, suitable for full-voltage across-the-line starting.
 - b. Three-phase motors: Design B, unless otherwise shown, with the following additional requirements:
 - (1) Up to and including 50-HP motors: Suitable for full-voltage across-the-line starting.
 - (2) Above 50-HP motors: Suitable for reduced-voltage starting.
4. Service factor:
 - a. Motors, one HP and smaller: In accordance with NEMA MG1.
 - b. Above one-HP up to and including 200-HP motors: 1.15.
 - c. Above 200-HP motors: 1.00.
5. Insulation: Class and allowable temperature rise above average ambient temperature of 30C and maximum ambient temperature of 40C as follows:
 - a. Integral-horsepower motors:
 - (1) Dripproof motors: Class B insulation with Class B temperature rise.
 - (2) Totally enclosed motors: Class F insulation with Class B temperature rise, unless otherwise shown or specified.
 - b. Fractional-horsepower motors: In accordance with NEMA MG1.
6. Noise level: NEMA MG1-12.49 but not to exceed requirements of OSHA 1910.95 when measured in accordance with IEEE 85.
7. Enclosure:
 - a. Dripproof, fully guarded; totally enclosed fan-cooled guarded; or totally enclosed air-over as specified.
 - b. Heavy-duty steel or cast-iron frame.
 - c. End bell:
 - (1) Up to 10HP: With cast-iron or aluminum end bells.
 - (2) 10HP and above: With cast-iron end bells.
 - d. Mounting: Foot-mounted on pad or adjustable pad, if necessary or as otherwise shown.
 - e. Provision for grounding.
 - f. Finish: Red-oxide zinc-chromate primer with finish coat of light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.
 - g. Totally enclosed air-over:
 - (1) Variation to totally enclosed fan-cooled machines with air flow for cooling supplied by fan specified elsewhere.

- (2) Fan/motor application factory-engineered for air flow shown or specified.
- 8. Conduit box:
 - a. Diagonally split, suitably gasketed.
 - b. Type:
 - (1) Up to 10HP: Steel, cast iron or aluminum with threaded or punched conduit holes.
 - (2) 10HP and above: Cast iron with threaded conduit holes.
 - c. Size suitable to accommodate motor and line leads including taping.
 - d. Capable of rotation in each 90-degree position.
- 9. Bearings:
 - a. Unless otherwise specified, average life 15 years, but not less than three years at continuous operation, with double shields.
 - b. Integral-horsepower motors:
 - (1) Five HP and smaller: Sealed ball bearings or roller bearings.
 - (2) Above five HP: Ball bearings or roller bearings with grease fittings and pressure-relief fittings for in-service lubrication.
 - c. Fractional-horsepower motors:
 - (1) 1/6 HP and larger: Sealed ball bearings.
 - (2) Below 1/6 HP: Sealed ball bearings or sleeve.
- 10. Motors for hermetically sealed and semi-hermetically sealed compressors: NEMA MG1, 18.076 through 18.093.
- 11. Motors for close-coupled pumps: Stainless-steel shaft in accordance with ASTM A582, Type 303.
- 12. Provide nameplate on each motor in accordance with NEMA MG1-10.37.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install motors where shown and in accordance with the NEC.
- B. Install conduit in accordance with Section 16130.
- C. Connect power cable in accordance with Section 16125.
- D. Ground motor enclosure in accordance with Section 16060.

3.02 FIELD QUALITY CONTROL:

- A. Furnish necessary equipment and perform the following tests:
 - 1. Check and test wiring connections in accordance with wiring diagram.
 - 2. Test to ensure that insulation resistance of motor winding is 10 megohms minimum.
 - 3. Test motor enclosure for continuity to grounding system.
 - 4. Test motors for proper operation with their associated controls.
- B. Submit certified test reports.

END OF SECTION

THIS PAGE NOT USED

SECTION 16260

UNINTERRUPTIBLE POWER SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing uninterruptible power system (UPS) consisting of rectifier/charger, storage battery, battery-disconnect circuit breaker, inverter, power transfer switch, main emergency panelboard, and floor mat.
- B. Related Work Specified Elsewhere:
1. Raceways, boxes and cabinets: Section 16130.
 2. Wire, cable and busways: Section 16120.
 3. Grounding and bonding: Section 16060.
 4. Circuit breakers, panelboards and load centers: Section 16440.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of jurisdictional authorities.
 2. National Electrical Code (NEC).
 3. National Electrical Manufacturers Association (NEMA): PE1, Uninterruptible Power Systems
 4. American National Standards Institute (ANSI): C39.1, Requirements, Electrical Analog Indicating Instrument; and Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
 5. ANSI/NEMA: PB1, Panelboards, and 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 6. ANSI/IEEE: C57.12.90, Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers; 450, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications, and 484, IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications.
 7. UL: 50, Enclosures for Electrical Equipment; 67, Panelboards; 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; and 198C, High-Interrupting-Capacity Fuses, Current Limiting Type.
 8. American Standards of Testing and Materials (ASTM): B187-00 Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes; and D635-98 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
 9. ANSI/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): 52.1, Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 10. ANSI/American Hardboard Association (AHA): 135.4, Basic Hardboard.
 11. The equipment manufacturer shall maintain ISO 9001 or ISO 9002 certification

B. Source Quality Control:

1. Design and production tests: Perform and submit, in accordance with the General Requirements certified test results for the following tests on the uninterruptible power system or provide certified test reports on identical unit. Furnish certified test reports showing test data and results as well as manufacturer's comments on oscillograph traces obtained during in-rush test and short-circuit coordination tests.
 - a. Storage battery: Perform tests to determine the following:
 - (1) Ampere-hour rating of battery during three-hour discharge period.
 - (2) Charge rate starting from fully discharged state based on 105-volt terminal voltage, to 90-percent of fully charged state within 12 hours.
 - (3) Maximum short-circuit current available at battery terminals at full charge.
 - b. Rectifier/Charger: Perform tests to ensure that:
 - (1) Unit has capacity to feed specified load including overload capacity of static inverter.
 - (2) Output voltage regulation is within specified tolerance.
 - (3) Unit has specified efficiency at rated output.
 - (4) Unit is current limiting when activated by an external contact closure from an engine driven generator.
 - c. Static inverter: Perform tests to ensure that:
 - (1) Unit has capacity to feed rated kVA into load which has power factor of 0.8 lagging.
 - (2) Unit has capacity to deliver specified overload.
 - (3) Output voltage has sine wave with maximum of five-percent total harmonic distortion.
 - (4) Output voltage and frequency regulation are within specified limits.
 - (5) Efficiency at rated output at unity power factor of load is within specified limits.
 - d. Power transfer switch: Perform tests as recommended by the manufacturer and verify compliance with specified requirements.
 - e. Uninterruptible power system: Perform following tests with UPS in normal operating mode and alternate power available on transfer switch:
 - (1) In-rush test: Test to verify that power transfer switch and inverter power circuits remain operative without reset or replacement of protective devices while the following test is performed:
 - (a) 480-208Y/120-volt transformer with primary protection and full-load on secondary side as specified below connected to load side of power transfer switch, close transformer primary switch 10 times to provide maximum magnetizing in-rush. Record calibrated oscillograph traces of three-phase output voltages and line currents on load side of power transfer switch. Include oscillograph traces with the submittals.
 - i. Inverter below 25 kVA: Nine-kVA transformer with disconnect switch fused at 20 amperes on primary side.
 - ii. Inverter 25 kVA or larger: 15-kVA transformer with disconnect switch fused at 30 amperes on primary side.

- (2) Short-circuit coordination test: Test to verify that distribution-panel fuses clear fault and that protective devices in inverter and power transfer switch continue to function without reset and equipment remains fully operable while the following test is performed:
 - (a) With main emergency panelboard connected to load side of power transfer switch using 10 feet of 1/0-AWG three-conductor cable, with UL Class J or RK1 fuses sized as follows, in one panelboard feeder, with specified short-circuit current available at input terminals of rectifier/charger and at bypass-circuit terminals of power transfer switch, close fuse switch on bolted three-phase fault at load terminals of branch circuit. Repeat test three times and record calibrated oscillograph traces of three-phase voltages of inverter output and bypass source, and fault current from power transfer switch.
 - i. In panelboard fed by inverter below 25 kVA: 20-ampere fuses.
 - ii. In panelboard fed by inverter 25 kVA and larger: 30-ampere fuses.
- (3) Input power factor: Test to determine input power factor at rated inverter output.

- C. Furnish products of a manufacturer regularly engaged in the manufacture of uninterruptible power systems.
- D. Qualifications of Instructor for Operation and Maintenance Training: Qualifications will be considered adequate when the following is demonstrated:
 - 1. Instructor has in-depth knowledge of the design, packaging, operations, maintenance and trouble-shooting of the systems to be taught.
 - 2. Instructor has been trained in teaching methods or has previous satisfactory experience in teaching with emphasis on the subject matter to be covered in the course of instruction.

1.03 SUBMITTALS:

- A. General: Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
- B. Shop Drawings: In accordance with Table 16260-1.
- C. Certification.
- D. Documentation:
 - 1. Submit field-test plan and documentation within 60 days after award with accompanying documentation in the form of test-data recording sheets and list of proposed test equipment.
 - 2. Do not proceed with testing until plan and documentation are approved.

3. Indicate in scope of test plan method of testing equipment in order to ensure safe and orderly transition from installation, through initial energizing, to specified field testing.
 4. Accompanying documentation to include data-recording sheets as used by manufacturer for in-plant testing of equipment and devices or as used by large industrial users of specified equipment.
 5. Submit certified copies of test data, dated and clearly identified within two weeks after completion of testing.
 6. Certified test data for specified enclosure intake filter performances.
 7. Instructor qualifications: Five copies of resume which outlines each instructor's qualifications and skills not later than 180 calendar days prior to commencement of training.
- E. Operations and maintenance training material: Five copies not later than 180 calendar days prior to commencement of training.
- F. Operations and Maintenance Manuals:
1. Include in manuals general theory of operation of the Uninterruptible Power System including description, purpose and function of:
 - a. Battery.
 - b. Rectifier/Charger.
 - c. Inverter.
 - d. Transfer switch.
 - e. Maintenance bypass arrangement.
 - f. Logic power supplies.
 - g. All logic boards.
 2. Describe and include in manuals procedures for:
 - a. Battery testing and for optimizing:
 - (1) Float voltages.
 - (2) Equalizing voltages.
 - (3) Equalizing time adjustments.
 - b. Operational checks of:
 - (1) Transfer to bypass source.
 - (2) Retransfer from bypass to inverter.
 - c. Alignment and adjustment of operating, detector and alarm circuits including rectifier, inverter and power transfer switch logic boards.
 - d. Troubleshooting to include test procedures and system logic in identifying malfunctions.
 3. Include in manual the shop drawings listed in Table 16260-1. Print shop drawings on folded pages in accordance with the General Requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Ship battery cells assembled and filled to proper level with electrolyte and fully charged.

- C. Temporary Bracing: Where necessary, brace each unit for hoisting, lowering and skidding into position. Temporary internal bracing of the equipment labeled as follows: TEMPORARY-REMOVE BEFORE OPERATION.
- D. Protection Against Concealed Damage: Include within shipping container mechanical impact recorder of rating recommended by manufacturer for shipment by railroad and submit in accordance with the General Requirements impact chart with manufacturer's recommendations for disposition of damaged materials.
- E. Store equipment in secure and dry storage facility.

1.05 WARRANTY FOR STORAGE BATTERY:

- A. In addition to warranty requirements of the General Provisions, furnish a four-year warranty for a total of five years against defective parts and workmanship and a 19-year warranty for intended operation for a total of 20 years.

1.06 OPERATION AND MAINTENANCE TRAINING:

- A. Perform operation and maintenance training in accordance with the General Requirements and the following additional requirements for development and performance of operation and maintenance training for uninterruptible power system:
- B. Use only instructors who are fully qualified for their presentations as required above under Quality Assurance.
- C. Concept of Training:
 - 1. Design classroom and field instruction to cover in detail the functions of each item of equipment. Cover fault isolation and troubleshooting technique to the extent necessary to permit a technician to diagnose and repair faulty modules. Design instruction to provide Authority maintenance personnel with practical experience in the performance of preventive and corrective maintenance. Provide troubleshooting and fault isolation of simulated faults for each item of equipment in the unit substation.
 - 2. Develop and provide all operation and maintenance training necessary for Authority-designated personnel to support the power equipment. Have classroom instruction include not only the anatomy and functioning of the parts under discussion, but the essentials of their routine care, including lubrication schedules, adjustments, limits, test frequency, inspection frequency, troubleshooting, removal and replacement. Have instruction cover theory of operation of the power systems, individual modules and special protective circuits. Use flow diagrams to show sequence of events and time required to complete each event.
 - 3. Have the course include performance of preventive maintenance operations on the equipment and hands-on troubleshooting of each subsystem.
 - 4. In training, assume the Authority's employees have no knowledge of the features of the new equipment. The Authority is permitted to videotape all class presentations.

D. Training materials:

1. Develop first-generation reproducible training material.
2. Conduct training using final manuals approved by the Authority and certified by the Contractor as being correct, as-built and reproducible. These materials become the property of the Authority at the end of program.
3. Develop the following training materials for each course:
 - a. Instructor material for each course.
 - b. Course outline: Course outline with learning objectives. Include a topic outline for each item of equipment. Include in maintenance training a section devoted to system-fault analysis and troubleshooting. State the learning objectives for each topic.
 - c. Lesson plans: A set of lesson plans for each item of equipment, corresponding to the topic outline, and containing the following information:
 - (1) Lesson title.
 - (2) Instruction time.
 - (3) Objectives.
 - (4) Training aids required.
 - (5) Instruction sequence (outline).
 - (6) Tests.
 - (7) Summary.
 - d. Training aids: For each topic, develop optimum use of visual aids, including transparencies size eight-inch by 10-inch, 35-mm slides, films, and mockups. Provide approved shop drawings in transparency.
 - e. Instructional material: Use the applicable equipment operation and maintenance manuals as the primary source of instructional material. In addition, develop notebooks for each course containing such additional drawings, descriptive information and procedures necessary to ensure that the learning objectives are met in an orderly and timely manner. Arrange notebook material by each item of equipment and sequence according to the topic outline.
 - f. Course topic outlines and schedules: Have the topic outline and schedules for each course contain the following:
 - (1) Description of course including course objectives and training program level.
 - (2) Course length and recommended numbers of students per course.
 - (3) List of training materials required including documentation and equipment.
 - (4) For each topic outline for the course, a topic objective and the time allotted to the topic.
 - (5) Schedules listing the major topics and subtopics on a time allocation for each topic.
 - g. Instructor guides and training aids: Have the instructor guide for each course include:
 - (1) Table of contents listing each topic and the time allotted.
 - (2) List of applicable documents.
 - (3) List of training materials.
 - (4) Course learning objectives, course length and recommended number of students.

- (5) Provide each topic with a cover sheet listing topic, objective, time allotted and training aids required.
- (6) Include training aids with the instructor guides.
- h. Student workbook: Reproduce diagrams, drawings and procedures from engineering data and manuals and include them in student handout.

E. Instructional Equipment: Conduct training utilizing installed equipment in normal operating conditions, permitting the trainees to perform hands-on work.

F. Course of Instruction:

- 1. Conduct this course for Authority-designated individuals; providing in-depth instruction on the fundamentals involved in the design of the complete system combined with practical aspects of operation and maintenance. Include also the following:
 - a. Practical exercises that require the trainees to make use of the operation and maintenance manuals.
 - b. Familiarization with the assembly, subassembly and components that make up a total system. Include instruction and practical exercises in troubleshooting at a level higher than that performed by equipment operators.
 - c. Use and replacement of original assemblies, subassemblies and components with compatible assemblies, subassemblies and components manufactured by others.
 - d. Handouts to each trainee that include information drawings, shop drawings, catalog cuts, manufacturer's literature, equipment maintenance check lists and other literature describing the total system.
 - e. Video and color slide presentations showing system installation, operation, troubleshooting, maintenance, module removal and replacement.
 - f. Tools and test equipment necessary to conduct operation and equipment maintenance troubleshooting.
- 2. Supplemental Training: In the event Contractor changes or performs modifications to equipment subsequent to the training that impact form, fit or function; provide supplementary training to the Authority's training instructor on a one-time basis.

G. Scope: The training program consists of the following:

Course Title	Length of Course Hours	Number of Persons Per Course	Number of Courses	Total Number of Course Hours
Operation and Maintenance Training	80	10	2	160

- 1. Provide practical training on equipment for not less than 60-percent of the course duration.
 - a. Location: Conduct training classes at facilities provided by the Authority.
 - b. Times: Set class times at the convenience of the Authority.

2. Contractor may propose four courses at 40 hours each in lieu of two courses at 80 hours each subject to approval.

H. Equipment:

1. Training equipment: Supply and deliver to the Engineer after completion of the course special tools required for maintenance training.
2. Test equipment: Supply and deliver to the Engineer after completion of the course test equipment required for maintenance training.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. General: Comply with NEMA PE1.

1. Interchangeability: Components of same type, size, rating, functional characteristics and make are to be interchangeable.
2. Enclosure:
 - a. Rectifier/charger, inverter, and power transfer switch provided with common ANSI/NEMA 250, Type 1-EFVF enclosure (Evacuated forced ventilation with inlet air filters), or ANSI/NEMA 250, Type 1-FVFF enclosure (Forced ventilation with inlet air filter and outlet air filter), with gasketed dust-tight doors.
 - b. Intake filter: Intake filter easily removable from front of unit, throw-away or washable, providing an average ANSI/ASHRAE 52.1 efficiency of 30-percent and an average ANSI/ASHRAE 52.1 arrestance of 95-percent.
 - c. Design: Panel-type, with hinged front door suitable for mounting meters and accessories, ventilated for satisfactory operation of equipment under ambient temperature up to 105F.
 - d. Fabricated from minimum 14-gauge steel sheet and reinforced with steel framework to form rigid structure with smooth outer surface free of burrs, ridges or other blemishes.
 - e. Equipped with latch and handle; screw fastenings will not be accepted in lieu of latch.
 - f. Provision for grounding enclosure.
 - g. Finish: Metallic surfaces cleaned, degreased, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1 Color 61, two mils minimum DFT.
3. Control and instrument wiring:
 - a. Factory-installed.
 - b. Wire: Type SIS tinned-copper wire; 22AWG minimum for control logic and printed circuit card and 18AWG minimum for other control circuits. Class C or D stranded wire used for wiring across hinged joints.
 - c. Wire terminals: Tinned-copper ring or spade-type compression terminals with insulated sleeve installed in accordance with manufacturer's recommendations.
 - d. Wire identification: Each wire identified with the circuit number corresponding to that shown on wiring diagrams adjacent to terminal connections.

4. Fuses: Current-limiting fuse installed in each control circuit and where necessary for protection and coordination in power circuits.
5. Nameplates:
 - a. Provide nameplate on each UPS in accordance with reference standards.
 - b. Three-ply, laminated phenolic plates; engraved through black face to white core and attached by means of steel rivets or screws.
 - (1) Lettering to be vertical Gothic using a round or square cutter. V-shaped groove not acceptable.
 - (2) Each UPS enclosure labeled with nameplate 1-1/2 inches high with letters one-inch high: UNINTERRUPTIBLE POWER SYSTEM.
 - (3) Each main emergency panelboard labeled with nameplate one-inch high with letters 1/2-inch high: EMERGENCY POWER PANEL.
 - c. Provide nameplate on each charger, battery, inverter and power transfer switch showing manufacturer's name, brand designation, reference standard, type, class, rating, wiring diagram and serial number, as applicable.
 - d. In addition to other information normally displayed on the equipment, provide nameplates showing switch positions, meaning of indicator lamps and other pertinent information.
6. System controls and indicators: Located on the front of the UPS cabinet; and as per manufacturer standard product with the following minimum requirements:
 - a. Monitoring and control: Provide a microprocessor based unit status display and controls section designed for convenient and reliable user operation. The monitoring functions such as metering status and alarms shall be displayed on a graphical LCD display. Additional feature of the monitoring and control system shall include graphical display of single line diagram of the UPS, menu-driven with pushbutton navigation, real time clock, alarm history with time and date, and battery back-up memory. All operation and parameters are firmware controlled, thus eliminating the need for manual adjustments or potentiometers.
 - b. Metering display:
 - (1) Input AC voltage, line to line, and line to neutral for each phase.
 - (2) Input AC current for each phase.
 - (3) Input frequency.
 - (4) DC bus voltage.
 - (5) Battery current and direction (charge/discharge).
 - (6) System output AC voltage, line to line and line to neutral for each phase.
 - (7) System output AC current for each phase.
 - (8) System output frequency.
 - (9) Bypass input voltage, line to line, line to neutral for each phase.
 - (10) Elapsed time-discharging battery.
7. Status displays, alarm messages and indication lights: Minimum requirement as specified for the rectifier/charger, inverter and power transfer switch units with the following additional requirements:
 - a. Indication lights: Long-life LED.
 - b. Clear identification of each indication light.
 - c. All alarm messages and indications resettable with push-button.

- d. Controls: A graphical LCD mimic screen to depict a single line diagram of the UPS with switch positions and power flow.
 - e. Operation Instructions: Display to provide all necessary instructions and step-by-step procedure for each sequence of operation
8. Accessibility of circuit boards and components:
- a. Front accessibility to rectifier/charger, inverter, and power transfer switch, including all cable connections.
 - b. Where a circuit-alignment procedure is required and adjustments require measurement of circuit points on circuit boards: Accessible test points on cards with appropriate designations and supplementary removable extender boards provided for making points accessible.
 - c. Sub-assemblies, parts and circuit boards that may require replacement: Arranged and mounted so that replacement requires no soldering or special tools.
 - d. All cable and conduit connections: Through top of cabinet.
9. Operational noise level: Not exceeding 70dB measured six feet from the equipment on the A weighting network of a general-purpose sound-level meter at slow response. Test conditions and correction factors in accordance with ANSI/IEEE C57.12.90.
10. Supervisory contacts: As specified for the rectifier/charger, inverter and power transfer switch units, with the following additional requirements:
- a. Dry-type sealed contacts rated to switch 500 milliamperes at 250 volts dc or three amperes at 24 volts dc.
 - b. Contact resistance: 0.10-ohm maximum.
 - c. Contact bounce: Five milliseconds maximum.
 - d. Wired to terminal block for remote connection to supervisory system.

B. Storage Battery:

- 1. Complete with accessories and battery racks.
- 2. Battery: UPS Cycle Duty, Industrial Flooded Lead Acid Cell.
 - a. Round cell or equal. Plate construction: Pure lead cylindrical cone-shaped. Positive grid minimum 0.2 inches thick.
 - b. Discharge capacity: Capable of providing dc inverter input to give rated inverter output at 0.8 power factor for three hours at 77F while simultaneously providing average load of 1.8 kW dc for switchgear operation and control, with peak demands of six kW for five seconds at each 30-minute interval during specified duration. Minimum battery-terminal voltage: 105 volts under full-load at end of three-hour discharge period.
 - c. Cycling duty: Capable of numerous cycling discharges at full load. Corresponding number of cycles for each discharge duration representing 100-percent of the available cycles: 30 seconds, up to 10,000 events; 30 seconds to 1.5 minutes, up to 2,000 events; 1.5 minutes to 4 minutes, up to 600 events and 3 hours, 50 events minimum.
 - d. Cell container:
 - (1) Extra-strength transparent plastic providing clear view of cell interior.
 - (2) Flammability rating: UL 94-V2, ASTM D635-98 self extinguishing, minimum Low Oxygen Index (LOI) 30-percent.
 - (3) Integral molded ribs for supporting internal elements without developing stresses caused by variation of temperature.

- (4) Ample sediment space below cell plate to prevent premature battery failure.
 - (5) Mark indicating level of electrolyte to be maintained.
 - e. Post type: Two or four, square copper insert posts with dual bolt holes.
 - f. Container cover:
 - (1) Sealed to provide permanent leakproof seal. Sufficient clearance from plate grids to allow for expansion and contraction of plate without cracking or splitting. Replace cells determined to have a cover leak within the warranty period at no additional cost to the Authority.
 - (2) Insulating material: Free from circuit leakage and impurities detrimental to plates or separators and impervious to absorption of electrolyte.
 - (3) NEMA flame arrester vent plugs.
 - (4) Flammability Rating: UL 94-VO, ASTM D635-98, self extinguishing.
 - g. Post seal: Historically proven and demonstrated leak-proof design. Replace cells determined to have a post seal leak within the warranty period at no additional cost to the Authority.
 - h. Factory test and shipping capacity: 100-percent capacity at time of delivery from factory. Factory tested for similar float and end of discharge voltages. Batteries tested together with a maximum difference of plus and minus 0.03 volts from the average cell voltage.
3. Accessory equipment:
- a. One syringe hydrometer with specific-gravity scale range no greater than 1.100 to 1.300.
 - b. One thermometer.
 - c. One torque wrench for battery connection.
 - d. Two cell-lifting devices complete with strap and spreader.
 - e. Two sets of stainless steel connecting bolts, nuts and washers.
 - f. Two sets of intercell connectors.
 - g. One set of manufacturer-recommended interrack cable and load-terminal lugs.
 - h. Pegboard: Hard board, ANSI/AHA 135.4, tempered, one smooth side (S1S), 1/4-inch nominal thickness, perforated, sized to accommodate all products specified above. Framed with one-inch by one-inch hardwood. Paint frame and hardboard in color selected by the Engineer. Include hardware for wall-mounting and pegboard accessories suited to the products to be mounted. Provide one-inch high nameplates as specified, with accessory names inscribed in 1/2-inch-high letters.
 - i. One portable lifting jig for battery, as recommended by battery manufacturer, in each battery room.
 - j. Battery Cycle Monitor: C&D BCM1100 or equal, electronic logging and event recorder/monitor to provide summary information for validating battery manufacturer's warranty. Install monitor in accordance with manufacturer instructions and requirements. Provide signal wiring, power wiring and conduits to ensure correct operation. Provide power wiring and conduits from nearest available distribution panel as selected by the Engineer. Ensure that

Monitor meets manufacturer's requirements for verifying load cycling warranty. As a minimum, make monitor able to:

- (1) Measure battery room temperature, present, maximum and minimum values. Maintain a register of the dates and values of the minimum and maximum occurrences.
 - (2) Indicate float voltage with record retrieval of the maximum and minimum values.
 - (3) Monitor the following parameters during discharge:
 - (a) Time of day the event started.
 - (b) Battery voltage at start and end of discharge.
 - (c) Battery load current during discharge.
 - (d) Length of time of the discharge.
 - (4) Provide a summary read-out showing detailed information on number of cycles on the battery.
 - (5) Provide alarm contacts to signal an event is occurring on the battery.
 - (6) Indicate total Kilowatt hours taken out of the battery.
 - (7) Indicate total ampere-hours taken out of battery.
 - (8) Indicate percent of cycle life remaining in battery.
4. Battery rack:
- a. Round Cell Battery:
 - (1) Two-tier type fabricated from polyester-glass-composite that is acid resistant, flame retarding, maintenance-free, electrical insulator.
 - (2) Floor mat: Durable, 1/4-inch thick, electrolyte-resistant black rubber mat
5. Enclosed dc circuit breaker:
- a. Two-pole, 250-volt dc, molded-case circuit breaker as specified in Section 16440.
 - b. Enclosure: ANSI/NEMA 250, Type 1, marked ON/OFF, capable of being padlocked in OFF position.
 - c. Location: In battery room.
- C. Rectifier/Charger:
1. Solid-state, three-phase: Continuous-duty rectifier including the following requirements:
 - a. Bridge rectifiers: Silicon-controlled or power transistor.
 - b. Six-pulse minimum, each pulse fully controlled.
 - c. Electronic current-limiting control for output.
 - d. Output voltage: Maximum six-percent rms ripple with battery not connected.
 2. Electrical characteristics:
 - a. For converting 480-volt, three-phase, 60 Hertz alternating current to direct current with characteristics suitable for charging associated battery and for providing input to the associated inverter.
 - b. Float and equalizing charge rate: As necessary for proper charging of associated battery, with the following additional requirements:
 - (1) Float voltage adjustable between 125 and 135 volts.
 - (2) Equalizing voltage adjustable between 135 and 144 volts.
 - c. Output rating: To provide dc input to inverter for giving rated inverter output while simultaneously providing average load of 1.8-kW dc for switchgear

loads as specified, with sufficient rating to simultaneously recharge the battery to 90-percent or more of fully charged condition in a 12-hour period from a discharged battery voltage of 105 volts.

- d. Output voltage regulation: Within plus-or-minus one percent from zero to 100-percent of charger rated capacity for ac supply-voltage variation of plus-or-minus 10-percent at 480 volts and supply-frequency variation of plus-or-minus five-percent at 60 Hertz.
 - e. Efficiency: 95-percent minimum at nominal input voltage with rectifier/charger supplying 100-percent of rated load.
 - f. Power factor: Input power factor minimum 0.7 with rated input voltage, UPS supplying 100-percent load, and battery on minimum float voltage.
3. Accessory equipment:
- a. Meters: As specified in Article 2.1.A.6.b
 - b. Indicating lights or status displays:
 - (1) One to monitor ac supply voltage (low voltage or loss on any phase).
 - (2) Status displays:
 - (a) Input circuit breaker closed.
 - (b) Rectifier/charger in float or equalizing mode.
 - (c) Rectifier/charger failed.
 - (d) For ungrounded dc system: Ground-fault indication lights.
 - c. Relay equipped with one NO contact and one NC contact for indicating normal and failure status of rectifier/charger output at remote location.
 - d. One 480-volt, three-pole, molded-case circuit breaker or one integrally fused circuit breaker in accordance with Section 16440 for incoming power to protect against available short-circuit current of rms symmetrical amperes at 0.15 power factor not less than the following based on substation-transformer capacity as shown:
 - (1) 750-kVA transformer: 17,500.
 - (2) 1,000-kVA transformer: 25,000.
 - (3) 1,500-kVA transformer: 35,000.
 - (4) 2,000-kVA transformer: 42,000.
4. Automatic control:
- a. Current-limiting device or circuit capable of limiting output current to rating of charger without disconnecting charger from battery or ac power supply. Provide a current limit, 0% to 25%(adjustable) of nominal full load current to limit the battery recharge current when activated by a remote
 - b. Automatic recharging on equalizing cycle after return of input ac voltage following an outage. Input current rate of increase limited (ramped) to achieve full-load input capability in no more than 15 seconds after turn-on.
 - c. Adjustable equalizing timer with range from one-hour to 60 hours minimum. Timer-adjustment function identified.
 - d. Built-in overload protection including short circuit at output terminals.
5. Manual control:
- a. Manual momentary contact switch to initiate equalizing operation and timer.
 - b. Manual momentary contact switch to stop equalizing operation, restore float operation and reset timer.
 - c. Screwdriver slot or locking knob-operated devices for adjusting float voltage and equalizing voltage, with function identified.

- D. Static Inverter:
1. Solid-state design using Insulated Gate Bipolar Transistor (IGBT) with Pulse Width Modulation/Step wave.
 2. Electrical characteristics:
 - a. Input voltage: Nominal input-voltage range from low voltage of 105 volt to highest equalizing voltage of 144 volts as specified for battery.
 - b. Output voltage: 480Y/277-volt, three-phase, four-wire, 60 Hertz.
 - c. Output rating:
 - (1) kVA rating: As shown.
 - (2) Capable of delivering rated three-phase KVA with any one phase 30-percent unbalanced from the other two phases within the dc input-voltage limits, and not exceeding three-percent voltage unbalance for any phase combination with no manual adjustment.
 - (3) Capable of delivering rated KVA into load which has power factor of 0.8 lagging.
 - d. Output-wave form: Sine wave, maximum of five-percent total harmonic distortion.
 - e. Output-voltage regulation: Zero to 100-percent rated load and dc input voltage within stated limits:
 - (1) Balanced load: Plus-or-minus one percent.
 - (2) Unbalanced load at 30-percent of rated load: Plus-or-minus 2.5 percent.
 - f. Output-voltage stability: With 100-percent step-load change, balanced load: Plus-or-minus 10-percent maximum deviation. Recovery to stated regulation band within six cycles.
 - g. Output-frequency control and synchronization:
 - (1) Inverter-output frequency phase locked to bypass source whenever source frequency is within plus-or-minus two-percent of standard 60 Hertz.
 - (2) Inverter-frequency control to shift to crystal- controlled oscillator in inverter whenever utility reference frequency goes outside limits. Whenever utility source returns within the frequency limits, frequency control to return to bypass source.
 - (3) Crystal-controlled oscillator to maintain a stable, continuous, standard 60-Hertz frequency within plus-or-minus one-half percent.
 - (4) Phase-lock control to maintain output-voltage wave of each phase to within six electrical degrees of the utility voltage wave (bypass source).
 - h. Overload rating: 125-percent of rated load for 15 minutes (without bypass source); 200-percent for 30 seconds (without bypass source).
 - i. Starting characteristics: Capacity to start at any load within overload rating with and without external ac power source.
 - j. Fault and surge override: Capacity to:
 - (1) Sustain fault at load terminals of main emergency panelboard until fault is cleared or load is transferred.
 - (2) Override magnetizing in-rush current of transformer as follows:
 - (a) Inverter below 15 kVA: Nine-kVA transformer.

- (b) Inverter 25 kVA and larger: 15-kVA transformer.
 - k. Inverter automatic shutdown: To occur when battery voltage reaches lower limit of 105 volts. Battery to continue to supply the specified switchgear load.
 - l. Inverter to restart automatically when dc voltage reaches nominal value of 125 volts.
 - m. Efficiency: Not less than the following with load power factor of 0.8 lagging.
 - (1) 15 kVA or less: 80-percent.
 - (2) 20 kVA through 50 kVA: 84-percent.
- 3. Accessory equipment:
 - a. Meters: As specified in Article 2.1A.6.b
 - b. Indicating lights or status displays:
 - (1) Inverter operating in normal mode.
 - (2) Inverter operating in standby mode or power transfer switch in bypass mode.
 - (3) Inverter operating and phase locked.
 - (4) DC voltage below minimum float voltage or above maximum equalizing voltage.
 - (5) Overtemperature.
 - (6) Low cooling air flow.
 - (7) Overload.
 - c. Relays and controls:
 - (1) Adjustable three-phase undervoltage relay or static circuitry to sense each phase of inverter output for initiating transfer to bypass power source. Initiation voltage adjustable over range of 80-percent to 90-percent of rated voltage.
 - (2) Voltage-sensing circuitry to prevent retransfer of load to the inverter unless voltage is within specified tolerance and frequency is phase locked within tolerance.
 - (3) Signals from the frequency and synchronization control to be used to inhibit retransfer from bypass to inverter if out-of-tolerance.
 - (4) Inverter control for restarting of a shutdown inverter.
 - (5) Manual ON/OFF control switch. ON position of switch to restart inverter for full-automatic operation.
 - (6) Devices and circuitry to protect inverter from dc over/under voltage, overload, short-circuit, and overtemperature.
 - (7) Device and circuitry equipped with two supervisory contacts, one NC and one NO, for remote monitoring inverter-output status.
- E. Static Transfer Switch: An integral part of the UPS; silicon-controlled rectifier-type with the following requirements:
 - 1. Automatic transfer of inverter load to bypass source: Transfer to be made under the following conditions provided transfer/retransfer selector switch is in automatic position:
 - a. Inverter-output failure occurs.
 - b. Overload is equal to or less than 25-percent for more than 15 minutes.
 - c. Overload greater than 25-percent occurs.
 - d. Inverter is shutdown with manual switch.

2. Automatic retransfer of load to inverter: Retransfer to be made under following conditions provided transfer/retransfer selector switch is in automatic position:
 - a. The overload condition is removed.
 - b. Inverter-output voltage is within specified tolerance for magnitude and frequency and within six electrical degrees of the bypass-source voltage.
 3. Manual transfer and retransfer:
 - a. Transfer of inverter load to the bypass source initiated by a switch closure. Inverter to remain operating and ready to accept the load.
 - b. Retransfer initiated by automatic control when transfer/retransfer selector switch is in automatic position.
 4. Switch identified as a transfer/retransfer selector switch: Two-position selector switch with positions labeled as follows:
 - a. AUTOMATIC (TRANSFER AND RETRANSFER).
 - b. MANUAL TRANSFER (INHIBIT RETRANSFER).
 5. Electrical characteristics:
 - a. Rated voltage: 480/277-volt, three-phase, 60 Hertz with neutral bus for four-wire bypass-source service and UPS-output neutral connection.
 - b. Rated continuous current: 125% rated load continuously and 200% rated load for 30 seconds.
 - c. Withstand capability: Withstand short-circuit current available at bypass source. Vendor may provide current-limiting protection to provide required withstand. Current-limiting fuses to provide coordination with the bypass source and the branch-circuit protection in the main emergency panelboard.
 - d. Capacity to close into short-circuit or let-through of fuses without functional degrading other than fuse clearing.
 6. Indicating lights or status displays:
 - a. Bypass-source undervoltage, overvoltage, loss of a phase, or out-of-frequency tolerance.
 - b. Power transfer switch on bypass.
 7. Maintenance bypass capability:
 - a. A manually operated maintenance bypass switching arrangement to transfer the UPS output load to the bypass ac source without interruption of UPS output while electronically isolating or permitting the isolation of the static transfer switch and the inverter from the bypass source.
 8. Circuit and device with two supervisory contacts, one NO and one NC for monitoring status of power transfer switch feeding load from inverter output or from bypass source.
- F. Main Emergency Panelboard:
1. ANSI/NEMA PB1, UL 67 fused-switch panelboard.
 2. Enclosure:
 - a. ANSI/NEMA 250, Type 1, fabricated from galvanized steel, surface-mounted, unless otherwise shown.
 - b. Minimum of four-inch side gutter and six-inch top and bottom gutters.
 - c. Mounting channel drilled and tapped to accommodate any combination of fused switches.
 - d. Provide latch and handle in accordance with UL 50; screw fastenings will not be accepted in lieu of latch.
 - e. Provisions for enclosure grounding.

- f. Finish: Metallic surfaces degreased, cleaned, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1 Color 61; two mils minimum DFT.
- 3. Busbar:
 - a. ASTM B187-00, 98-percent-conductivity copper with silver-plated or tin-plated contact surface, drilled and tapped to accommodate any combination of fused switch units.
 - b. Neutral and ground bus of the same rating as that of phase bus. Neutral bus mounted on insulated block.
 - c. Rated at minimum 150-percent of inverter rating and not less than power transfer switch bypass overcurrent protection.
- 4. Type of service: 277/480 volts, three-phase, four-wire, 60 Hertz.
- 5. Type of mains: Main lugs only, located at top or bottom as shown.
- 6. Branch circuit: Equipped with fused switch unit, number of circuits as shown.
- 7. Fused switch unit:
 - a. Individually enclosed, quick-make/quick-break switching mechanism with silver-alloy contacts, external operating handle with provision for padlocking in ON or OFF positions.
 - b. Mechanical defeatable door interlock to prevent opening door when the switch is in ON Position.
 - c. Pressure-type fuse clip, with Class J cartridge fuse conforming to UL 198C.
 - d. Number of poles: As shown.
 - e. Current rating: As shown. Maximum rating 30 amperes.
 - f. If single-pole fused switch unit is not available, use a two-pole or three-pole fused switch unit for each circuit shown with a single-pole fused switch unit. Two or more separate circuits are not to be fed from a two-pole or three-pole fused switch unit.
- 8. Fuse time-current characteristic coordinated with upstream fuse time-current characteristic for providing selective overcurrent tripping.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install UPS where shown in accordance with the following requirements:
 - 1. Storage battery: Anchor battery rack to floor, then mount and connect battery cells in accordance with manufacturer's recommendations, with the following additional requirements:
 - a. For connecting cells mounted on same rack, use lead-plated or tin-plated solid-copper conductor as recommended by battery manufacturer.
 - b. For connecting cells mounted on different racks, use Class D stranded single-conductor insulated cable sized the same as the battery cable. Run cable in two-inch, galvanized-steel rigid conduit in accordance with Section 16130.
 - c. Use nylon-insulated bushing at each end of conduit where cable passes through conduit to protect cable insulation from damage.
 - d. Install conduit and cable to connect battery to UPS as shown.

- e. Use two-tier-battery racks as specified for battery type used. All batteries to be easily accessible from floor. Three-tier and three-step racks are prohibited.
 - 2. Anchor UPS enclosure to floor as shown and approved. Install input and output power and control wiring as shown and as approved in accordance with Section 16120. Ground enclosure in accordance with Section 16060.
 - 3. Main emergency panelboard: Install as shown and in accordance with Section 16440.
 - 4. Install pegboard at location approved by the Engineer. Mount accessories and associated nameplates on pegboard.
- B. Initial Energizing:
- 1. Initial energizing of each UPS will be under the guidance of the manufacturer's engineering representative who will advise Contractor and Authority personnel on step-by-step procedures.
- C. Apply touch-up paint where necessary.
- D. Floor Mat for Battery Rack: Cover walking area with floor mat cut to fit entire room layout, six inches larger than the overall width and length of rack to protect floor from electrolyte.

3.02 FIELD QUALITY CONTROL:

- A. Field Testing and Inspection:
- 1. General:
 - a. Conduct field inspection and field testing at each ac switchboard room to ensure proper operation of devices and equipment provided.
 - b. Operation and protective-device setting: The Contractor is responsible for setting and calibration of protective devices for proper operation during field testing.
 - 2. Field inspection:
 - a. Prior to field testing, check equipment installation in accordance with manufacturer's recommendations and applicable IEEE and ANSI standards, including verification of the following:
 - (1) Connection of circuit in accordance with wiring diagram.
 - (2) Tightness of cable and busbar connections.
 - (3) Battery-intercell bus-link integrity.
 - 3. Field Testing:
 - a. Furnish equipment to perform tests.
 - b. Provide services of manufacturer's engineering representative and supporting field crew for a period not less than three man-days. Conduct tests in the presence of the Engineer. Perform approved tests including, but not limited to, those specified.
 - c. Test grounding conductors and enclosures on equipment for continuity to room ground bus.
 - d. Storage battery:
 - (1) Measure battery-charging voltage, electrolyte specific gravity and level.

- (2) Compare measured value and correct to manufacturer's specified tolerances.
- e. Power transfer switch:
 - (1) Calibrate and set voltage-sensing device and transfer time-delay as specified and as approved.
 - (2) Perform automatic transfer by:
 - (a) Simulating loss of inverter output.
 - (b) Return to normal power.
- f. Uninterruptible power system:
 - (1) Perform load test at inverter rated output with UPS operating in normal mode. Provide equipment necessary to achieve rated capacity load.
 - (2) Under the following conditions, perform automatic-throwover operation and manual restoration of utility service in associated ac switchboard room and check for normal operation of UPS:
 - (a) With UPS in normal mode and feeding connected load.
 - (b) With battery fully charged, no ac power fed to rectifier/charger and alternate feeder to power transfer switch and UPS feeding connected load.
 - (3) In combined ac switchboard room: Check for normal operation of UPS when feeding rated load during simultaneous loss of both 13.8-kV or 34.5-kV, as applicable, feeders and subsequent manual restoration of both services.
 - (4) With no ac power available to UPS, stop and restart inverter five times.
 - (5) Acceptance testing:
 - (a) Perform installation related measurement and acceptance testing in accordance with ANSI/IEEE 450 and ANSI/IEEE 484. In the event of a conflict between this procedure and the ANSI/IEEE documents, this procedure will take precedence.
 - (b) Calibrate test equipment used during this procedure, calibration date not older that one year from the date of testing, calibrations traceable to NIST. Have calibration stickers visible on all applicable equipment. As a minimum, calibrate the following equipment with accuracy as stated:

	<u>Equipment</u>	<u>Accuracy</u>
i.	Multimeter	± 0.1%
ii.	Microhm meter	± 0.5%
iii.	Current measuring equipment	± 1 amp
iv.	Cell voltage monitor equipment	± 0.5%
(c)	Initial measurements:	
i.	Read and record individual cell voltages to two decimal places while the battery is on a normal float charge.	

- ii. Read and record the ac ripple voltage out of the rectifier utilizing an ungrounded oscilloscope. Read and record ac ripple current utilizing an ac clamp on meter.
 - iii. Read and record intercell connection resistance using a microhm meter . Remake and re-measure any connection that has a resistance measurement more than 10-percent or 5 microhms, whichever is greater, over the average for each type of connection.
 - iv. Read and record each cell's internal impedance or conductance. Note make and model of meter.
 - v. Read and record the specific gravity of each cell.
 - vi. Read and record the temperature of each cell and the ambient temperature of the room.
- (d) Rectifier test:
- i. Apply ac load at inverter rated output with UPS operating in normal mode. Have battery connected and fully charged.
 - ii. Using infrared thermography, scan accessible UPS internal components. Also, scan UPS fuses, circuit breakers, associated circuit breakers, and UPS ac feed networks where accessible. Record abnormal heating and save these images for incorporation into the report.
 - iii. With full ac load still applied, attached dc load to UPS output. Slowly increase dc load until the point where the UPS rectifier is at current limit. This will occur when the voltage begins to sag to a point where current will begin to flow from the battery. Reduce load slightly so that no current is being drawn from the battery. Record the total dc current out of the UPS rectifier at the current limit point. Leave the rectifier at this current limit point for 20 minutes. During the 20 minutes, utilize infrared thermography to scan components as outlined above. Record abnormal heating and save these images for incorporation into the report. Utilizing an ungrounded oscilloscope, read and record the ac ripple voltage out of the rectifier at the current limit point. Also, measure and record the ac ripple current using an ac clamp on meter.
 - iv. Remove the load from both the rectifier section and the UPS ac output.
- (e) Full UPS test:
- i. Attach a monitor to the battery to measure every individual cell voltage. Ensure that this monitor can read and record every cell voltage not less than

once per minute. Also use the monitor to measure and record overall battery voltage and total battery discharge current

- ii. Attach an automatic load bank to the battery. When initiated, have the load bank provide a constant 1.8 KW load to the battery until the end of the full UPS test. Every 30 minutes increase this load to 6.0 kW for five seconds and then return it to 1.8 KW. Program this to occur automatically until the end of the full UPS test.
- iii. Apply ac load at inverter rated output with UPS operating in normal mode. Have battery connected and fully charged.
- iv. Trip breaker feeding ac power to rectifier/charger. This will initiate the UPS to operate on battery. Simultaneously, initiate the dc load bank and the battery voltage/current monitor. While test is running, utilize infrared thermography to scan the battery, associated interconnects, and ups components where accessible. Record abnormal heating and save these images for incorporation into the report. Continue the test until the under-voltage device operates on the UPS. Record the time and the battery voltage when this occurs. Turn off the dc load bank and stop the battery voltage/current monitor.
- v. Attach a current monitor to the battery that can measure and record current into the battery every 10 minutes. Disconnect all other load equipment and monitors. Re-energize circuit breaker to UPS. Start monitoring current. Check monitor after 12 hours. Record ampere hours that have been returned to the battery.
- vi. Remove all equipment from UPS area. Read and record float voltages.

(f) Pass-fail criteria:

- i. The UPS battery is acceptable only if the battery operates for a minimum of three hours and the battery capacity is a least 90-percent. No individual cell capacity may be less than 80-percent. Base capacity on a temperature correction to 77F.
- ii. Specific gravities are to be within the manufacturer's specified values.
- iii. Intercell connection resistances are to be within 10-percent or five microhms, whichever is greater, over the average for each type of connection.

- iv. Have the battery 90-percent charged within 12 hours after returning normal power to the UPS. This can be determined by the ampere hours returned to the battery after the 12-hour period. At least 100-percent of the ampere hours removed from the battery must be returned to the battery in order to be 90-percent charged.
- (g) Report: Include the following items:
 - i. Abnormal heating detected by the infrared thermography.
 - ii. Time of battery operation under full load. Include final overall battery voltage at time of UPS under-voltage device operation.
 - iii. Battery capacity percentage corrected to 77F. Base this on the battery manufacturer's's constant power data.
 - iv. Graph of overall battery voltage versus time. Supply this data also in tabular form.
 - v. Graph of individual cell voltages at the three-hour point, at the final reading, and at the 80-percent, 90-percent and 100-percent capacity points. Supply this data also in tabular form.
 - vi. Graphical display of cell float voltages before and after test, with the required minimum and maximum values annotated. Supply this data also in tabular form.
 - vii. Graphical display of temperature-corrected cell specific gravities with the required minimum and maximum values annotated. Supply this data also in tabular form.
 - viii. Graphical display of impedance/conductance values. Supply this data also in tabular form.
 - ix. Current limit value of rectifier section of UPS.
 - x. Print-out of ac ripple voltage wave form during full-load and no-load conditions. Include ac ripple current values.
- (6) After battery is discharged to level of 105 volts, initiate equalizing mode. After 12 hours, measure ampere hours to determine that 90-percent of recharge condition remains; then recharge to 100-percent level.
- (7) Simulate operations of rectifier/charger, inverter and power transfer switch operations for verifying equipment-status indication at DTS cabinet.
- (8) Set UPS to normal mode with rectifier/charger on automatic control.
- g. Compliance:
 - (1) If testing indicates failure to comply with specified requirements, replace, correct or modify equipment so that it does comply.

- (2) Conduct additional tests witnessed by the Engineer to prove compliance with specified requirements.

B. Field-Testing Personnel:

1. Provide services of manufacturer's engineering representative to perform specified field-testing program.
2. When more than one representative is involved, Contractor to ensure proper coordination.
3. Provide engineering, technicians and journeymen personnel as necessary to set-up and implement testing.

C. Authority Tests:

1. The Authority reserves the right to require the Contractor to conduct acceptance tests of voltage regulation and sound level on each UPS at each passenger station within one-year after installation.
2. In order to perform sound-level tests, the Contractor may re-create test conditions of applicable standards to the extent possible without disturbing existing structure or installed equipment or materials.

D. Submit certified test report

THIS SPACE NOT USED.

TABLE 16260-1

SCHEDULE OF SHOP DRAWINGS AND MANUFACTURER'S LITERATURE

Item	Requirements	Submit (a)	Within Days (b)
1.	Outline dimensions, including weights and foundation requirements for equipment furnished.	X	90 (c)
2.	Front views, floor plans, and mounting details for equipment furnished.	X	90 (c)
3.	One-line block diagrams.	X	120 (c)
4.	List of standard symbols and nomenclature.	X	120 (c)
5.	Elementary diagrams with description of each circuit.	X	120 (c)
6.	Interconnection wiring diagram.	X	120 (c)
7.	Wiring diagrams, showing internal wiring of equipment furnished.	X	150 (c)

TABLE 16260-1 (CONT.)

SCHEDULE OF SHOP DRAWINGS AND MANUFACTURER'S LITERATURE

Item	Requirements	Submit (a)	Within Days (b)
8.	Certified test reports.	-	30 (d)
9.	Storage battery, including: a. Ampere-hour rating at three-hour discharge rate. b. Available short-circuit current. c. Weight of each cell.	-	45 (c)
10.	Rectifier/Charger, including: a. kW Output. b. Efficiency at rated load. c. Power factor at rated input voltage with rectifier/charger supplying rated load.	-	45 (c)

TABLE 16260-1 (CONT.)

SCHEDULE OF SHOP DRAWINGS AND MANUFACTURER'S LITERATURE

Item	Requirements	Submit (a)	Within Days (b)
11.	<p>Static inverter, including:</p> <p>a. kVa rating at 0.8 lagging power factor and unity power factor.</p> <p>b. Efficiency at rated load.</p>	-	45 (c)
12.	<p>Power transfer switch, including:</p> <p>a. Current rating.</p> <p>b. Short-circuit withstand capability.</p>	-	45 (c)
13.	<p>Clearing time-current curves of circuit breakers and fuses used, including unlatch time of circuit breakers.</p>	-	120 (c)

14.	Coordination chart, including time-current fault-clearing curves of protective devices including largest emergency-panelboard fuse.	X	120 (c)
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TABLE 16260-1 (CONT.)

SCHEDULE OF SHOP DRAWINGS AND MANUFACTURER'S LITERATURE

Item	Requirements	Submit (a)	Within Days (b)
15.	Equipment-arrangement drawing for each UPS including battery racks.	X	120 (c)

NOTES AND LEGEND

- (a) Initial submittal for approval. Unless otherwise shown, in accordance with General Requirements.
- (b) Approved final drawings or certified data.
- (c) After receipt of Notice to Proceed.
- (d) After completion of tests.
- X Submittal required.
- Submittal not required.

TABLE 16260-2

SCHEDULE OF OPERATIONS AND MAINTENANCE REQUIREMENTS

Item	Requirements	Submit (a)	Within Days (b)
1.	Shipping and handling data: Instructions and drawings for unloading, handling erection and installation.	-	120 (c)
2.	Bills of Material, with reference to components showing original manufacturer's part numbers.	-	30 (c)
3.	Operation and Maintenance Manuals, complete, including separate manuals for charger/rectifier, inverter, power transfer switch and battery with information on each type of equipment and device furnished, shop drawings from Table 16260-1, excluding manufacturing details and Items 1. and 2. above.	(d)	(d)

4.	Operation and Maintenance Training.	180 (e)	30 (e)
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TABLE 16260-2 (CONT.)
SCHEDULE OF OPERATIONS AND MAINTENANCE REQUIREMENTS

NOTES AND LEGEND

- (a) Initial submittal for approval.
- (b) Approved final document.
- (c) Before shipment.
- (d) See General Requirements.
- (e) Prior to commencement of training.
- Submittal not required.

END OF SECTION

THIS PAGE NOT USED

SECTION 16269

VARIABLE FREQUENCY CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors. Provide VFCs compatible with the equipment being controlled.

1.02 DEFINITIONS

- A. BMS: Building management system.
- B. IGBT: Integrated gate bipolar transistor.
- C. LAN: Local area network.
- D. PID: Control action, proportional plus integral plus derivative.
- E. PWM: Pulse-width modulated.
- F. VFC: Variable frequency controller.

1.03 SUBMITTALS

- A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFC.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.
- C. Manufacturer Seismic Qualification Certification: Submit certification that VFCs, accessories, and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate

- and describe mounting and anchorage provisions.
- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: For **manufacturer and testing agency**.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for VFCs and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and market for intended use.
- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: 0 to 40 deg C.
 - 2. Humidity: Less than 90 percent (non-condensing).
 - 3. Altitude: Not exceeding 3300 feet.
- B. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Indicate method of providing temporary electrical service.
 - 3. Do not proceed with interruption of electrical service without Owner's written permission.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.07 COORDINATION

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.01 VARIABLE FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
 - 1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:

1. Input ac voltage tolerance of 208 V, plus or minus 5 percent or 380 to 500 V, plus or minus 10 percent.
 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
 4. Minimum Displacement Primary-Side Power Factor: 96 percent.
 5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 6. Starting Torque: 100 percent of rated torque or as indicated.
 7. Speed Regulation: Plus or minus 1 percent.
- E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
1. Electrical Signal: 4 to 20 mA at 24 V.
 2. Pneumatic Signal: 3 to 15 psig (20 to 104 kPa).
- F. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 2 to a minimum of 22 seconds.
 4. Deceleration: 2 to a minimum of 22 seconds.
 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- G. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
 2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 5. Instantaneous line-to-line and line-to-ground overcurrent trips.
 6. Loss-of-phase protection.
 7. Reverse-phase protection.
 8. Short-circuit protection.
 9. Motor overtemperature fault.
- H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.
- I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- K. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- M. Input Line Conditioning: As required by WMATA.
- N. VFC Output Filtering: As required by WMATA.
- O. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on.
 2. Run.
 3. Overvoltage.

4. Line fault.
 5. Overcurrent.
 6. External fault.
- P. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- Q. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (VDC).
 9. Set-point frequency (Hz).
 10. Motor output voltage (V).
- R. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 2. Pneumatic Input Signal Interface: 3 to 15 psig.
 3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
 4. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
 5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 for remote indication of the following:
 - a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- S. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.
- T. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall

be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

- U. Bypass Controller: NEMA ICS 2, full-voltage, non-reversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.
- V. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker or NEMA KS 1, fusible switch with lockable handle.
- W. Isolating Switch: Non-load-break switch arranged to isolate VFC and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
- X. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.02 ENCLOSURES

- A. NEMA type 1, fabricated from galvanized steel, surface-mounted, unless otherwise required.
- B. Minimum 3 inch wire gutters on all sides.
- C. Mounting Channel drilled and tapped to accommodate any combination of fused switches.
- D. Provide latch and handle in accordance with UL 50; screw fastenings will not be accepted in lieu of latch.
- E. Provisions for enclosure grounding.

2.03 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Standard Displays:
 - 1. Output frequency (Hz).
 - 2. Set-point frequency (Hz).
 - 3. Motor current (amperes).
 - 4. DC-link voltage (VDC).
 - 5. Motor torque (percent).
 - 6. Motor speed (rpm).
 - 7. Motor output voltage (V).
- F. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.
- G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply

voltage; with adjustable response delay.

2.04 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.

3.03 INSTALLATION

- A. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.
- B. Install VFCs on concrete bases.
- C. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- D. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 16 Section "Fuses."

3.04 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 16 Section "Basic Electrical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

3.05 IDENTIFICATION

- A. Identify VFCs, components, and control wiring according to Division 16 Section "Electrical Identification."
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.06 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices according to Division 16 Section

"Conductors and Cables."

- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.07 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 16 "Grounding and Bonding."

3.08 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
 - 3. Report results in writing.
- C. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- E. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.09 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 16270

TRANSFORMERS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing transformers.
- B. Related Work Specified Elsewhere:
 - 1. Wire connection accessories: Section 16125
 - 2. Grounding and bonding: Section 16060.
- C. Design Criteria:
 - 1. Floor loading: Transformer base compatible with floor design-loading of 250 pounds per square foot.

1.02 QUALITY ASSURANCE:

- A. Qualifications: Select a manufacturer who is regularly engaged in the repetitive production of transformers and automatic voltage regulators of the types and ratings described in these specifications using the latest technology and who has a proven record of successful manufacturing and testing of same or similar type equipment. The equipment manufacturer shall have and maintain ISO 9001 or ISO 9002 certification.
- B. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. NEMA: ST1, ST20, 107, 250.
 - 4. ANSI: C57.12.50, C57.12.51, Z55.1.
 - 5. ASTM: D3487.
 - 6. ANSI/IEEE: C57.12.00, C57.12.90, C57.12.91, C57.15, C57.94, C57.113, C57.124, C62.11.
 - 7. IEEE: C57.12.01.
 - 8. UL: 506, 1561, 1562.
- C. Factory Testing:
 - 1. General requirements for distribution transformers:
 - a. Perform design tests and short-circuit tests on one transformer of each type and rating furnished in this Contract.
 - b. Perform routine tests, impulse test and partial discharge test on each transformer furnished in this Contract.
 - 2. Dry-type transformers: Perform design and routine tests in accordance with IEEE C57.12.01 and ANSI/IEEE C57.12.91 and the following additional tests:
 - a. Perform impulse test without using surge arrestors to protect the transformer.
 - b. Perform partial discharge test to establish partial discharge inception and extinction voltage during induced voltage test in accordance with ANSI/IEEE C57.124 and the following requirements:
 - (1) Measure partial discharge in pico-coulombs at 10-percent increments when the voltage is raised from 70 percent to 200 percent and lowered from 200 percent to 70 percent of rated voltage during the induced voltage test to verify the following requirements:
 - (a) Inception of partial discharge occurs above 120 percent of

- rated voltage when voltage is raised from 70 percent to 200 percent. At 120 percent, the partial discharge reading shall be 10 pico-coulombs or less.
 - (b) Extinction of partial discharge occurs above 120 percent of rated voltage when voltage is lowered from 200 percent to 70 percent and partial discharge level is below 10 pico-coulombs.
 - c. Perform short-circuit tests in accordance with IEEE C57.12.01 and ANSI/IEEE C57.12.91.
- 3. Oil-filled transformers: Perform design and routine tests in accordance with ANSI/IEEE C57.12.00 and C57.12.90 and the following additional tests:
 - a. Perform lightning impulse test without using surge arrestors to protect the transformer.
 - b. Perform partial discharge test using one of the following test methods:
 - (1) Perform partial discharge test to determine radio-influence voltage and associated partial discharge inception and extinction in accordance with NEMA 107 and the following requirements:
 - (a) Measure radio-influence voltage in micro-volts at 25-percent increments when the voltage is raised from 100 percent to 200 percent and lowered from 200 percent to 100 percent of rated voltage during the induced voltage test to verify the following requirements:
 - i. Radio-influence voltage not to exceed 250 micro-volts for transformers with 13.8 kV primary voltage and 650 micro-volts for transformers with 34.5 kV primary voltage.
 - ii. Inception (i.e. sudden increase in radio-influence voltage as the voltage is raised from 100 percent to 200 percent) occurs above 120 percent of the highest tap voltage.
 - iii. Extinction (i.e. sudden decrease in radio-influence voltage as the voltage is lowered from 200 percent to 100 percent) occurs above 120 percent of the highest tap voltage.
 - (2) Perform partial discharge test to determine terminal partial discharge level and partial discharge at five-minute intervals on each terminal during a 60-minute period of induced voltage test in accordance with ANSI/IEEE C57.113 and to verify the following requirements:
 - (a) Terminal partial discharge level not-to-exceed 200 pico-coulombs.
 - (b) Partial discharge measurements during a 60-minute period meet the requirements of ANSI/IEEE C57.113.
 - (3) Perform short-circuit tests in accordance with ANSI/IEEE C57.12.00 and C57.12.90.
- 4. Perform design and routine tests for general-purpose transformers in accordance with NEMA ST20.
- 5. Notify the Engineer not less than 14 days prior to factory testing to allow witnessing of tests.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- B. Shop Drawings: In accordance with Section 16360.
- C. Certification:
 - 1. Furnish certified test report of all design and short-circuit tests performed on one transformer of each type and rating furnished in this Contract or on identical transformers built by same manufacturer within the last five years.
 - 2. Furnish certified test report of all routine, impulse and partial discharge tests performed on each transformer furnished in this Contract.
 - 3. Furnish certificates from manufacturers verifying that products conform to specified requirements. Include certificates with submittal of shop drawings.
- B. Documentation:
 - 1. Field-testing plan: In accordance with Section 16360.
- C. Operation and Maintenance Manuals: In accordance with Section 16360.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Temporary Bracing: Where necessary, brace transformer for hoisting, lowering and skidding into position. Label temporary internal bracing: TEMPORARY - REMOVE BEFORE OPERATION.
- C. Protection Against Concealed Damage: Include within shipping container mechanical impact recorder of rating recommended by manufacturer for shipment by railroad and submit impact-record chart with manufacturer's instructions for disposition of damaged materials.
- D. Store transformers in secure and dry storage facility.

1.05 OPERATION AND MAINTENANCE TRAINING:

- A. In accordance with the General Requirements and Section 16360.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements for Transformers:
 - 1. Interchangeability: Components of the same type, size, rating, functional characteristics, and make are to be interchangeable.
 - 2. Nameplate provided on each transformer in accordance with reference standard.
 - 3. Efficiency/losses:
 - a. Dry-type, three-phase transformers, 501 kVA and larger:
 - (1) Full-load efficiency: 98.0-percent minimum.
 - (2) Half-load efficiency: 98.5-percent minimum.
 - (3) No-load loss, maximum, of nameplate kVA rating:
 - (a) 13.8 kV - 480Y/277-volt units: 0.5 percent.
 - 4. Impedance voltages:
 - a. Three-phase transformers, 501 kVA and larger:
 - (1) 13.8 kV - 480Y/277 volt units: 5.75 percent.
 - b. Other transformers, lower ratings or lower voltages: In accordance with applicable standard or manufacturer's standard.

5. Magnetic circuit:
 - a. Material: Best quality non-aging silicon steel sheet with high-magnetic permeability and low hysteresis and eddy-current losses. Sheet insulated on both sides with inorganic material to minimize eddy current.
 - b. Laminations cut in direction of grain, free of burrs and uniformly stacked in same direction without gap. Lap and butt joints closely fitted and rigidly clamped to minimize core loss and noise level.
 - c. Capable of up to 10-percent overvoltage excitation while maintaining magnetic-flux density below saturation level.
6. Audible sound level: Distribution transformers designed to limit average sound level to within the following maximum values when measured at the factory in accordance with ANSI/IEEE C57.12.91 for dry-type transformers and in accordance with ANSI/IEEE C57.12.90 for oil-filled transformers:
 - a. Dry-type, three-phase transformers:

Transformer Rating in kVA	Sound Level in dB for Ventilated, Self-Cooled Rating	Sound Level in dB for Ventilated, Forced-Air-Cooled Rating
150	55	-
225, 300	58	-
500	60	67
750, 1,000	64	67
1,500	65	68
2,000	66	69
3,500	68	71
3,750	70	73
150, 225, 300	56	61
500	56	61
750	57	61
1,000	58	61

- b. General-purpose transformers designed to limit average sound level to within maximum values in NEMA ST20.
7. Winding:
 - a. Dry-type, 3-phase transformer, 501KVA and larger.
 - (1) Copper conductors free from burrs, kinks or slivers. Each winding braced for high-mechanical strength and spaced to provide adequate circulation for coolant.
 - b. Dry-type, 3-phase and single-phase transformer 500KVA and smaller.
 - (1) Copper or aluminum conductors free from burrs, kinks or slivers. Each winding braced for high-mechanical strength and spaced to provide adequate circulation for coolant.
8. Buses: Transformers equipped with adequately supported copper or aluminum buses, with the following additional requirements:

- a. Busbar silver-plated or tin-plated at bolted connection point.
- b. Joints welded or bolted for mechanical and electrical short-circuit stresses.
- 9. Ground pad: Enclosure equipped with grounding pad, drilled and tapped for connection to station grounding system.
- 10. Finish: Metallic surfaces degreased, cleaned with iron-phosphate solution, rinsed with chromic acid solution, dried and finished with light-gray coating, ANSI Z55.1, Color 61; two mils minimum DFT as follows:
 - a. Indoor location: Electrostatically deposited polymer polyester powder or epoxy powder, cured by baking and UL recognized, or spray enamel.
 - b. Outdoor location: Epoxy enamel.
- 11. Nameplate: Provided on each transformer showing manufacturer's name and brand designation, reference standard, type, class, rating and other required information as applicable in accordance with reference standard.
- 12. Space heaters:
 - a. Each distribution transformer for indoor use provided with 120-volt, single-phase, 60 Hertz heating element to facilitate drying and prevent condensation under no load or light load conditions.
 - b. Heaters enclosed in grille guard with no sharp edges and located so that they are accessible for replacement. Heaters controlled by thermostat adjustable from 40F to 80F. Panel ammeter, approximately 2-1/2 inches square, marked to indicate heater load. Thermostat set in accordance with manufacturer's recommendations.
 - c. Power and control circuits to heaters and thermostat connected and protected up to devices and to incoming junction box with galvanized-steel rigid conduit or liquid-tight flexible conduit. Heater power junction box sized four inches square by two inches minimum depth and located at top of transformer for top entry of minimum 3/4-inch conduit. Remote connection leads to power source labeled: 120-volt and NEUTRAL.

B. Distribution Transformers:

- 1. Transformers for indoor use:
 - a. IEEE C57.12.01, ANSI C57.12.50, C57.12.51, ANSI/IEEE C57.12.91, UL 1562, floor-mounted, dry-type, ventilated self-cooled/forced-air-cooled, Class AA/FA, or ventilated self-cooled, Class AA, as specified, double-wound, three-phase, 60 Hertz with secondary neutral brought out, and using the following type of winding construction for both primary and secondary windings of a transformer:
 - (1) Solid cast-coil windings.
 - b. kVA rating:
 - (1) Transformers, 501 kVA and larger: Ventilated self-cooled kVA rating as shown, with capacity in current-carrying parts to permit 33-1/3 percent increase in kVA rating (Class AA/FA) by operation of integral forced-air cooling fans.
 - (2) Transformers, 300 kVA and smaller: Ventilated self-cooled, Class AA, kVA rating as shown.
 - c. Voltage rating: 13.8 kV delta to 480Y/277 volts, as shown.
 - d. Enclosure:
 - (1) NEMA 250, Type 2 dripproof enclosure with removable front and rear panels and ventilation louvers to prevent entrance of falling dirt and liquids and accidental access to live parts.
 - (2) Provision for jacking, lifting, skidding, and towing in any direction.
 - (3) Provision for complete isolation of core and coils from the enclosure using rubber vibration isolation pads or other suitable means.
 - (4) Core visibly grounded to ground pad with flexible grounding

- conductor sized in accordance with applicable ANSI and UL Standards.
- (5) Exterior surfaces of core and structural members of core and coil assembly protected from corrosion after assembly with a coating having a temperature rating exceeding the temperature rating of the associated transformer insulation system.
- e. Rated insulation-level withstand:
- (1) 13.8 kV - 480Y/277 volt units:
- (a) High-voltage winding, lightning basic-impulse voltage (BIL) without the use of surge arrestors: 95 kV.
- (b) High-voltage winding, low-frequency withstand: 34 kV.
- (c) Low-voltage winding, lightning basic-impulse voltage (BIL):
- i. Transformers with solid cast-epoxy windings: 30 kV.
- (d) Low-voltage winding, low-frequency withstand: 4 kV.
- f. Transformer terminals:
- (1) High-voltage side: Provide tin-plated terminal pads in air-filled transition compartment suitable to receive and terminate cable or bus connections from high-voltage switchgear, as applicable. Bushings or terminations through sidewall of transformer enclosure to have minimum BIL equal to that of transformer.
- (2) Low-voltage side: Provide tin-plated terminal pads in air-filled transition compartment opposite high-voltage side, suitable for bus connection to low-voltage switchgear. Terminations and transformer secondary bus or terminal supports to have short-circuit current-withstand equal to that of low-voltage switchgear; minimum BIL equal to that of transformer.
- g. Insulation system:
- (1) 185°C insulation system for dry-type transformers having solid cast-epoxy windings with maximum allowable continuous full-load temperature rise above average ambient temperature of 30C and maximum ambient temperature of 40°C:
- (a) By winding resistance: 80C.
- (b) By hottest spot in winding: 110C.
- (2) 185C insulation system for dry-type transformers having solid cast-epoxy windings with maximum allowable continuous full-load temperature rise above average ambient temperature of 30C and maximum ambient temperature of 40C:
- (a) By winding resistance: 80C.
- (b) By hottest spot in winding: 110C.
- h. Taps:
- (1) Capable of delivering rated output at each setting.
- (2) 13.8 kV - 480Y/277 volt units: Two 2-1/2 percent taps above and four 2-1/2 percent taps below rated voltage on primary side.
- (3) Tap changing on face of coil using removable links accessible from front or back of transformer.
- i. Thermometer/auxiliary relay:
- (1) Digital-type thermometer with scale range as required and two sets of contacts.
- (2) One set of thermometer contacts designed to operate two auxiliary relays powered by associated transformer:
- (a) First relay with minimum of one NC and one NO contact for remote supervisory indication.

- (b) Second relay for operation of forced-air cooling fans through an automatic-manual selector switch on transformers rated 501 kVA and larger.
 - (3) Second set of thermometer contacts to trip essential main feeder at impermissible transformer over temperature.
 - (4) Contacts set in accordance with manufacturer's recommendations.
 - (5) Auxiliary relay may be located in associated low-voltage switchgear.
 - (6) Relay contacts for remote indication to be wired to accessible terminal block, with the following additional requirements:
 - (a) Rated 250 milliamperes at 250 volts dc or three amperes at 24 volts dc.
 - (b) Dry-sealed, with resistance of 0.10 ohms maximum.
 - (c) Contact bounce: Five milliseconds maximum.
 - j. Solid cast-epoxy winding construction:
 - (1) Each winding for each phase separately cast as a rigid tubular coil and installed coaxially around the core.
 - (2) Each winding reinforced with glass cloth.
 - (3) Epoxy characteristics:
 - (a) High electrical, mechanical and thermal strength.
 - (b) Non-flammable and self-extinguishing.
 - (c) Coefficient of expansion compatible with that of copper windings.
 - (d) Suitable for operation in ambient temperature range from minus 40C to plus 40C without cracking or degradation.
 - (e) Nonhygroscopic and suitable for operation at 40C ambient temperature and 100-percent humidity.
 - (4) Epoxy cast in metal mold under vacuum to ensure homogeneous casting free from voids.
 - (5) Windings fabricated in a facility with successful experience in the manufacture of solid cast-epoxy transformer windings.
 - k. Forced-air cooling fans and control panel:
 - (1) Forced-air cooling fans to permit 33-1/3 percent increase in transformer ventilated self-cooled kVA rating.
 - (2) Power supply for fans and control panel provided from associated transformer. Fans, control panel and associated circuits equipped with protective devices.
 - (3) Control panel flush-mounted with transformer enclosure and equipped with the following:
 - (a) Automatic-manual selector switch for controlling forced-air cooling fans. Fans activated by thermometer in automatic position.
 - (b) Indicating lights:
 - i. Green light for control power available.
 - ii. Amber light for fans operating.
 - (c) Automatic exercising of fans once a month.
2. Transformers for outdoor use:
- a. ANSI/IEEE C57.12.00, C57.12.90, floor-mounted, oil-filled, self-cooled/forced-air cooled, Class OA/FA or self-cooled, Class OA, as specified, double-wound, three-phase, 60 Hertz with secondary neutral brought out through insulating bushing.
 - b. kVA rating:
 - (1) Transformers, 501 kVA and larger: Self-cooled kVA rating as shown, with capacity in current-carrying parts to permit 15-percent increase in kVA rating (Class OA/FA) by operation of integral forced-

- air cooling fans.
 - (2) Transformers, 300 kVA and smaller: Self-cooled, Class OA, kVA rating as shown.
- c. Enclosure:
 - (1) Sealed-tank construction with lifting brackets, cooling radiator, braced and anchored to withstand jacking, skidding and towing.
 - (2) Equipped with two one-inch pipe fittings, one at top and one at bottom of tank, for filling and filter connection; one one-inch drain valve; and one 3/8-inch sampling valve.
- d. Insulating oil: ASTM D3487. Mineral insulating oil free from polychlorinated biphenyl (PCB) contamination.
- e. Rated insulation level:
 - (1) For 13.8 kV to 480Y/277-volt transformers: Class 15 kV, capable of withstanding:
 - (a) Low-frequency voltage: 70 kV.
 - (b) Full-wave basic-impulse voltage: 200 kV.
 - (2) For 34.5 kV to 480Y/277-volt transformers: Class 34.5 kV, capable of withstanding:
 - (a) Low-frequency voltage: 70 kV.
 - (b) Full-wave basic-impulse voltage: 200 kV.
- f. Bushings:
 - (1) 13.8 kV - 480Y/277-volt transformers:
 - (a) Primary bushings with glazed-porcelain surface, located on sidewall of transformer, with 15 kV insulation class with minimum 110 kV BIL in an air-filled junction box.
 - (b) Secondary-line bushings with glazed-porcelain surface, located on sidewall of transformer opposite primary bushings, with 1.2 kV insulation class with minimum 10 kV BIL in an air-filled junction box.
 - (2) Secondary neutral bushings:
 - (a) Low-voltage neutral bushings to be provided for each transformer.
 - (b) Low-voltage neutral bushings same as low-voltage line bushings, except neutral bushings may have reduced low-frequency insulation level in accordance with ANSI/IEEE C57.12.00.
 - (3) Provide silver-plated terminal pads suitable to receive cable terminals on high-voltage side and to receive cable terminals or bus connectors on low-voltage side, as necessary.
- g. Maximum allowable temperature rise under continuous full-load above ambient temperature of 30C average, 40C maximum.
 - (1) By winding resistance: 55C.
 - (2) By hottest spot in winding: 65C
- h. Taps:
 - (1) Capable of delivering rated output in each position.
 - (2) For 34.5 kV to 480Y/277-volt transformers: Two 2-1/2 percent taps above and two 2-1/2 percent taps below rated voltage on primary side.
- i. Tap changer:
 - (1) Externally mounted and manually operated no-load tap changer with locking provision for each position.
 - (2) Tap-change operating handle arranged for operation at no-load only through key interlocking with associated primary breaker in open position.
- j. Thermometer/auxiliary relay: As specified for transformers for indoor use.

- k. Liquid-level indicator: Float-operated magnetic-type continuously indicating liquid level, installed for easy removal and replacement without unsealing transformer enclosure.
 - l. Pressure-relief device: Mechanically operated self-resetting and self-reclosing type with manually resettable visual indicator and set of NO contacts to initiate tripping of associated primary breaker when pressure-relief device is activated.
 - m. Pressure vacuum-gauge range: Minus 10 to plus 10 psig.
 - n. Forced-air cooling fans and control panel:
 - (1) Forced-air cooling fans to permit 15-percent increase in transformer self-cooled kVA rating.
 - (2) Power supply for fans and control panel provided from associated transformer. Fans, control panel and associated circuits equipped with protective devices.
 - (3) Control panel with NEMA 250, Type 3R enclosure and equipped with the following:
 - (a) Automatic-manual selector switch for controlling forced-air cooling fans. Fans activated by thermometer in automatic position.
 - (b) Indicating lights:
 - i. Green light for control power available.
 - ii. Amber light for fans operating.
 - iii. Automatic exercising of fans once a month.
 - o. Surge arrester: ANSI/IEEE C62.11, intermediate class with metal-oxide varistor construction, one per phase, mounted on high-voltage terminals in air-filled junction box with the following requirements:
 - (1) For 13.8 kV - 480Y/277 volt unit: Hubbell/The Ohio Brass Company Type PVR, Catalog Number 218613, or equal, with ratings as follows:
 - (a) Duty-cycle voltage, kV, rms: 15.
 - (b) Maximum continuous operating voltage, kV, rms: 12.7.
 - (c) Insulation-withstand impulse test voltage, kV: 110.
- C. General-Purpose and Specialty Transformer:
- 1. NEMA ST20 and ST1, UL 506 and 1561, indoor, dry, double-wound with insulated copper conductor, suitable for operation on 60 Hertz.
 - 2. Rating:
 - a. kVA rating: As shown.
 - b. Voltage rating:
 - (1) Three-phase transformers: 480 volts primary to 208Y/120 volts secondary with secondary neutral brought out.
 - (2) Single-phase transformers: 480 or 277 volts primary to 120 volts secondary.
 - 3. Enclosures:
 - a. 9 kVA and below: Non-ventilated, NEMA 250, Type 3R weatherproof enclosure with encapsulated core and coils.
 - b. Above 9 kVA: Ventilated, NEMA 250, Type 2 drip-proof enclosure with removable front panel and louvers to prevent entrance of falling dirt and accidental access to live parts, and with lifting brackets or holes.
 - c. 45 kVA and below: Wall-mounted unless otherwise shown.
 - d. Above 45 kVA: Floor-mounted or platform-mounted as shown.
 - 4. Insulation system as specified below, capable of withstanding full-wave impulse of 10 kV.

kVA Rating	Insulation System
1 - 2	150C
3 - 30	185C
Above 30	220C

5. Maximum allowable temperature rise under continuous full-load above an average ambient temperature of 30C and maximum of 40C.

kVA Rating	1 - 2	3 - 30	Above 30
By winding resistance	150C	115C	150C
By hottest spot in winding	185C	145C	180C

6. Taps:

- a. Tap-changing links providing taps as follows, capable of delivering rated output in each position.
- b. Single-phase transformers: Provide taps on primary side in accordance with the following:

kVA Rating	Quantity	Taps Size:	Percent-age of rated voltage
3 - 15	2	5	below
25 - 100	4	2-1/2	below
	2	2-1/2	above

- c. Three-phase transformers: Provide taps on primary side in accordance with the following:

kVA Rating	Quantity	Taps Size:	Percent-age of rated voltage
30 - 300	4	2-1/2	below
	2	2-1/2	above
9 - 15	2	5	below
6 and below	None required		

- D. Automatic Voltage Regulator:

- ANSI/IEEE C57.15, indoor, self-air-cooled, induction-type.
- Compensating automatically for voltage drop on long feeder runs of nominal 480-volt, three-phase, three-wire or nominal 480/277-volt, three-phase, four-wire, 60 Hertz system as shown.
- Range of regulation: As necessary to maintain output voltage of regulator at receiving

- end of feeder not less than 466 volts or 480 volts as specified, minimum range of plus 10 percent and minus 10 percent range of regulation. Regulation adjustable over full range in increments of one percent or less.
4. Circuit kVA rating: As shown.
 5. Equipped with automatic solid-state control for maintaining output voltage within plus-or-minus one percent of pre-selected voltage level over temperature range of minus 30C to plus 40C.
 6. Speed of response: Voltage correction to start within four cycles and complete within three seconds for two-percent change and within 10 seconds for adjustment to required voltage.
 7. Capable of withstanding a minimum of 15 times rated full-load current under short-circuit condition.
 8. Operating mechanism permanently lubricated.
 9. Full-load efficiency: 98-percent minimum.
 10. 150C insulation system; maximum allowable temperature rise under continuous full-load above an average ambient temperature of 30C and maximum ambient temperature of 40C: 80C.
 11. Enclosure: Fabricated from sheet steel, wall-mounted or floor-mounted as appropriate, as follows:
 - a. Electric rooms, traction-power substations and tie-breaker stations: NEMA 250, Type 1.
 - b. Fan shafts and pumping stations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install each transformer and automatic voltage regulator in position shown and in accordance with manufacturer's recommendations and NEC requirements.
- B. Make power-conductor and control-wire connections in accordance with manufacturer's drawings, Section 16125 and as shown.
- C. Ground each transformer and automatic voltage regulator as shown and in accordance with Section 16060.
- D. Connect space heater circuit to prevent condensation during installation.

3.02 FIELD QUALITY CONTROL:

- A. Prior to testing, check transformer installation in accordance with ANSI/IEEE C57.94.
- B. Submit field-testing plan including, but not limited to, the following tests. Furnish equipment and perform the following tests in the presence of Engineer, in accordance with approved procedure:
 1. Distribution transformers: In accordance with Section 16360.
 2. General-purpose and specialty transformers:
 - a. Perform insulation-resistance tests winding-to-winding and winding-to-ground. Record and correct resistance value to temperature.
 - b. Perform ac high-voltage tests between high-voltage winding and low-voltage winding, between high-voltage winding and ground and between low-voltage winding and ground. Perform tests at 65 percent of factory test voltage for one-minute duration.
 - c. Test voltage ratio of each tap. Results not to deviate more than 0.5 percent from calculated ratio. Set taps as directed.
 - d. Check polarity by means of vector check.
 3. Automatic voltage regulator:

- a. Test circuit for connection in accordance with wiring diagram.
 - b. Test insulation of nongrounded conductors to ensure 10-megohms minimum resistance to ground.
 - c. Test regulator enclosure for continuity to grounding bus.
 - d. Set output voltage and check actual output voltage and speed of voltage correction as follows:
 - (1) For regulator supplying ventilation fans in fan shaft, set output voltage to 466 volts minimum and check actual output voltage and speed of voltage correction for providing required voltage output within specified time for each increment of additional load brought on line by sequential automatic starting of fan motors when load is supplied by each of two sources.
 - (2) For regulator supplying pumps in drainage pumping station, set output voltage to 466 volts minimum and check actual output voltage and speed of voltage correction for providing required voltage output within specified time for each increment of additional load brought on line by automatic starting of the first pump followed by the second pump when load is supplied by each of two sources.
 - (3) For regulator supplying facilities other than fan shafts and drainage pumping stations described above, set output voltage to nominal 480 volts and check actual output voltage and speed of voltage correction for providing required voltage output within specified time to the connected load.
 - e. For regulators supplying ventilation fans in fan shafts and pumps in drainage pumping stations, check actual output voltage and speed of voltage correction for providing required output when total load of all connected motors is transferred from one source to the second source by simulating power failure in each of the two sources connected to the automatic transfer switch.
- C. Submit certified test reports.

END OF SECTION

SECTION 16294

CONTACT RAIL HEATING SYSTEM FOR TRACTION POWER

PART 1. GENERAL

1.01 SUMMARY

- a. This section specifies installation of a complete contact rail heating system comprised of numerous sub-systems and components.
- b. New contact rail heat tape, fiberglass channel/extrusion, and attachment clips will be furnished by WMATA for installation by Contractor.
- c. This work includes but is not limited to the following:
 - i. Furnishing and delivery to job site of all materials other than WMATA-furnished materials.
 - ii. Removal of selected contact rail heat tape at indicated locations necessitated by relocation of existing contact rail, and installation of new contact rail heat tape after relocation of contact rail. Extend and reconnect existing power circuits to new (replacement) contact rail heat tape.
 - iii. Existing control panels/controllers are to be reused. Relocate if and as necessary as part of track rework.
- d. Related Work Specified Elsewhere
 - i. Section 01006 - Program Criteria for Traction Power and Yard Lighting
 - ii. Section 16128 - Wire and Cable For Traction Power
- e. Measurement and Payment
 - i. Wiring: Lump sum.
 - ii. Conduit: Lump sum.
 - iii. Installation and field-testing: Lump Sum.

1.02 DEFINITIONS

- A. Definitions:
1. Contact Rail Heater: A heating cable installed on the contact rail to electrically heat the mass of the rail. The cable is one of parallel circuit design utilizing a metal alloy/fiber composite heating element spirally wrapped around the parallel bus wires of the cable.
 2. 32°F Substrate: A metal surface that is maintained at 32°F.
 3. Nominal service voltage: The voltage at which the heater cables are expected to operate when in normal operation, i.e., 750V DC.
 4. Rated Power Output: The watt/foot of heating cable, eight feet or longer, energized at 750V DC, when mounted on a 32°F substrate.
 5. Sheath Temperature: The temperature of the outermost jacket.
 6. Maximum Sheath Temperature: The highest sheath temperature that a heater is

capable of generating when powered at 750V DC in still air.

7. Factory Fabricated: A heating cable including terminations and lead wires completely assembled and tested at the manufacturer's plant prior to shipment.
8. Heat Transfer Aids: Includes any materials that are extruded on to the heater for the purpose of conducting heat from the heater to the contact rail.
9. Traction Power Zone: Includes all contact rail fed from a DC switchgear feeder breaker.

1.03 SUBMITTALS

Submit the following for approval in accordance with the Division 1 and with the additional requirements as specified for each:

- A. Documentation:
 1. Submit Installation and Maintenance Manuals: as required by Division 1.

1.04 QUALITY ASSURANCE

- A. Codes, Regulations, Reference Standards and Specifications:
 1. Codes and regulations of jurisdictional authorities.
 2. ASTM: A283, B368, B633, D88, D130, D149, D217, D256, D495, D543, D570, D638, D648, D696, D790, D792, D942, D1056, D1263, D1264, D2509, D2565, D3032, F593, G3, PRACTICE G26 METHOD 1.
 3. IEEE STD 515 - 1997
 4. IEEE STD 515.1- 1995
- B. Production Tests: Visual Examination for overall uniformity and acceptable surface quality.

PART 2 PRODUCTS

2.01 EQUIPMENT - CONTACT RAIL HEAT TAPE

Contact rail heat tape will be furnished by WMATA for installation by the Contractor.

2.02 EQUIPMENT - HEATER CONTROLLERS

- A. Existing heater controllers are to be reused.
- B. Existing Track side Heater Control Panels are to be reused.
- C. Existing Zone Heater Control Panels are to be reused.
- D. Existing Fusebox Disconnects are to be reused.
- E. Existing Master Heater Control Panels are to be reused.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Complete the power wiring circuits and the control power circuits in accordance with requirements of shop drawings.

- B. Contact Rail Preparation:
 - 1. Aluminum-Clad (Composite) Contact Rail: Clean the side of contact rail where heater is to be installed. Area to be cleaned will cover the upper portion of the aluminum extrusion beneath the rail head and extends the entire length of the rail. Clean aluminum extrusion using a soft wire brush or wooden scraper. Exercise extreme care when cleaning the aluminum extrusion to prevent surface gouging.
 - 2. Install heater tape elements within four (4) hours of rail surface preparation at each individual job location.
 - 3. Obtain written approval from Authority Representative when motorized tools are to be used to accomplish wire brushing of rail surface.

- C. Installation of Heater Tape:
 - 1. Contractor shall make field survey and measurements for actual lengths of heater cable prior to ordering of heater cable.
 - 2. Prepare contact rail surfaces prior to heater installation.
 - 3. Where heater is installed on field side, terminate the heater cable as close as possible to either the end-approach or the traction power cable connections to the third rail. Do not install heater tape over end-approach, power cable connections or expansion joint.
 - 4. Where heater is installed on railside, terminate the heater cable as close as possible to the end-approach of the contact rail. The cables for connections and power termination on either side shall be routed to the field side for continuation of circuits and shall be secured safely without any slack to avoid their interference with rail or equipment movement on the rail side.
 - 5. Adhere to the installation instructions noted in these Specifications, as well as those in the heater element manufacturer's installation instructions. Bring any differences to the immediate attention of the Authority Representative for clarification. Install heater on the aluminum cladding found on aluminum-clad contact rail. Make sure that complete heater assembly does not interfere with existing operation of collector shoe or contact rail protection covers assemblies, etc.
 - 6. In general, installation of heater tape elements involves utilization of a fiberglass channel and clip system to provide intimate contact between the element itself and the rail surface. Mechanical strain relief clamps are also used when going around rail splice bars and at element ends.
 - 7. Each particular contact rail site scheduled for heater installation work, will require discrete tape element lengths.
 - 8. Provide special abrasion pads for protection of the heater tape at any protrusion or burrs on rail and splice plates. Do not install fiberglass channel on such locations.
 - 9. Route power lead wires away from the head of the rail and secure to prevent damage by passing trains.

3.02 IDENTIFICATION

- A. Identify field assembled heaters at the power termination and with Circuit number description using a heat shrinkable permanent ink labeling system.

3.03 FIELD QUALITY CONTROL

- A. Furnish equipment required to perform tests. Prior to insulation resistance tests, isolate the heater circuit. Conduct tests in the presence of the Authority Representative.
- B. Perform heating system testing in each subsystem to complete the testing of the total installed system specified in Article 1.05.
- C. Submit test procedure for approval and perform approved tests. Do not perform tests without approved test procedure. Schedule all tests through the Authority Representative. Tests include but not limited to the following:
 - 1. Visually inspect heater for continuous coverage by the containment channel, sufficient attachment clips, and abrasion pads at all welds, brackets, and obstructions.
 - 2. Measure insulation resistance using 1000V DC megger between heater conductors and contact rail. Must be greater than 1000 megohms - ft.
 - 3. Perform operation tests.
- D. Field Testing and Inspection:
 - 1. General Requirements:
 - a. Conduct field testing and inspection of each sub-system to ensure proper operation of equipment provided.
 - 2. Field Inspection:
 - a. Prior to field testing, check equipment installation, including verification of the following:
 - 1) Integrity of insulation.
 - 2) Integrity of #4 AWG cable exothermic connection to contact rail and running rail.
 - 3) Tightness of connections for control, power and ground wiring.
 - 4) Adequate support to provide proper contact between heater tape and contact rail.
 - 5) Adjustment of pick-up current of each magnetic current relay.
 - 6) Adjustment of time-delay pick-up time for each time-delay relay.
 - 7) Proper operation of door safety interlocking in track-side heater control panel.
 - 3. Field Testing:
 - a. Furnish equipment required to perform tests and provide evidence of calibration.
 - b. Provide services of manufacturer's engineering representative and supporting field crew.
 - c. Prior to insulation resistance tests, disconnect instruments and equipment which might be damaged during such tests. Conduct tests in presence of the Authority Representative.
 - d. Submit test procedure for approval and perform approved tests. Do not perform tests without approved test procedure. Schedule all test through the Authority Representative.
 - e. Perform insulation resistance test of 60-second duration on all equipment in accordance with the following requirements:
 - 1) Test Voltage:

<u>Voltage Rating</u>	<u>Test Voltage</u>
150-750V	1,000V, dc
 - 2) Insulation resistance: kV rating plus one megohm but not less than minimum value recommended by manufacturer.
 - f. Continuity Check

- g. Perform functional tests on control, interlocking, and supervisory indication circuits, including verification of interconnections between equipment and interface points.
 - h. Energize and test each heater circuit for proper operation.
- E. Field Testing Personnel:
 - 1. Provide services of qualified manufacturer's engineering representatives to perform specified field testing program
 - 2. When more than one representative is involved, the Contractor is responsible for coordination of testing effort.
 - 3. Provide engineers, technicians and journeymen as necessary to set up and implement testing.
- F. Submit certified test reports within seven days after field tests.

END OF SECTION

THIS PAGE NOT USED.

SECTION 16320

HIGH-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing 13.8 kV metal-clad switchgear.
- B. Related Work Specified Elsewhere:
 - 1. Raceways, boxes, and cabinets: Section 16130.
 - 2. Wire, cable and busways: Section 16120.
 - 3. Wire connection accessories: Section 16125.
 - 4. Grounding and bonding: Section 16060.
- C. Design Criteria:
 - 1. Floor loading: Switchgear compatible with floor design-loading of 250 pounds per square foot.
 - 2. Switchgear suitable for anchoring to a concrete floor steel-trowel finished to tolerance level of 1/8 inch in 10'-0".

1.02 QUALITY ASSURANCE:

- A. Qualifications: Select a manufacturer who is regularly engaged in production of similar switchgear.
- B. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. NEMA: SG4.
 - 4. ANSI: C37.06, Z55.1.
 - 5. ANSI/IEEE: C37.09, C37.20.2, C37.90, C57.13, C62.11.
 - 6. AHA: IS1.
- C. Factory Testing: Submit design tests or certified copies of test reports for identical units performed for each type and rating of circuit breaker as assembled in its complete switchgear unit including bus compartment.
 - 1. Circuit-breaker tests: In accordance with the requirements of ANSI/IEEE C37.09 including the following:
 - a. Design tests:
 - 1) Rated maximum voltage.
 - 2) Rated voltage-range factor.
 - 3) Rated frequency.
 - 4) Rated continuous-current test.
 - 5) Short-circuit rating.
 - 6) Rated standard operating duty.
 - 7) Rated permissible tripping delay.
 - 8) Rated interrupting time.
 - 9) Rated reclosing time.
 - 10) Rated dielectric strength.
 - 11) Rated control voltage.

- 12) Load-current switching.
- 13) Mechanical life.
- b. Production tests: Applicable tests in accordance with ANSI/IEEE C37.09.
- 2. Switchgear assembly tests: In accordance with ANSI/IEEE C37.20.2 and including the following:
 - a. Design tests for metal-clad switchgear:
 - 1) Dielectric tests.
 - 2) Rated continuous-current tests.
 - 3) Short-time current-withstand test.
 - 4) Momentary-current test.
 - 5) Mechanical endurance tests.
 - 6) Flame-resistance and tracking-resistance tests for sheet, molded or cast insulating materials for support of primary buses and connections.
 - 7) Flame-resistance test for applied insulation metal-clad switchgear.
 - 8) Paint qualification test.
 - b. Production tests for metal-clad switchgear: Applicable tests in accordance with ANSI/IEEE C37.20.2.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings: In accordance with Section 16360.
- B. Certification:
 - 1. Certify switchgear complies with 250 pounds per square foot floor-load design.
 - 2. Certified test reports for specified factory testing.
- C. Documentation:
 - 1. Short-circuit calculations and coordination study: In accordance with Section 16360.
 - 2. Field-testing plan: In accordance with Section 16360.
- D. Operations and Maintenance Manuals: In accordance with Section 16360.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. Ship each unit securely packaged, braced and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Temporary Bracing: Where necessary, brace switchgear for hoisting, lowering and skidding into position. Label temporary internal bracing of switchgear: TEMPORARY-REMOVE BEFORE OPERATION
- C. Protection Against Concealed Damage: Include within shipping container mechanical impact recorder of rating recommended by manufacturer for shipment by railroad and submit impact-record chart with manufacturer's instructions for disposition of damaged material.
- D. Assembly for Shipment:
 - 1. Design enclosures to permit lifting by jacks or slings and moving horizontally on rollers or skidding in any direction.

2. Maximum dimensions of shipping sections to be coordinated with the dimensions of access hatches, corridors and doors to ensure shipping dimensions will allow movement of switchgear through structure without damage to equipment or structure or undue difficulty.
 3. For shipping split, coil interconnecting wiring on one side of the shipping split with matching terminal block on other side of split. Identify wiring and terminal-block points for reconnection.
 4. Draw-out relays mounted in their proper cases with moving parts properly secured and packed for shipment.
 5. Removable circuit-breaker elements packaged separately.
- E. Store switchgear in secure and dry storage facility.

1.05 OPERATION AND MAINTENANCE TRAINING:

- A. In accordance with the General Requirements and with Section 16360.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements for 13.8 kV Metal-Clad Switchgear:
1. ANSI/IEEE C37.20.2, for indoor use.
 2. Common ratings of switchgear:
 - a. Rated frequency: 60 Hertz.
 - b. Rated continuous current: 1,200 amperes.
 - c. Rated momentary current: Corresponding to circuit-breaker momentary ratings.
 3. Insulation structure:
 - a. Material not to support combustion, produce toxic gases, absorb moisture or track.
 - b. When subjected to electric arc, emission of conducting materials from insulating structure limited so as not to interfere with performance of circuit breaker.
 4. Primary circuit breaker:
 - a. NEMA SG4 and ANSI C37.06, for indoor use.
 - b. Type: Three-pole, single-throw, drawout-type.
 - c. Electrically powered, spring-charged, stored-energy operating mechanism, with the following additional requirements:
 - (1) Voltage requirements:
 - (a) Charging of stored-energy operating mechanism: 125 volts dc.
 - (b) Closing by means of closing release coil capable of operation from 100-140 volts dc.
 - (c) Tripping by means of shunt trip coil capable of operation from 70-140 volts dc.
 - (2) Mechanically and electrically trip-free.
 - (3) Unless otherwise specified, closing release coil energized by means of push-button.
 - (4) Shunt trip coil energized manually by push-button or automatically by relay.

- (5) Equipped with mechanical devices on front of breaker to actuate closing and tripping operations in case of failure of control power.
 - (6) Compressed-spring, stored-energy operating mechanism, with sufficient energy storage for closing/opening operation at rated short-circuit current or at related capabilities.
 - (7) Stored-energy mechanism automatically charged within 10 seconds following each closing of circuit breaker.
 - (8) Stored-energy mechanism suitable for manual charging by means of removable handle in case of failure of control power.
 - (9) White indicator light on control panel of circuit-breaker unit or mechanical indicator on front of breaker to indicate that stored-energy closing mechanism is charged.
- d. Racking mechanism:
- (1) Horizontal-drawout breaker: Manually-operated mechanism designed to permit racking of breaker with door closed by inserting crank through opening of limited size in door.
 - (2) Vertical-lift breaker:
 - (a) Racking accomplished electrically using control switch inserted into receptacle mounted on breaker door to permit racking with door closed.
 - (b) White and amber indicator lights provided at raise/lower control switch.
 - (c) Manual racking mechanism for emergency use.
 - (3) Racking-mechanism gear ratio: To permit one man to raise or lower breaker or rack it in and out manually in four minutes maximum.
 - (4) When breaker element is in fully-lowered or racked-out position, circuit breaker, complete with its operating mechanism, capable of being withdrawn from housing and moved on wheels integral with mechanism. Separate handling device for moving circuit breaker, other than transfer truck or fifth-wheel steering bar, is prohibited.
 - (5) Positive stops for preventing overtravel and guides for proper alignment of breaker.
- e. Grounding:
- (1) When breaker is in connected position, case and frame grounded by positive contact with ground bus.
 - (2) Breaker ground shoe designed to connect breaker frame to ground bus prior to engagement of primary-breaker terminals.
 - (3) Ground connection capable of carrying fault current equal to rated short-circuit current and related necessary capabilities.
- f. Interlocks: Provide suitable interlocks to perform the following functions:
- (1) Automatic discharge of stored-energy mechanism of the circuit breaker prior to its withdrawal from the unit.
 - (2) Prevent raising and lowering or racking in and out unless circuit breaker is in OPEN position.
 - (3) Prevent removal of vertical-lift breaker until it is entirely lowered.
 - (4) Prevent either electrical or manual operation of the breaker unless it is in the operating or test position.
 - (5) Automatically trip associated secondary main breaker when the primary breaker trips. This interlocking scheme does not prevent primary breaker from closing when associated secondary main breaker is open.

- g. Primary connection: Connection between the removable and stationary unit made by male-and-female contacts, with the following additional requirements:
 - (1) Silver-plated, high-pressure contacts.
 - (2) Automatic shutter to cover contact orifice when breaker is withdrawn and to uncover orifice when breaker is returned to connected position.
 - (3) Automatic shutters constructed to withstand force of racking mechanism in case shutters fail to open when breaker is racked into position.
 - h. Secondary connection: Control and interlocking-circuit connections between stationary and removable elements of switchgear made using device consisting of recessed stationary receptacle and set of self-aligning multiple-contact plugs on removable elements with sufficient number of contacts to accommodate control and interlock circuits, including spares, without resorting to auxiliary relays.
 - i. Non-resettable mechanical-operation counter registering one count for each circuit-breaker closing operation.
 - j. Mechanical position indicator, showing breaker as OPEN or CLOSED.
 - k. Auxiliary contacts for indicating CLOSED and OPEN position of the circuit breaker at remote location, with the following additional requirements:
 - (1) Dry contacts, minimum of one NC and one NO, rated 250 milliamperes at 250 volts or three amperes at 24 volts dc, wired to accessible terminal block.
 - (2) Contact resistance not to exceed 0.10 ohm in closed state when operating in circuit with open-circuit voltage of three volts dc and closed-circuit current of 10 milliamperes.
 - (3) Contact bounce not to exceed five milliseconds.
5. Current transformers:
- a. ANSI/IEEE C57.13, molded rubber or epoxy construction, wound-type transformer, complying with ANSI/IEEE requirements for relaying accuracy classification under burden imposed by devices specified. Minimum relay current transformer accuracy class is C-200. Mounted in a compartment isolated from the control panel. When approved by the Engineer, fully insulated, window-type current transformer may be used.
 - b. Quantity: Three.
 - c. Current ratio: As shown and determined by approved coordination study.
 - d. Insulation class:
 - (1) 13.8 kV with basic-impulse insulation level of 95 kV full-wave.
 - e. Capable of withstanding thermal and magnetic stresses from flow of current equal to the momentary and interrupting rating of the circuit breaker.
 - f. Maximum allowable-temperature rise under continuous full load above an average ambient temperature of 55C:
 - (1) By winding resistance: 30C.
 - (2) By hottest spot in winding: 40C.

- g. Transformer secondary neutral and frame individually grounded by copper wire to switchgear ground bus. Keep each ground connection run as short as possible. Avoid grouping such connections with control or other wiring.
6. Potential transformers:
- a. ANSI/IEEE C57.13, molded rubber or epoxy, one of the following configurations:
 - (1) Current-limiting primary fuses mounted on drawout carriage.
 - (2) Drawout transformer with integrally mounted fuses.
 - b. Quantity: One.
 - c. Connection:
 - (1) For 13.8 kV source: Phase-to-ground.
 - d. Voltage ratio:
 - (1) For 13.8 kV source: 14.4 kV to 120 volts.
 - (2) Insulation class:
 - (3) For 13.8 kV source: 13.8 kV with basic-impulse insulation level of 95 kV full-wave.
 - (4) Maximum allowable temperature rise under continuous full load above average ambient temperature of 55C:
 - (5) By winding resistance: 30C.
 - (6) By hottest spot in winding: 40C.
 - e. Install in switchgear so as to allow access from the floor without use of ladder.
2. Protective relays:
- a. General requirements:
 - (1) Semi-flush mounted, adjustable drawout relays each with test switches.
 - (2) Rustproof-metal rectangular cases finished in dull black.
 - (3) With targets, hand reset for targets and seal-in units.
 - (4) Contact and adjusting device readily visible, accessible and adjustable from front of relay.
 - (5) Designed, constructed and tested in accordance with applicable requirements of ANSI/IEEE C37.90.
 - b. Overcurrent relays:
 - (1) Three 50/51 phase-time and instantaneous-overcurrent relays and one 50N/51N residual ground-time and instantaneous-overcurrent relay for 34.5 kV service or three 50/51 phase-time and instantaneous-overcurrent relay and one 50N residual-ground instantaneous-overcurrent relay for 13.8 kV service, as appropriate.
 - (2) Exact characteristics and settings determined by manufacturer to provide necessary protection and coordination.
 - (3) Having very inverse time characteristics where protection and coordination permit.
 - (4) Relays set as low as practicable, time-dial setting and current tap, to provide fault protection and coordination with overcurrent device on associated secondary main breaker.
 - (5) Relays operating associated lockout relay as follows:
 - (a) 13.8 kV switchgear: Relays 50/51 and 50N.
 - (b) Voltage relay:
 - (6) For 13.8 kV source: One undervoltage/overvoltage (27/59), single-phase, time-voltage relay.

- c. One rotary, hand-reset, 125-volt dc lockout relay, equipped with green light for indicating reset position.
 - d. Auxiliary relays: Provided where required, General Electric Company Type HGA or HFA or equal, mounted inside instrument compartment.
 - e. Relay test equipment: One test set suitable for testing all solid-state relays furnished.
3. Circuit-breaker control switch: Heavy-duty, rotary, with red pistol-grip operating handle, switch position marked TRIP/NORMAL/CLOSE, with spring return to normal and indicator lights as follows:
- a. Red light: Circuit breaker is closed.
 - b. Green light: Circuit breaker is open.
 - c. Amber light: Circuit breaker is automatically tripped.
4. Test switches: Provided between instrument transformers and the protection relays as follows:
- a. One test switch on line side of overcurrent relays and lockout relay.
 - b. One test switch on line side of undervoltage/overvoltage relay.
5. Control panel: For relays, meters and control equipment, hinged panel of formed steel, with rolled edges and conveniently located handle for opening.
6. Line-voltage indicators: Three neon glow-tube, capacitance-coupled, high-voltage indicators, Airco Type RS or equal.
7. Surge arrestor:
- a. ANSI/IEEE C62.11, intermediate class with metal-oxide varistor construction, one per phase, mounted on line side of circuit breaker with the following requirements:
 - (1) For 13.8 kV source: Hubbell/The Ohio Brass Company Type PVI, Catalog Number 218613, or equal, with ratings as follows:
 - (a) Duty-cycle voltage kV, rms: 15.
 - (b) Maximum continuous operating voltage, kV, rms: 12.7.
 - (c) Insulation-withstand impulse test voltage, kV: 110.
8. Indicator lights: LED
9. Space heaters:
- a. Each unit of switchgear provided with 120-volt, single-phase, 60-Hertz heating element to facilitate drying and prevent condensation.
 - b. Heaters enclosed in grille guard with no sharp edges and located so that they are accessible for replacement without requiring de-energization of switchgear bus. Heaters controlled by thermostat adjustable from 40F to 80F. Panel ammeter, approximately 2-1/2 inches square, marked to indicate heater load. Thermostat set in accordance with manufacturer's recommendations.
 - c. Power and control circuits to heaters and thermostat connected and protected up to devices and to incoming junction box with 1/2-inch minimum size conduit. Heater-power junction box sized four inches square by two inches minimum and located at top of switchgear for top entry of minimum 3/4-inch conduit.
10. Instrument and control wiring: Instrument and control wiring including electrical interlocks and intercompartment wiring factory-installed in accordance with the following requirements:
- a. Wire: Copper conductor minimum 14AWG, insulation rated 600 volts, Type SIS or equal. Use flexible Class C or higher stranded, insulated copper wire for wiring across hinged joints.

- b. Use one continuous length of wire from terminal to terminal without splice or tap.
 - c. Install and connect removable-element control wiring in accordance with manufacturer's standards for circuit-breaker wiring.
 - d. Design and install control wiring so that trouble in one main circuit cannot be communicated to control wiring of another main circuit.
 - e. Make connections only at terminals of device, on terminal blocks or on control buses. Make wiring connections using insulated-shank ring-type terminals.
 - f. Terminate interconnecting wiring between cubicles and compartments on terminal blocks before wiring to components.
 - g. Terminal blocks: With washerhead screw-type terminals, circuit-marking strips for indicating control-wire number, phenolic laminated dust cover and 10-percent minimum spare terminal points.
 - h. For each wire, use corresponding identification on terminal-block marking strips and identify internal wiring at each termination, with same number as that shown on wiring diagram, using plastic sleeve.
 - i. External wiring:
 - (1) External control wiring to enter from bottom or top.
 - (2) Allow space to route and terminate external single-conductor or multiple-conductor control cable.
 - (3) Top entrances provided with removable coverplates for field-drilling of conduit and cable entrance holes.
 - j. Tests:
 - (1) Check wiring for accuracy, open circuits, short-circuits, ground connections and insulation integrity by means of high-potential, continuity and operational tests.
 - (2) Subject wiring to high-potential test of 1,500 volts to ground for one minute.
 - (3) Verify that wiring is in accordance with manufacturer's wiring diagrams. Check complete wiring, including interconnections at shipping breaks.
11. Enclosure:
- a. Dead-front, free-standing, indoor metal enclosure designed for lineup with 13.8 kV to 480Y/277-volt transformer.
 - b. Steel structure with framework of welded or bolted structural steel, free from distortion and welding strain and sufficiently rigid to support equipment under normal and short-circuit conditions.
 - c. Switchgear cubicles and circuit-breaker compartment equipped as follows:
 - (1) 13.8 kV enclosure:
 - (a) Front: Hinged door.
 - (b) Rear: Bolted cover with alignment pins or hinged door with padlock provisions.
 - (2) Bolted cover furnished with alignment studs and keyhole slots for positioning prior to bolting.
 - (3) Hinged front door in accordance with the following:
 - (a) Handle and three-point latch to hold door securely closed.
 - (b) Doorstop to hold door open.
 - (c) Structural reinforcing provided as necessary to prevent sagging of door.

- (d) Circuit-breaker compartment door designed not to hinder movement of breaker in and out of compartment when door is open and doorstop set.
 - (4) Circuit breaker cubicles to provide for interchangeability of removable circuit-breaker elements.
 - d. Transition compartment sized as necessary, with front and rear bolted covers to line up and coordinate with transformer.
 - e. Finish: Metallic surfaces degreased, primed and finished light-gray enamel, Color No. 61, ANSI Z55.1 in accordance with reference standard; two mils minimum dry-film thickness.
12. Nameplates:
- a. Three-ply, laminated phenolic plates, engraved through black face to white core and attached by means of stainless-steel rivets or screws. Vertical Gothic lettering using a round or square cutter. V-shaped groove is prohibited.
 - b. Provide nameplate on each switchgear showing manufacturer's name and brand designation, the referenced standard, type, class and rating as applicable in accordance with reference standard.
 - c. Provide additional functional nameplates for each component.
 - (1) Each switchgear labeled with nameplate 1-1/2 inches high, inscribed in letters one-inch high: 13.8 kV METAL-CLAD SWITCHGEAR .
 - (2) Each switchgear compartment labeled with nameplate one-inch high, inscribed in letters 1/2-inch high: INCOMING LINE PRIMARY BREAKER or AUXILIARY COMPARTMENT, as appropriate.
 - (3) In addition to other information normally displayed on equipment, provide one-inch nameplate showing in letters 1/2-inch high switch positions, meaning of indicator lamp and other pertinent information.
13. Major components to be products of the same manufacturer.
14. Switchgear accessories: One set of the following accessories for each substation as applicable:
- a. One breaker test cabinet with provision for electrical operation of circuit breaker with control switch and provision for other accessories as necessary.
 - b. One transfer truck or fifth-wheel steering bar.
 - c. Crank for manually racking circuit breaker in switchgear cubicle.
 - d. One circuit-breaker maintenance lever.
 - e. One spare set of each type of high-voltage fuse.
 - f. One complete set of relay test plugs and relay test switch.
 - g. One set of special tools necessary for erection, operation and maintenance of switchgear including ones recommended by relay manufacturer including breaker secondary or control disconnect coupler.
 - h. Pegboard: Hardboard, AHA IS1, tempered, S1S, 1/4-inch nominal thickness, perforated, sized to accommodate all products specified in paragraphs 2.1 A.19.a. through 2.1 A.19.g. Framed with one-inch by one-inch hardwood. Frame and hardboard painted color selected by the Engineer. Include hardware for wall mounting and pegboard accessories suited to the products to be mounted. Provide nameplates as specified in paragraph 2.1 A.17. one-inch wide, with accessory names inscribed in 1/2-inch vertical letters.
 - i. 13.8 kV grounding, phasing and testing device: Designed to be inserted into the switchgear unit in place of and in the same manner as the circuit breaker removable elements, to permit grounding either the bus or the line, or making external connections to either the bus or the line for phasing purposes, testing purposes or both, with the following additional requirements.

- (1) Momentary and three-second current carrying capacities equal to or greater than those of the circuit breaker removable elements.
- (2) BIL rating: 95 kV.
- (3) Include a power-operated circuit closing device (grounding switch) so arranged with a gang-operated three-pole selector disconnect switch to effectively ground either the bus or the line when the device is inserted into the unit and closed, with the following additional requirements:
 - (a) Closing by means of a portable remote control push-button station mounted on the end of a 50-foot, four-conductor, flexible (class C Stranding) cable providing common, close, trip and ground conductors.
 - (b) Power obtained through the secondary disconnecting device in the switchgear unit.
- (4) Grounding device solidly connected to the switchgear ground bus in the operated or grounded position. Make provisions for padlocking in the grounded position.
- (5) No automatic tripping provided.
- (6) Provide suitable windows or transparent enclosure and barriers to permit visual observation of the position of all selector switch blades before the device is inserted into the stationary housing.
- (7) Fabricate steel panels from No. 11 USSG steel.
- (8) Connect the selector switch hinge end directly to the grounding switch.
- (9) Provide insulated covers for bolt heads used to attach insulated panel to the front of the device if not at ground potential.
- (10) External connections for testing made by insulated plug connectors for insertion in deep ports or wells accessible at the face of the device. One set of test ports connected directly to the bus. A second set of test ports connected directly to the line terminals.
 - (a) Mount ports on insulating material and provide closing shutters of like material.
 - (b) Provide separate closing shutter for each set of test ports; each shutter with provisions for padlocking in the closed position.
 - (c) Provide three test plugs or probes for each grounding, phasing and testing device for external connections.
- (11) The Contractor is responsible for obtaining approval of shop drawings and submittal including catalog data from electric utility company for the grounding, phasing and testing device prior to manufacturing. Make submittals to the Engineer for obtaining electric utility company approval.

2. 13.8 kV Metal-Clad Switchgear:

1. Rating for switchgear assembly:
 - a. Rated nominal voltage: 13.8 kV.
 - b. Rated maximum voltage: 15.0 kV.
 - c. Insulation level, 60 Hertz withstand: 36 kV, rms.
 - d. Insulation level, impulse withstand: 95 kV.
2. Potheads or terminators:
 - a. Provision for mounting one three-phase pothead or three single-phase terminators or cables terminated with stress cones furnished by 13.8 kV-

- source electric utility company (Potomac Electric Power Company) for incoming line connections and grounding.
- b. Short flexible connector installed between each pothead or terminator connecting lug and rigid bus. Where cables are terminated without potheads or terminators, provide two-hole NEMA drilling for cable terminal lugs furnished by 13.8 kV-source electric utility company and furnish cable support.
 - c. Pothead or terminator mounted in inverted position with incoming service cable at the top and connecting lugs below unless otherwise shown.
3. Primary circuit breaker:
- a. Type: Air-break or vacuum-break.
 - b. Rating on symmetrical basis:
 - (1) Nominal voltage class, kV, rms: 13.8.
 - (2) Nominal three-phase MVA Class: 750.
 - (3) Rated maximum voltage, kV, rms: 15.
 - (4) Rated withstand test voltage:
 - (a) Low frequency, kV, rms: 36.
 - (b) Impulse, kV: 95.
 - (5) Rated continuous current at 60 Hertz, amp, rms: 1,200.
 - (6) Rated interrupting-time cycles: Five maximum.
 - (7) Rated voltage-range factor (k): 1.30.
 - (8) Rated short-circuit current at rated maximum, kV, amp, rms: 28,000.
 - (9) Maximum symmetrical interrupting capability, amp, rms: 36,000.
 - (10) Closing and latching capability, amp, crest: 97,000.
4. Buses:
- a. General requirements:
 - (1) Copper bus bars of sufficient size to carry specified current without exceeding allowable-temperature rise stated in ANSI, NEMA and IEEE Standards.
 - (2) Capable of withstanding the mechanical stresses and heat from maximum short-circuit current.
 - (3) Bus connections bolted or welded. Contact surfaces of bolted connections silver-plated or tin-plated.
 - (4) Each joint having impedance not more than that of bus bar of equal length and clamped to maintain such impedance throughout life of equipment.
 - (5) Connection coordinated for proper mating with adjacent equipment terminals and enclosures. Provide flexible joint at transformer connection to avoid overstressing transformer or circuit-breaker insulators and coordinated with transformer-bushing locations. Flexible connection to be leaf or braid-type. Provide access plates for assembly and inspection of connections and joints.
 - b. Power buses: Three-phase, three-wire buses fully insulated with factory-installed, flame-retardant, nonhygroscopic, track-resistant insulation. Provide each bolted connection with minimum of four bolts equipped with palnut or equal and fully insulated.
 - c. Incoming-line bus device for connecting portable ground clamp:
 - (1) Connecting device consisting of copper bracket with 7/16-inch diameter bronze or copper rod positioned horizontally and parallel to rear of switchgear.
 - (2) Connecting device mounted near pothead on each incoming bus.

- (3) Connecting device to provide three-inch length between end supports of rod and minimum 2-1/2 inch radial clearance around rod.
 - (4) Connecting device accessible from rear of switchgear following removal of bolted cover or opening of padlockable door.
 - (5) Six-inch insulating barriers to be provided on each side of connecting devices or stirrups and extending to rear of switchgear a minimum of six inches all around.
 - (6) Size, thickness, insulating material and placement of insulating barriers designed to achieve adequate mechanical strength without compromising voltage withstand specified for switchgear.
 - (7) Design coordinated and approved by 13.8 kV-source electric utility company.
- d. Ground bus:
- (1) Copper bus, not less than two inches by 1/4-inch provided throughout length of switchgear section.
 - (2) In switchgear unit where power cables enter or leave switchgear at top as shown, copper ground bus not less than one inch by 1/8 inch extending from main ground bus to top of unit for grounding incoming cable-ground sheath or shielding tape by short connection to bus.
 - (3) Joints in ground bus made with two bolts minimum and overlap of four inches.
 - (4) Mechanical connector provided in each unit for field connection of 4/0 to 500 KCMIL ground cable to switchgear ground bus.
- e. Control bus:
- (1) 125-volt dc bus not less than 6AWG copper.
 - (2) One two-pole knife switch provided in switchgear cubicle for disconnecting control circuit.
 - (3) UL Class J or RK-5 fuses used for control and auxiliary-service protection.
 - (4) Closing circuit fused; tripping circuit unfused.
 - (5) White light mounted on control panel to indicate availability of dc control power.
5. Auxiliary cubicle:
- a. Indoor metal cubicle for installing metering transformers, design coordinated with 13.8 kV-source electric utility company.
 - b. Separate compartment for mounting two 15 kV current transformers furnished by 13.8 kV-source electric utility company, with the following additional requirements:
 - (1) Current transformer accessible through sealable hinged door. Bolted access plates prohibited.
 - (2) Connection between bus and current transformer of same size and current rating as that of main bus.
 - (3) Compartment sized and arranged so that current transformer can be readily removed or replaced after cubicle is installed as integral part of switchgear assembly.
 - c. Separate compartment for mounting two 14,400/120-volt potential transformers furnished by 13.8 kV-source electric utility company, with the following additional requirements:
 - (1) Equipped with sealable hinged door. Bolted access plates prohibited.

- (2) Fuse clips one-inch long, mounted on 11-1/2 inch centers for accommodating fuse size 1-9/16 inch diameter ferrules and 12-7/8 inches long.
 - (3) Provide silver-plated contact designed to provide adequate contact pressure.
 - (4) Drawout carriage designed so that contacts are disconnected and visibly grounded before fuses become accessible for checking or replacement.
 - (a) Sealable in closed and operating positions.
 - (b) Equipped with high-voltage connectors and fuse clips.
 - (5) For grounding cases of transformers, one connection extended from ground bus to the potential-transformer compartment.
 - (6) Compartment designed to provide access to potential transformers from the floor without use of ladder.
- d. One 10-inch square by six-inch deep pull box for secondary connecting of electric utility company metering transformers, with the following additional requirements:
- (1) Equipped with two 1-1/2 inch conduits, one to current-transformer compartment and one to potential-transformer compartment.
 - (2) Provision for installing one 1-1/2 inch conduit from pullbox to electric utility company metering panel.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install switchgear in position as shown and in accordance with manufacturer's recommendation and the NEC.
- B. Install conduit, raceways, boxes and cabinets as shown and in accordance with Section 16130.
- C. Make power-cable and control-wire connections as shown and in accordance with Section 16125.
- D. Make grounding connections as shown and in accordance with Section 16060.
- E. Make arrangements with applicable electric utility company for making connections with incoming lines.
- F. Use services of manufacturer's engineering representative for assistance in field assembly, installation and testing of the switchgear in accordance with Section 16360.
- G. Connect space-heater circuit to prevent condensation during installation.
- H. Install breaker test cabinet and connect it to 125-volt dc supply.
- I. Install pegboard at location approved by the Engineer. Mount switchgear accessories and associated nameplate on pegboard.

J. Install wire, cable and busways in accordance with Section 16120.

3.02 FIELD QUALITY CONTROL:

A. Switchgear Field-Testing and Inspection: As specified in Section 16360.

END OF SECTION

SECTION 16341

D.C. SWITCHGEAR, SWITCHBOARD AND RELATED EQUIPMENT

PART 1- GENERAL

1.01 REFERENCES:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. ANSI: C37.14, C37.20
 - 4. ANSI/IEEE: C37.14.
 - 5. IEEE: No.27

1.02 QUALITY ASSURANCE

- A. Comply with the requirements of Section 01470

PART 2 - PRODUCTS

2.01 DC SWITCHGEAR

- A. Except as hereinafter specified, the shop dc switchgear and switchboards shall be designed, constructed and tested in accordance with the requirements of ANSI C37.14 and ANSI C37.20 and shall include all features and accessory equipment specified therein. Supervisory control and indication, automatic reclosing equipment, remote indication, automatic reclosing equipment, impulse trip devices and lightning arresters will not be required. The switchgear shall include the ground relaying and lockout relay, ammeter shunts, and ammeters. The circuit breaker which feeds the shop dc switchboard shall be equipped with a key interlock which shall permit the closing of the circuit breaker in the connected position only when the front doors of the compartments of the shop dc switchboard are closed. The key shall be retained in the breaker when the breaker is in the connected position and closed.
- B. The DC feeder breaker shall be manufactured by Control Power Corporation (Type HSNP) or by Whipp & Bourne (Type MM74) or approved equal, with the following requirements:
 - 1. When subjected to electric arc, emission of conducting materials from insulating structure limited so as not to interfere with performance of circuit breaker.
 - 2. Power circuit breaker compliant with NEMA SG3, ANSI/IEEE C37.14, ANSI C37.16/16a, C37.17. Single-pole, single-throw, air break, high-speed, drawout type, with electrically controlled solenoid closing, mechanically latching, and electrically controlled tripping, mechanically and electrically trip-free, complying with applicable parameters in Table 11 of ANSI C37.16a and with the following additional requirements. For the purposes of this specification, a single-pole breaker constitutes a switching device with a single current path and a single arcing path during current interruption
 - a. Nominal voltage: 750 Volts dc.
 - b. Rated maximum voltage: 800 Volts dc.
 - c. Insulation dielectric withstand: 4200 Volts.
 - d. Short-circuit interrupting capacity: 200 kA. In addition complying with rated peak current and short-time current ratings in Table 11, ANSI C37.16a.
 - e. Operation counter: Non-resettable with at least four digits for recording trip operations.
 - f. Endurance: Electrical and mechanical endurance performance not less than requirements in ANSI C37.16 table 14.
 - g. Control voltage:

- 1) 125 Volts dc nominal, individually fused.
 - 2) Upon loss of control voltage, circuit breaker shall automatically open. The under voltage release mechanism shall be designed and rated to operate at 135V DC continuously without overheating.
- h. Racking mechanism: The circuit breaker alignment, shutter mechanism and racking mechanism are considered an integral part of the circuit breaker. There shall be adequate clearance between equipment of the circuit breaker element and all equipment mounted on the switchgear enclosure. The racking mechanism shall be designed and constructed for moving the breaker between three (3) positions : the disconnected, test and connected positions. Clockwise rotation of the racking mechanism shall result in breaker movement toward the connected position and when in the fully racked-in connected position the racking mechanism shall turn freely. Counterclockwise rotation of the breaker racking mechanism shall result in breaker movement from the connected to the test and then to the disconnected position. The racking mechanism shall be a manually operated closed-door mechanism, designed to prevent over-travel, and equipped with guides for alignment of the breaker with a stationary unit and an indicator to show breaker position within the compartment. Use of an electro-mechanical toggle device for racking mechanisms will not be permitted. An inertia block device shall be installed in the cubical to absorb the force of the circuit breaker being inserted.
- i. Connected position: Both primary disconnect device and secondary disconnect device in full contact, breaker ready for normal operation.
- j. Test position: Primary disconnect device open and separated by a safe distance, secondary disconnect device in full contact.
- k. Disconnected position: Both primary disconnect device and secondary disconnect device open and separated by a safe distance.
- l. Primary connection (main disconnects): Connections between the removable and stationary unit made by male-and-female contacts, with the following additional requirements:
- 1) Silver-plated, high pressure contacts.
 - 2) Automatic shutter to cover the contact orifices when the breaker is withdrawn and uncover the orifices when breaker is returned to connected position.
 - 3) The racking mechanism gear ratios shall be designed in combination with the design of the shutters covering the main stationary disconnect, such that the shutters can withstand the force of the racking mechanism if the shutters fail to open as the breaker is racked in.
- m. Secondary connection (control and auxiliary disconnects): Control and interlocking circuit connections between stationary and removable elements of switchgear made using device consisting of recessed stationary receptacle and set of self-aligning contacts to accommodate control and interlock circuits, including spares, without resorting to auxiliary relays.
- n. Auxiliary switch contacts: Operated by breaker mechanism in both the connected and test position with sufficient number of contacts for operation, indication and interlocking of the breaker together with at least four spare sets of reversible contacts, each wired through secondary disconnect device contacts to accessible terminal blocks.
- o. Shunt trip device for 135 VDC operation.
- p. Electrically operated, mechanically latched, electrically and mechanically trip free, non-pumping, quick make, quick break mechanism insuring full contact pressure until the time of opening with following additional requirements:
- 1) Voltage requirement.

- a) Closing by means of closing solenoid mechanism and coil capable of operation from 90-140 Volts dc.
- b) Tripping by means of tripping solenoid mechanism and coil capable of operation from 70-140 Volts dc.
- 2) Equipped with mechanical device on front of breaker, available with door closed, to manually (without electrical power) actuate tripping operations and with indicator, visible with door closed, to show open or closed condition. Operable in the disconnected, test and connected positions.
- q. Arc chute: The arc chute shall be comprised of a number of vertical steel arc splitter plates designed to confine and direct the arc and break the arc into a number of smaller arcs which are cooled and extinguished as the arcs move toward the top of the plates. Sucker Loops are to be included in the metallic splitter plates. Splitter plates are to be insulated at the extremity to ensure that the arcs are extinguished. The arc chute is to be constructed to prevent the escape of arc plasma and the emission of metal from beneath the arc chute. The manufacturer shall demonstrate to the satisfaction of the Authority that the design of the switchgear does not result in operation of Energized Structure Relay or Grounded Structure Relay under fault openings, and that a voltage is not impressed on control wiring under fault conditions. The design of the switchgear and associated control and relaying equipment shall ensure against breakdown of insulation to ground for all fault conditions.
- r. Main contacts: Surfaced with silver, nonwelding silver alloy or equivalent combining high conductivity and necessary arc-resistant properties.
- s. Integral wheels for moving a circuit breaker element in and out of a cubicle and sized to carry breaker weight without deforming or cutting into the concrete or amazite surface. Plastic wheels are not acceptable. The wheels shall roll (not slide) and guide the circuit breaker between full length guide bars to align the circuit breaker element to engage the racking mechanism. No lifting devices shall be permitted to lift the circuit breakers in and out of its switchgear cubicle.

C. Series Trip Device

- 1. The circuit breaker shall be provided with direct acting forward and reverse current series trip device, adjustable between 75 percent and 300 percent of the circuit breaker continuous and current ratings.

D. Lock-Out Relay

- 1. The shop dc switchgear shall be furnished with a lockout relay, whose function shall be to trip and lockout the air circuit breaker.

E. Grounding Relays

- 1. The shop dc switchgear shall be provided with a high resistance ground relay, connected between the dc switchgear enclosure and ground which shall detect any accidental grounding of either the dc switchgear metal enclosures or the switchboard. The switchgear and the switchboard will be bonded together and both will be insulated from ground except through the high resistance ground relay. The high-resistance ground relay shall be provided with auxiliary contacts to permit installation of a local annunciator. The ground relaying network shall be fail-safe so that if its own circuit should malfunction, an annunciator is initiated. The switchgear and switchboard shall be provided with a "hot structure" ground relay, connected between the dc switchgear/switchboard enclosures and ground and which shall detect any part of the metal enclosures which may become energized. The "hot structure" ground relay shall be provided with auxiliary contacts connected to the dc switchgear look-out relay to initiate tripping and lock-out of the dc circuit breakers in

the switchgear. The ground relaying network shall be fail-safe so that its own circuit should malfunction, an annunciator is initiated.

2.02 DC SWITCHBOARD

- A. The shop dc switchboard shall be a dead front, free-standing, metal enclosed assemble, suitable for indoor service. The switchboard shall contain dc positive bus and bus connections, fusible branch circuit switches, and terminal connectors and all other auxiliary equipment and devices required. Shipping sections including shipping skids shall be of sufficiently small size to facilitate installation during construction, and subsequent maintenance/replacement by WMATA forces without demolition of structural or finished components of the completed shop buildings.
- B. Switchboard Service
 - 1. The switchboards shall be used to supply power to stingers and car receptacles at 750V dc. Ambient temperature will not exceed 40°C.
- C. Switchboard Standards
 - 1. Except as otherwise noted herein, the switchboard shall be designed, constructed and tested in accordance with the applicable provisions of ANSI Standard C37.20 and its supplements a, b and c (IEEE Standard No. 27) "Switchgear Assemblies Including Metal Enclosed Bus".
- D. Switchboard Ratings
 - 1. The switchboard shall have the following ratings from ANSI C37.20.
 - a. Rating Nominal Voltage 750 volts dc
 - b. Rating Maximum Voltage 800 volts dc
 - c. Insulated Test Level 2,775 volts dc
 - d. Withstand 3,900 volts dc Short Circuit Rating
 - e. Peak 75,000 amperes
 - f. Steady-State 75,000 amperes
 - g. Rate-of-rise 2,000,000 amperes per second
 - 2. Continuous Current Ratings - As indicated.
 - 3. The switchboard assembly, including all components, shall be designed to safety withstand the available short circuit currents without damage.
- E. Switchboard Enclosures
 - 1. Metal enclosed switchboard structure shall be rigid, self supporting, self contained steel, constructed in accordance with ANSI C37.20 "Standards for switchgear assemblies including metal-enclosed bus". Each branch feeder switch shall be fully compartmentalized so that they permit isolated access while serving load and confine faults to a single compartment. All switches shall be externally operable. The nominal height of the switchboard shall not exceed 90 inches. The enclosure shall be insulated from and anchored to a concrete floor which shall be covered by an insulating topping. (Leveling channels will not be furnished). The supplier shall provide the means for insulated anchoring to the finish floor. Wherever the switchboard enclosure is less than three feet from any vertical building surfaces such as a wall or column, the Contractor shall form sheet insulation of a non-hygroscopic type required to insulate the vertical building surfaces to a height of nine feet above the floor. A 2500 volt 60 Hz high-potential insulation test will be given to the insulation between enclosure and ground and also between the surface of the wall insulation and ground, upon completion of installation.
- F. Design
 - 1. The switchboard shall be designed and arranged to provide convenient access to all

components for normal operation and maintenance. The switches and fuses shall be accessible from the front of the switchboard, but they shall be enclosed behind full height front doors. The front doors shall be full height, not more than 36 inches wide, with viewing windows so that the positions of the switches will be visible without opening the doors. The front doors shall be key-interlocked with the dc main circuit breaker so that the doors cannot be opened without the insertion of a key, which shall be available from the circuit breaker only when the breaker is open. The key shall be retained in the front door until the door is closed and locked to prevent closing of the circuit breaker with the door open. The front doors shall be designed so that they can be closed and locked when the switches are either open or closed. The buswork and cable connections shall be accessible from the rear of the switchboard. The rear of the switchboard shall be provided with removable covers.

G. Branch Circuit Switches

1. Each branch switch shall be single pole, non-load break with current limiting fuse. The fuse compartment shall have a hinged door interlocked with the handle so the door cannot be opened while the switch is in the "ON" position. Provisions shall be provided to padlock the switch in the "Off" position.
2. Branch Circuit switches and fuses supplying power to the stingers shall be rated at 600 amperes at 750V dc. Branch circuit switches supplying power to receptacles shall be rated at 150 amperes at 750V dc.

H. Terminal Connectors

1. The combination switches shall be provided with solderless terminal connectors for outgoing cables. Connectors shall be of the long barrel, double indentation, compression type. The connectors shall be of one piece tubular construction formed of pure electrolytic copper and tin-plated to resist corrosion.

I. Nameplates

1. Each switch shall be provided with a circuit identifying nameplate. Nameplates shall consist of three-ply laminated phenolic plates (21/2"x 61/2") engraved through black face to white core. Lettering shall be 1/2 high condensed vertical gothic using a rounded or square cutter. V-shaped grooves are not acceptable. Nameplate legends shall be as follows:
 - a. DC STINGER NO. 1 (etc.)
 - b. DC RECEPTACLE POWER - NO. 1 (etc.)

J. Incoming Line Section

1. The DC switchboard shall be provided with an incoming line section which shall include provisions for the connections of incoming feeders (cables, or bus, as required.) Cable connectors shall be of the long barrel, double-indentation, compression type. The connectors shall be of one piece tubular construction formed of pure electrolytic copper and tin-plated to resist corrosion. Connectors shall be NEMA standard.

K. Ground Relaying

1. The switchboard enclosure shall be insulated from ground. The enclosure will be bonded to the dc switchgear, so that the switchgear-mounted ground and hot structure relays shall monitor and protect the switchboard, as well as the switchgear, from accidental grounding and accidental energizing of the enclosure.

L. Dc Bus and Bus Connections

1. The dc switchboard bus shall be made of electrical conductivity, high quality copper or aluminum of sufficient size to limit the temperature to 55 degrees C. The switchboard bus shall be adequately braced and supported to withstand mechanical forces exerted during short circuit conditions. All connections shall be tightly bolted.

M. Testing

1. The dc distribution switchboard shall be tested with fuses in place and shall withstand for one minute, without breakdown, a 60 cycle alternating potential of 3.7 times the maximum rated voltage. The switchgear shall also withstand for one minute, without breakdown, a direct current test voltage of 5.2 times the maximum rated voltage.
2. The test potential is to be increased gradually from zero until the required test value is reached and is to be held at the value for one minute.

END OF SECTION

SECTION 16360

UNIT SUBSTATIONS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing substation equipment for 13.8 kV primary service.
- B. Related Work Specified Elsewhere:
 - 1. Wire connection accessories: Section 16125.
 - 2. Grounding and bonding: Section 16060.
 - 3. High-voltage switchgear: Section 16320.
 - 4. Low-voltage switchgear and switchboard: Section 16435.
 - 5. Transformers: Section 16270.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. ANSI/IEEE: 141.
 - 4. IEEE: C57.93, C57.94.
- B. Main Components for Substation: Produced for assembly as specified, factory-coordinated and tested before delivery to job site as follows:
 - 1. 13.8 kV metal-clad switchgear 13.8 kV to 480Y/277-volt transformer: For in-line assembly.
 - 2. 480-volt switchgear and switchboard: For assembly of various sections as integral unit for in-line assembly with transformer where shown.
- C. Qualifications of Instructor for Operation and Maintenance Training: Qualifications will be considered adequate when either of the following is met:
 - 1. Designer of the system is the instructor and has the ability to communicate facts about the system in understandable terms.
 - 2. Instructor has been trained in teaching methods and is familiarized fully with the subject matter.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings: In accordance with Table 16360-1.
 - 1. Submit shop drawings for high-voltage switchgear to electric utility company as applicable for the service area, for coordination and approval by the power company.
 - 2. Submit to the Engineer shop drawings approved by the power company as well as shop drawings for complete unit-substation equipment.
- B. Certification.

- C. Documentation:
1. Short-circuit calculations and system coordination study for system protection and selective overcurrent tripping:
 - a. In accordance with ANSI/IEEE 141 for fault calculations and coordinated system protection.
 - b. Include high-voltage source, relays, fuses if used, on high-voltage switchgear, transformer, low-voltage switchgear, molded-case circuit breakers for low-voltage feeders in switchboards, panelboards, motor control centers and motor starters.
 - c. Available short-circuit currents based on power company contribution of 750 MVA for 13.8 kV service and actual motor contribution at low-voltage switchgear but not less than 25 percent of transformer kVA rating for motor contribution if the actual is less.
 - d. Recommended settings and adjustment of protective devices.
 2. Field-test plan and documentation:
 - a. Submit field-test plan within 60 days after award, with accompanying documentation in the form of test-data recording sheets and list of proposed test equipment.
 - b. Do not proceed with testing until plan and documentation are approved.
 - c. Indicate in scope of test plan how equipment will be tested to ensure safe and orderly transition from installation, through initial energizing, to specified field-testing.
 - d. Accompanying documentation to include standard data-recording sheets as used in manufacturer's in-plant testing of equipment and devices or as used by major utilities or large industrial users of specified equipment. Submit certified copies of test data, indexed by substation, within two weeks after completion of testing.
 - e. Verify schematic diagrams for proper operation. Submit one complete set of certified yellow-line schematics at time of initial energizing of equipment. Schematic diagrams to indicate verification and tests of functional and protective devices. Indicate each circuitry correction or modification in red-line.
 3. Instructor qualifications: Five copies of resume which outlines each instructor's qualifications and skills not later than 180 calendar days prior to commencement of training.
- D. Operations and maintenance training material: Five copies not later than 180 calendar days prior to commencement of training.
- E. Operation and Maintenance Manuals: In accordance with Table 16360-2.

1.04 OPERATION AND MAINTENANCE TRAINING:

- A. Perform operation and maintenance training in accordance with the General Requirements and the following additional requirements for development and performance of operation and maintenance training for unit substation.
- B. Use only instructors who are fully qualified for their presentations as required above under Quality Assurance.
 1. Concept of Training: Design classroom and field instruction to cover in detail the functions of each item of equipment. Cover fault isolation and troubleshooting

technique to the extent necessary to permit a technician to diagnose and repair faulty modules. Design instruction to provide Authority maintenance personnel with practical experience in the performance of preventive and corrective maintenance. Provide troubleshooting and fault isolation of simulated faults for each item of equipment in the unit substation.

2. Develop and provide all operation and maintenance training necessary for Authority-designated personnel to support the power equipment. Have classroom instruction include not only the anatomy and functioning of the parts under discussion, but the essentials of their routine care, including lubrication schedules, adjustments, limits, test frequency, inspection frequency, troubleshooting, removal and replacement. Have instruction cover theory of operation of the power systems, individual modules and special protective circuits. Use software flow diagrams in order to show sequence of events and timing of system operations.
3. Have the course include hands-on troubleshooting of all subsystems. Allot students adequate time for performing preventive-maintenance operations on the equipment in addition to troubleshooting "bugged" system.
4. In training, assume the Authority's employees have no knowledge of the features of the new equipment. The Authority is permitted to videotape all class presentations.

C. Training Methods and Materials:

1. Develop first-generation reproducible training material.
2. Conduct training using final manuals approved by the Authority and certified by the Contractor as being correct, as-built and reproducible. These materials become the property of the Authority at the end of program.
3. Develop and furnish the following training materials for each course for the Combined Training Program:
 - a. Instructor material for each course.
 - b. Course outline: Course outline with learning objectives. Include a topic outline for each item of equipment. Include in maintenance courses a section devoted to system-fault analysis and troubleshooting. State the learning objectives for each topic.
 - c. Lesson plans: A set of lesson plans for each item of equipment, corresponding to the topic outline, and containing the following information:
 - (1) Lesson title.
 - (2) Time.
 - (3) Objectives.
 - (4) Training aids required.
 - (5) Instruction sequence (outline).
 - (6) Tests.
 - (7) Summary.
 - d. Training aids: For each topic, develop optimum use of visual aids, including transparencies size 8-inch by 10-inch, 35-mm slides, films, and mockups. Provide approved shop drawings in transparency.
 - e. Instructional material: Use the applicable equipment operation and maintenance manuals as the primary source of instructional material. In addition, develop notebooks for each course containing such additional drawings, descriptive information and procedures necessary to ensure that the learning objectives are met in an orderly and timely manner. Arrange notebook material by each item of equipment and sequence according to the topic outline.
 - f. Course topic outlines and schedules: Have the topic outline and schedules for each course contain the following:.

- (1) Description of course including course objectives and type of training, Level One, Level Two or Level Three.
 - (2) Course length and recommended numbers of students per course.
 - (3) List of training materials required including documentation and equipment.
 - (4) For each topic outline for the course, a topic objective and the time allotted to the topic.
 - (5) Schedules listing the major topics and subtopics on a time allocation for each topic.
- g. Instructor and training aids: Have the instructor guide for each course include:
- (1) Table of contents listing each topic and the time allotted.
 - (2) List of applicable documents.
 - (3) List of training materials.
 - (4) Course learning objectives, course length and recommended number of students.
 - (5) Provide each topic with a cover sheet listing topic, objective, time allotted and training aids required.
 - (6) Include training aids with the instructor guides.
- h. Students handouts: Reproduce diagrams, drawings and procedures from engineering data and manuals and include them in student handout.
- D. Instructional Equipment: Conduct training utilizing installed equipment in normal operating conditions, except use maintenance training-lab equipment for shop and maintenance instruction.
- E. Training Program:
1. Include the following:
 - a. Level One - Equipment-Operating Training Course: Conduct this course for Authority-designated personnel; providing training for equipment operation and troubleshooting, and basic theory of operation of each piece of equipment. In handouts include specific check lists on each piece of power equipment.
 - b. Level Two - Field-Maintenance Training Course: Conduct this course for Authority-designated personnel; emphasizing preventive maintenance, as well as location and correction of faults and equipment failures. Present sufficient training in operation, theory of operation and fault isolation to isolate problems to modules on subassemblies. Stress use of the maintenance manuals to help identify faults.
 - c. Level Three - Shop-Maintenance Training Course: Conduct this course for Authority-designated personnel; providing in-depth training on theory of operation of the systems, individual components, each subassembly (including Contractor-designed, off-the-shelf OEM and other vendor-supplied assemblies), special test equipment; shop test procedures, module and printed circuit board, all replacement and troubleshooting procedures to the circuit-board level, overhaul and testing procedures, operations procedures, and preventive-maintenance procedures. Provide information drawings, including schematics, bills of material and other material required to troubleshoot to the component level.
 2. Supplemental Training: In the event Contractor changes or performs modifications to equipment subsequent to the training that impact form, fit or function; provide supplementary training to the Authority's training instructor on a one-time basis.

- F. Scope: The following number of Authority personnel will attend the training program:

Course Title	Length of Course Hours	Number of Students Per Session	Number of Courses	Number of Course Hours
Field Maint.	80	6	2	160
Shop Maint.	40	8	1	40

1. Provide practical training on equipment for not less than 60 percent of the course duration.
 - a. Location: Conduct training classes at facilities provided by the Authority.
 - b. Times: Set class times at the convenience of the Authority.
2. For Level Two - Field-Maintenance Training Course, the Contractor may propose four courses at 40 hours each in lieu of two courses at 80 hours each subject to approval.

G. Equipment:

1. Training equipment: Supply and deliver to the Engineer special tools required for maintenance training.
2. Test equipment: The Field-Level maintenance training requires students to use test equipment provided by the Contractor. The Shop-Level maintenance training requires students to use test equipment provided by the Contractor.
3. Service equipment: Prior to final turnover to the Authority, furnish and install the following for substation maintenance equipment:
 - a. 72" x 36" x 36" heavy-duty metal storage cabinet with four-shelf arrangement.
 - b. Eight-foot fiberglass step ladder.
 - c. Full set of approved, half-size electrical and equipment shop drawings, bound in stiff cover resistant to oil, water and wear. Make drawings capable of being stored in the metal cabinet.
 - d. Wall-mounted Maintenance Map/Single Line Diagram. Use frame made of metal with lexan or plexiglass. Mount frame as directed.
 - e. 30" x 48" x 34"-high heavy-duty metal work bench with task stool, reinforced steel top, 1/4-inch thick rubber matting covering entire top, and one 12-gauge steel shelf for full width and depth of bench with back turned up two inches.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver and handle equipment as specified.
- B. Store equipment in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. High-Voltage Switchgear: Section 16320, kV rating, type and quantity as shown.
- B. Low-Voltage Switchgear and Switchboard: Section 16435, quantity as shown.

- C. Transformers: Section 16270, voltage rating, type and quantity as shown.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install substation equipment at location shown in accordance with manufacturer's recommended installation procedure, the NEC and as follows:
1. Install high-voltage switchgear in accordance with Section 16320, low-voltage switchgear in accordance with Section 16435 and transformers in accordance with Section 16270. Arrange and connect the switchgear and the transformers as shown.
 2. Make power-cable and control-wire connections as shown and in accordance with Section 16125.
 3. Make grounding connections as shown and in accordance with Section 16060.
 4. Interconnect secondary of two substations to form secondary selective network as shown. In combined switchboard room, use bus duct for secondary tie feeder.
 5. Arrange with electric utility company for providing primary service to switchgear and coordinate incoming-service termination details.
 6. Apply touch-up paint where necessary.
- B. Manufacturer's Engineering Representative:
1. Arrange for assistance of manufacturer's engineering representative during field-assembly, installation and adjustment of substation equipment.
 2. Initial energizing of each substation to be under guidance of manufacturers' engineering representative who will advise Authority personnel on step-by-step procedure.

3.02 FIELD QUALITY CONTROL:

- A. Field-Testing and Inspection:
1. General requirements:
 - a. Conduct field-testing and inspection at each ac-switchboard room to ensure proper operation of equipment provided
 - b. Relays and trip-device setting: The Contractor is responsible for setting protective relays and trip devices in accordance with approved coordination study and their calibration for proper operation during field-testing.
 2. Field inspection:
 - a. Prior to field-testing, check equipment installation in accordance with manufacturer's recommendations and ANSI/IEEE 141 including, but not limited to, verification of the following:
 - (1) Integrity of bus insulation.
 - (2) Tightness of connections.
 - (3) Adequate support of busbars.
 - (4) Correct grounding, anchoring and alignment of switchgear in accordance with manufacturer's drawings.
 - (5) Ease of racking drawout breakers in and out of cubicle.
 - (6) Physical interchangeability of similar circuit breakers.
 - (7) Adjustment of circuit-breaker contact.
 - (8) Functioning of interlock and closing of safety shutter with breaker in disconnect or withdrawn position
 - (9) Transformer installation in accordance with IEEE C57.93 and C57.94.

- (10) Verify mechanical clearances and proper operation of disconnecting and grounding devices associated with potential transformers.
- (11) Tightness of bolted bus joints by calibrated torque-wrench method, based on manufacturer's recommended values.
- (12) Ground-fault system:
 - (a) Inspect for physical damage and compliance with approved shop drawings. Verify location relative to sensors of main neutral-to-ground bus disconnect link and avoidance of multiple ground connections in combined-switchboard rooms.
 - (b) Inspect control-power transformer to ensure adequate capacity for system.
 - (c) Inspect zero-sequence system for symmetrical alignment of core-balance transformers about current-carrying conductors.
 - (d) Verify by device operation, ground-fault device circuit nameplate identification.
- (13) Calibrate protective devices/relays and set them in accordance with approved coordination study.

3. Field-testing:

- a. Furnish equipment required to perform tests.
- b. Provide services of manufacturer's engineering representative and supporting field crew for a period not less than three man-days. Conduct tests in the presence of the Engineer. For each item, submit for approval and perform approved tests including, but not limited to, those specified.
- c. Perform insulation-resistance test of 60-second duration in accordance with the following requirements:
 - (1) Test voltage:

Voltage Rating	Test Voltage
150 - 600 volts	1,000 volts
601 - 5,000 volts	2,500 volts
Above 5,000 volts	5,000 volts

- (2) Insulation resistance: kV rating plus one megohm but not less than minimum value recommended by manufacturer.
- (3) Do not perform dielectric-withstand test unless insulation resistance is equal to or greater than minimum value specified.
- d. For high-voltage switchgear, low-voltage switchgear and switchboard:
 - (1) Perform insulation-resistance test between phase-to-phase and phase-to-ground.
 - (2) Test grounding conductors and enclosures for continuity to room ground bus.
 - (3) Test protective relays and trip devices, except power fuses in accordance with ANSI/IEEE 141 procedures, modified as necessary, for compliance with approved coordination study.
 - (4) Test operation of each circuit and control in accordance with approved sequence.
 - (5) Test interlock system as follows:
 - (a) Make closure attempt on locked open devices.

- (b) Make opening attempt on locked closed devices.
- (6) Dielectric-withstand tests: Perform dielectric-withstand test of 60-second duration on entire assembled and erected switchgear and switchboard lineup using 60-Hertz voltage level as specified. Perform tests in accordance with reference standards and as follows:
 - (a) 13.8 kV switchgear: 27,000 volts rms.
 - (b) 480-volt switchgear and switchboard: 2,500 volts rms.
 - (c) Control wiring: 1,500 volts rms.
- (7) Test current-transformer circuits for polarity, ratio and protective-device operation by secondary-injection method.
- (8) Test potential transformer ratio and polarity.
- (9) Perform functional tests on control, interlocking, blocking and supervisory circuits, including verification of interconnections between equipment and interface points which have been installed by others. Verification of these tests to be substantiated by lined-in schematics and signed by the Contractor and the Engineer.
- e. Distribution transformers:
 - (1) Perform insulation-resistance test between winding-to-winding and winding-to-ground. Correct resistance value to temperature.
 - (2) Test transformer shell and neutral terminal for continuity to ground bus.
 - (3) Perform ac high-voltage test between high-voltage winding and ground and low-voltage winding and ground. Perform test at 75 percent of factory test voltage for 60-second duration.
 - (4) Test voltage ratio for full-winding and taps. Test result not to deviate more than 0.5 percent from calculated ratio. Set transformer tap as directed.
 - (5) Check polarity or phase relation.
 - (6) Check contacts of dial-type thermometer for indicating normal and overtemperature condition of transformers at remote location and to initiate tripping of associated essential main-feeder breaker or primary breaker as appropriate under abnormal temperature conditions. Set thermometer contacts in consultation with manufacturer, as necessary.
 - (7) Transformer for outdoor use:
 - (a) Test transformer for oil leaks in accordance with IEEE C57.93.
 - (b) Test samples of insulating liquid from top and bottom of tank.
 - (c) Test to verify that dielectric strength is not less than 22 kV for mineral oil.
- f. Substation busway:
 - (1) Where directed, test resistance of busway connections. Resistance not to exceed value recommended by manufacturer.
 - (2) Test insulation resistance to ground and between insulated busbar.
 - (3) On busway showing insulation resistance of less than one megohm, perform high-potential test of 60-second duration at 2,200 volts, rms.
 - (4) Check phase rotation and phase crossing on buses when energized from either source.
- g. Ground-fault systems:

- (1) Insulation resistance: Remove neutral-ground disconnect link and measure system neutral insulation resistance to ensure that no shunt ground paths exist. System neutral insulation to be 10,000 ohms minimum, preferably one megohm or greater. Reinstall link.
 - (2) Determine relay pickup current by primary injection at sensor and operation of circuit interrupting device. Pickup current to be within ten percent of device setting.
 - (3) Test relay timing by injecting 150 percent and 300 percent of pickup current into sensor. Relay timing to be within manufacturer's published time-current characteristic curve.
- h. Proof of compliance:
- (1) If testing indicates failure to comply with specified requirements, replace, correct or modify equipment so that it does comply.
 - (2) Conduct additional tests witnessed by the Engineer to prove compliance with specified requirements.

B. Field-Testing Personnel:

1. Provide services of qualified manufacturer's engineering representatives to perform specified field-testing program.
2. When more than one representative is involved, the Contractor is responsible for coordination of testing effort.
3. Provide engineers, technicians and journeymen as necessary to set up and implement testing.

C. Authority Tests:

1. The Authority reserves the right to require the Contractor to conduct acceptance tests of sound level on each transformer unit at each passenger station within one year after installation.
2. In order to perform sound-level tests, the Contractor may recreate test conditions of applicable standards to the extent possible without disturbing existing structure or installed equipment or materials.

THIS SPACE NOT USED

D. Submit certified test reports.

TABLE 16360-1 SCHEDULE OF SHOP DRAWINGS REQUIREMENTS			
Item	Requirements	Submit (a)	Within Days (b)
1.	Outline dimensions, including weights and foundation requirements for equipment furnished.	X	90 (c)
2.	Front views, floor plans, and mounting details for equipment furnished.	X	90 (c)
3.	One-line diagrams	X	120 (c)
4.	List of standard symbols and nomenclature.	X	120 (c)
5.	Elementary diagrams with description of each circuit.	X	120 (c)

TABLE 16360-1 (Cont.)			
SCHEDULE OF SHOP DRAWINGS REQUIREMENTS			
Item	Requirements	Submit (a)	Within Days (b)
6.	Interconnection wiring diagrams.	X	120 (c)
7.	Wiring diagrams, showing internal wiring of equipment furnished.	X	150 (c)
8.	Wiring diagram, showing interconnection between	X	150 (c)
9.	Cross sections showing internal construction of equipment.	X	120 (c)
10.	Physical details of connections to transformers.	X	90 (c)

TABLE 16360-1 (Cont.)
SCHEDULE OF SHOP DRAWINGS REQUIREMENTS

Item	Requirements	Submit (a)	Within Days (b)
11.	Physical details of bus connections.	X	90 (c)
12.	Certified test reports.	-	30 (d)
13.	Transformer data, including: a. Excitation current. b. Impedance, percent based on rated kVA. c. Reactance, percent based on rated kVA. d. Resistance, percent based on rated kVA. e. Full-load and half-load efficiency. f. No load loss. g. Weights: (1) Core and coils. (2) Tank and fittings. (3) Insulating liquid. (4) Total.	X	45 (c)

TABLE 16360-1 (Cont.)			
SCHEDULE OF SHOP DRAWINGS REQUIREMENTS			
Item	Requirements	Submit (a)	Within Days (b)
14.	AC-Switchgear data, a. Circuit breaker duty-cycles before required maintenance: (1) No-load operation. (2) Full-load operation. (3) Rated fault operation. b. Weight of circuit breaker only.	X	45 (c)
15.	Control-power data for each substation, a. Continuous 125-volt dc load. b. Continuous 120-volt ac load. c. Closing and tripping loads of: (1) 480-volt circuit breakers, for each rating. (2) 34.5 kV circuit breakers. (3) 13.8 kV circuit breakers. d. Trip setting for dc control-power feeder breaker.	X	120 (c)

TABLE 16360-1 (Cont.)			
SCHEDULE OF SHOP DRAWINGS REQUIREMENTS			
Item	Requirements	Submit (a)	Within Days (b)
16.	Clearing time-current curves of relays, circuit breakers and fuses, if used, including unlatched time of circuit breakers.	X	120 (c)
17.	Short-circuit calculations and system coordination study for system protection and selective overcurrent tripping including time-current fault-clearing curves of protective devices.	X	120 (c)
18.	Detailed equipment arrangement drawing for each substation.	X	120 (c)

THIS SPACE NOT USED

TABLE 16360-1 (Cont.)	
SCHEDULE OF SHOP DRAWINGS REQUIREMENTS	
NOTES AND LEGEND	
(a)	Initial submittal for approval. Unless otherwise shown, in accordance with General Requirements.
(b)	Approved final drawings or certified data.
(c)	After receipt of Notice to Proceed.
(d)	After completion of test.
X	Submittal required.
-	Submittal not required.

THIS SPACE NOT USED

TABLE 16360-2			
SCHEDULE OF OPERATIONS AND MAINTENANCE REQUIREMENTS			
Item	Requirements	Submit (a)	Within Days (b)
1.	Shipping and handling data: Instructions and drawings for unloading, handling erection and installation.	-	120 (c)
2.	Bills of Material, with reference to components showing original manufacturer's part numbers.	-	30 (c)
3.	Operation and Maintenance Manuals, complete, including separate manuals for ac switchgear, transformer, switchboard and busways, with information on each type of equipment and device furnished, shop drawings from Table 16360-1, excluding manufacturing details and Items 1. and 2. above.	(d)	(d)
4.	Operation and Maintenance	180 (e)	30 (e)

TABLE 16360-2 (Cont.)	
SCHEDULE OF OPERATIONS AND MAINTENANCE REQUIREMENTS	
NOTES AND LEGEND	
1.02	Initial submittal for approval.
1.03	Approved final document.
1.04	Before shipment.
1.05	See General Requirements.
1.06	Prior to commencement of training.
	Submittal not required.

END OF SECTION

THIS PAGE NOT USED

SECTION 16425

MOTOR STARTERS AND CONTROL CENTERS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing motor starters and control centers.
- B. Related Work Specified Elsewhere:
 - 1. Grounding and bonding: Section 16060.
 - 2. Circuit breakers, panelboards and load centers: Section 16440.
 - 3. Motors: Section 16225.
 - 4. Wire connection accessories: Section 16125.
 - 5. Raceways, boxes and cabinets: Section 16130.
 - 6. Unit substations Section 16360.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. NEMA AB1, ICS-2, ICS-2.3, 250.
 - 4. ANSI: Z55.1.
 - 5. ASTM: A47, A653, B187.
 - 6. UL: 845, Electrical Construction Materials Directory
 - 7. ITS: Directory of ITS Listed Products.
- B. The following items to be listed or labeled per referenced UL or ETL directory.
 - 1. Motor starter.
 - 2. Combination starters.
 - 3. Motor circuit protectors.
 - 4. Motor control centers.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Interconnection wiring diagrams.
- B. Certification.
- C. Operation and Maintenance Manuals.
- D. Short-circuit calculations and coordination study in accordance with Section 16055.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Store motor starters and control centers in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements for Motor Starters:
 - 1. Interchangeability: Equipment of same type, size, rating, functional characteristics and make is to be interchangeable.
 - 2. NEMA ICS-2, ac general-purpose, Class A.
 - 3. Rating: Continuous-current rating suitable for associated motor as shown.
 - 4. Type:
 - a. Up to and including ½ HP: Manual starter operable on 120-volt, single-phase, 60 Hertz supply unless otherwise shown.
 - b. From above ½ HP up to and including 50 HP: Across-the-line magnetic starter operable on 480-volt, three-phase, 60 Hertz supply.
 - c. Above 50 HP: Closed-transition autotransformer starter operable on 480-volt, three-phase, 60 Hertz supply.
 - 5. Provide ground-fault protection with five-ampere pick-up in each motor starter for fans in fan shafts and pumps in drainage-pumping stations.
 - 6. Enclosure:
 - a. Type:
 - (1) For aboveground indoor locations and electrical rooms: NEMA 250, Type 1.
 - (2) For outdoor locations: NEMA 250, Type 3R.
 - b. Materials:
 - (1) Zinc-coated steel sheet: ASTM A653, coating designation G90, minimum thickness 14 gauge.
 - (2) Malleable iron: ASTM A47.
 - c. Finish: Metallic surface cleaned, degreased, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.
 - 7. Nameplate:
 - a. Nameplate provided on each motor starter and control center in accordance with NEMA ICS, showing manufacturer's name and brand designation, the referenced standard, type, class and rating as applicable.
 - b. Additional functional nameplates for each component as follows:
 - (1) Three-ply, laminated phenolic plates, engraved through black face to white core and attached by means of stainless-steel rivets or screws.
 - (2) Lettering to be vertical gothic using a round or square cutter. V-shaped groove not acceptable.
 - (3) Each starter labeled with one-inch wide nameplate showing starter's designation and function in ½-inch high characters.
- B. Manual Starters: Quick-make/quick-break toggle mechanism, manual-reset thermal-overload device, position indicator showing ON/OFF/TRIPPED positions, red indicating light showing closed position.

- C. Across-The-Line Magnetic Starter:
1. Reversing or nonreversing as shown.
 2. NEMA size: As shown, not smaller than NEMA 1.
 3. 480-volt primary to 120-volt secondary control transformer with fuse in the primary circuit
 4. Manual-reset overload relay, one per phase, with the following additional requirements:
 - a. In starter for motors in fan shafts: Magnetic-type sensitive to current.
 - b. In starters for motors in other locations: Thermal-type.
 5. Two NO contacts with provision for addition of two NO or NC contacts.
 6. Nonreversing-type: START/STOP pushbutton mounted on door.
 7. Reversing-type: FORWARD/REVERSE/STOP pushbutton mounted on door.
 8. HAND/OFF/AUTO selector switch provided when specified.
- D. Autotransformer Starter:
1. Reversing or nonreversing closed-transition type as shown.
 2. NEMA size: As shown.
 3. Adjustable taps for 50, 65 and 80 percent of line voltage.
 4. 480-volt primary to 120-volt secondary control transformer with fuse in primary circuit.
 5. Manual-reset overload relay, one per phase.
 - a. In starter for motors in fan shafts: Magnetic-type sensitive to current.
 - b. In starters for motors in other locations: Thermal-type.
 6. One pneumatic adjustable timing relay.
 7. Two NO contacts with provision for addition of two NO or NC contacts.
 8. Nonreversing-type: START/STOP pushbutton mounted on door.
 9. Reversing-type: FORWARD/REVERSE/STOP pushbutton mounted on door.
 10. HAND/OFF/AUTO selector switch provided when specified.
- E. Motor Circuit Protectors (MCP):
1. NEMA AB1, molded-case, quick-make/quick-break, mechanically trip-free switching mechanism with adjustable magnetic trip for instantaneous short-circuit protection.
 2. Rating:
 - a. Number of poles: Three.
 - b. Continuous-current rating: As shown, not less than full-load current of motor.
 - c. Voltage: 480-volt, three-phase, 60 Hertz.
 - d. Interrupting rating: As shown.
 - e. Trip range: As necessary to provide maximum protection to associated motor.
 3. Where shown or necessary, individually removable current limiter, internally mounted on load side of MCP, with the following additional requirements:
 - a. Limiter current rating and time-current limiting characteristics coordinated with time-current characteristics of MCP to provide the following:
 - (1) Interruption by MCP under fault-current level up to interrupting capacity of MCP.
 - (2) Interruption by current limiter in conjunction with the MCP of fault-current level above interrupting capacity of MCP.
 - (3) Where necessary to protect associated motor starter. Limit fault-current below withstand capability of the starter.
 - (4) Where necessary to protect associated motor-circuit conductors. Limit fault-current below withstand capability of cable insulation.
 - b. Current-limiter housing interlocked with MCP tripping mechanism so that breaker will trip upon removal of cover.
 - c. Equipped with common trip mechanism for tripping all poles simultaneously on blowing of current limiter to prevent single phasing.

- d. Capable of interrupting minimum fault-current up to 100,000 rms symmetrical amperes at 480 volts ac.
- F. Combination Starter:
- 1. NEMA ICS-2, rated 480 volts, three-phase, 60 Hertz.
 - 2. Motor starter: Across-the-line magnetic or autotransformer starter as shown and specified.
 - 3. One 480-volt, three-pole MCP.
 - 4. Externally mounted operating handle with position indicator showing ON/OFF/TRIPPED condition of MCP. Operating handle interlocked for preventing opening and closing of door when MCP is in ON position. Defeater provided to bypass interlock. Provision for padlocking in OFF position.
- G. Motor Control Centers:
- 1. NEMA ICS-2.3, Class 1, Type B, rated 480-volt, three-phase, 60 Hertz, totally enclosed, deadfront, free-standing, modular assembly having vertical and horizontal buses, wireways, compartments equipped with circuit breakers, MCP and starters as shown.
 - 2. Enclosure: Modular assembly allowing maximum of six compartment units in one vertical assembly and units' layout in any combination without structural interference, with the following additional requirements:
 - a. Type:
 - (1) Above ground indoor locations and electrical rooms: NEMA 250, Type 1.
 - (2) Outdoor locations: NEMA 250, Type 3R.
 - b. Each unit compartment provided with individual door having concealed hinges. Unit door mechanically interlocked with unit circuit breaker to prevent opening or closing when the circuit breaker is in the ON position. Defeater provided to bypass interlock. Provision for padlocking in OFF position.
 - c. Horizontal wireway with removable coverplate provided at top and bottom for wiring between sections, incoming conduit and cable, motor and control wiring. Top trough separated by barrier from main horizontal bus.
 - d. Vertical wireway, with its own door, provided adjacent to each vertical assembly and accessible to two adjacent vertical assemblies when applicable.
 - e. Reinforced with adequate steel framework to form rigid structure with smooth outer surface free of burrs, ridges or other blemishes.
 - f. Zinc-coated steel sheet: ASTM A653 coating designation G90, minimum thickness 14 gauge
 - g. Finish: Metallic surface cleaned, degreased, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.
 - 3. Horizontal and vertical buses: Main horizontal buses provided at top of structure. Vertical buses for feeding power to each compartment provided in each vertical assembly and securely bolted to main buses.
 - a. Busbar: ASTM B187, 98-percent-conductivity copper, contact surfaces tin-plated, fully insulated by extruded sleeve or wound tape.
 - b. Each horizontal and vertical bus rated for a minimum of 600 amperes and 300 amperes, respectively, with current density not to exceed 1,000 amperes psi or to meet ANSI temperature of 50-degree rise unless otherwise shown.
 - c. Each bus rigidly held by bus supports which have high-dielectric qualities, are moisture-resistant, noncarbonizing and nontracking and have vertical creepage surfaces to prevent faults due to buildup of conductive dirt.

- d. Bus assembly braced to withstand short-circuit rating of 22,000 symmetrical amperes, rms or available short circuit determined by short-circuit calculations, whichever is greater.
 - e. Unit guides provided in unit compartment for aligning starter stubs.
 - f. Continuous bare-copper ground bus, 1/4-inch by two-inch cross-section, provided throughout length of control center.
- 4. Motor starter: Across-the-line magnetic or autotransformer starter, as shown and specified, with tin-plated stub assembly for connecting to vertical buses in unit compartment.
 - 5. Circuit breaker:
 - a. Main circuit breaker: One 480-volt, three-pole, rating as shown and in accordance with Section 16440.
 - b. Branch circuit breaker: One 480-volt, three-pole MCP for each unit compartment.
 - 6. Indicator light: One red light mounted on each unit compartment showing ON position of circuit breaker.
 - 7. Nameplate: As specified under General Requirements for motor starters, with the following additional requirement:
 - a. Each motor control center labeled with 1-1/2 inch wide nameplate showing designation in one-inch high characters.
 - b. Each compartment labeled with one-inch wide nameplate showing function and number of the motor controlled in 1/2-inch high characters.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Embed iron sills for anchoring motor control center flush with raised concrete pad as shown.
- B. Install motor starters and control centers as shown in accordance with manufacturer's recommendations.
- C. Install conduit in accordance with Section 16130 and the NEC.
- D. Connect power cable and control wire as recommended by manufacturers and as follows:
 - 1. Make power-cable and control-cable connections to manual starters, across-the-line magnetic starters and autotransformer starters by means of integral mechanical connectors. If such items are not furnished with integral mechanical connectors, make connections using compression connectors in accordance with Section 16125.
- E. Install motor starters and control centers as shown and in accordance with the NEC and Section 16225.
- F. Ground motor starter, complete motor control center in accordance with Section 16060.
- G. Apply touch-up paint as necessary.

3.02 TESTING:

- A. Furnish necessary equipment and perform the following tests:
 - 1. Test circuits for connections in accordance with wiring diagram.
 - 2. Test to ensure that insulation resistance to ground of nongrounded conductor is in accordance with Section 16060.

3. Test equipment enclosures for continuity to grounding system.
 4. Test operation of circuits and controls.
- B. Submit certified test reports.

END SECTION

SECTION 16435

LOW-VOLTAGE SWITCHGEAR AND SWITCHBOARD

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing 480-volt switchgear and switchboard.
- B. Related Work Specified Elsewhere:
 - 1. Raceways, boxes, and cabinets: Section 16130.
 - 2. Wire connection accessories: Section 16125.
 - 3. Grounding and bonding: Section 16060.
 - 4. Circuit breakers, panelboards, and load centers: Section 16440.
 - 5. Unit substations: Section 16360.
 - 6. Uninterruptible power system: Section 16260.
- C. Design Criteria:
 - 1. Floor loading: Compatible with floor design loading of 250 pounds per square foot.
 - 2. Switchgear and switchboard suitable for anchoring to a concrete floor steel trowel finished to a tolerance level of 1/8 inch in 10 feet.

1.02 QUALITY ASSURANCE:

- A. Qualifications:
 - 1. Select manufacturer regularly engaged in production of switchgears and switchboards.
 - 2. Furnish low-voltage switchgear, switchboard, and their main components from one manufacturer.
- B. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. NEMA: PB2.
 - 4. ANSI: C37.16, C37.17, C37.50, Z55.1.
 - 5. UL: 891.
 - 6. ASTM: B187.
 - 7. ANSI/IEEE: C37.13, C37.20.1, C57.13.
- C. Factory Testing: Submit design tests or certified copies of test reports on identical units performed for each type and rating of circuit breakers as assembled in its complete switchgear or switchboard unit including bus compartment.
 - 1. Circuit breaker tests in accordance with requirements of ANSI C37.50 and including the following:
 - a. Design test:
 - (1) Trip-device calibration-check test.
 - (2) AC dielectric withstand-voltage test.
 - (3) Continuous-current test.
 - (4) Overload-switching test.
 - (5) Endurance tests.
 - (6) Short-circuit current tests.
 - (7) Short-time current test.

- b. Production tests: All applicable tests in accordance with the requirements of ANSI C37.50.
 - 2. Switchgear assembly tests: In accordance with the requirements of ANSI/IEEE C37.20.1 and including the following:
 - a. Design tests:
 - (1) Dielectric tests.
 - (2) Rated continuous-current tests.
 - (3) Short-time current withstand tests.
 - (4) Short-circuit current withstand tests.
 - (5) Mechanical endurance tests.
 - (6) Flame-resistance tests.
 - (7) Rod entry test.
 - (8) Paint qualification test.
 - b. Production tests: All applicable tests in accordance with requirements of ANSI/IEEE C37.20.1.
 - 3. Switchboard assembly tests: In accordance with the requirements of NEMA PB2 and UL 891 and including the following:
 - a. Design tests:
 - (1) Temperature-rise tests.
 - (2) Short-circuit current tests.
 - (3) Enclosure tests.
 - (4) Dielectric test.
 - b. Production tests: All applicable tests in accordance with requirements of NEMA PB2 and UL 891.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings: In accordance with Section 16360.
- B. Certification: Certified test reports for specified factory testing.
- C. Documentation:
 - 1. Short-circuit calculations and system coordination study: In accordance with Section 16360.
 - 2. Field-testing plan: In accordance with Section 16360.
- D. Operation and Maintenance Manuals: In accordance with Section 16360.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Ship each unit securely packaged, braced and labeled for safe handling in shipment and to avoid damage and distortion.
- B. Temporary Bracing: Where necessary brace switchgear for hoisting, lowering and skidding into position. Label temporary internal bracing: TEMPORARY - REMOVE BEFORE OPERATION.
- C. Protection Against Concealed Damage: Include within shipping container mechanical impact recorder of rating recommended by manufacturer for shipment by railroad and submit impact-record chart with manufacturer's instruction for disposition for damaged material.

- D. Assembly for Shipment:
1. Design enclosures to permit lifting by jacks or slings and moving horizontally on rollers or skidding in any direction.
 2. Maximum dimensions of shipping sections to be coordinated with dimensions of access hatches, corridors and doors to ensure shipping dimensions will allow movement of switchgear through structure without damage to equipment or structure or undue difficulty.
 3. Draw-out relays mounted in their proper cases with moving parts properly secured and packed for shipment.
 4. Removable circuit-breaker elements packaged separately.
 5. For shipping split, interconnecting wiring coiled on one side of shipping split with matching terminal block on other side of split. Wiring and terminal block points identified for reconnection.
- E. Store switchgear in secure and dry storage facility.

1.05 OPERATIONS AND MAINTENANCE TRAINING:

- A. In accordance with the General Requirements and Section 16360.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements for Switchgear:
1. ANSI/IEEE C37.20.1, for indoor use.
 2. Ratings:
 - a. Maximum voltage: 508 volts.
 - b. Frequency: 60 Hertz.
 - c. Insulation level: Low-frequency withstand: 2.2 kV.
 - d. Continuous current: As shown and in accordance with reference standards.
 - e. Short-time current: In accordance with reference standards and approved coordination study.
 3. Insulation structure:
 - a. Not to support combustion, produce toxic gases, absorb moisture or track.
 - b. When subjected to electric arc, emission of conducting materials from insulating structure limited so as not to interfere with performance of circuit breaker.
 4. Power circuit breakers:
 - a. ANSI/IEEE C37.13, ANSI C37.16, three-pole, single-throw, air-break drawout-type, with manually or electrically controlled closing and electrically controlled tripping, mechanically and electrically trip-free, with the following additional requirements:
 - (1) System nominal voltage: 480 volts.
 - (2) Rated maximum voltage: 508 volts.
 - (3) Rated frequency: 60 Hertz.
 - (4) Insulation dielectric-withstand: 2,200 volts.
 - (5) Three-phase short-circuit current rating (symmetrical amperes): As shown and in accordance with reference standards and approved coordination study.
 - (6) Frame size (amperes):
Secondary main circuit breaker: Minimum frame size suitable to carry continuous forced-air cooling rating of its distribution

transformer.

- (a) Essential main and secondary tie circuit breakers:
Minimum frame size as shown.
- (7) Equip each power circuit breaker with a solid-state tripping system consisting of three current sensors, microprocessor-based controlled-phase overcurrent trip device, time coordinated ground fault protection and flux-transfer shunt trip. Provide trip device complying with ANSI C37.16, and C37.17, with adjustable long-time and short-time elements, communication interface, power metering and non-volatile memory for protective settings, Cutler Hammer Digitrip RMS 810, Siemens Static Trip III CP, or equal. Range of trip-device current rating in amperes and setting as shown and in accordance with approved coordination study. True RMS sensing protection to be achieved by analyzing the secondary current signals from the circuit breaker current sensors and initiating trip signals to the circuit breaker. Protective settings, metering values and stored data to be accessible from the data communication network interface and locally from a digital alpha-numeric display unit mounted on the trip unit or breaker. Additional features to include:
 - (a) Provide the trip unit with an information system that provides LED's to indicate mode of trip following an automatic-trip operation. The indication of the mode to be retained after an automatic trip. Provide a trip reset button to turn off the LED indication after automatic trip.
 - (b) Provide the trip unit with a front panel display that indicates the protection-function settings. Have the unit continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.
 - (c) Provide the trip unit with a portable secondary current test set with matching connector plug or with an integral test panel, either of which enables the user to select the values of test currents within the range of available settings; with the basic protective settings not affected during testing operations.
 - (d) Provide an alpha-numeric display to indicate cause of trip, instantaneous value of maximum phase current and level of fault current that initiated an automatic-trip operation.
 - (e) Have the trip unit include a potential transformer module (PTM), suitable for operation up to 600 volts, 60 Hz; the primary of the PTM connected internally to the load side of the circuit breaker through a dielectric disconnect plug.
 - (f) Equip the trip unit with an energy-monitoring function processor to provide at a minimum; Phase Current (amps), Peak Demand (kilowatts), Present Demand (kilowatts), and Energy Consumption (kilowatt-hours).
 - (g) Equip the trip unit with a communication interface via a network twisted pair for remote monitoring and control.
 - (h) Provide the unit with an external power supply if voltage source is different than that provided to control the breaker; the main supply to the power supply to be 125 volts dc.
- (8) Operation counter.
- (9) Endurance: Electrical and mechanical-endurance performance not less than requirements in reference standard.
- (10) Control voltage: 125 volts dc nominal, individually fused.

- (11) Racking mechanism: With connected, test and disconnected positions; manually operated closed-door mechanism by insertion of crank through small opening in door; positive stops for preventing overtravel and guides for alignment of breaker with stationary unit; racking- mechanism gear ratio and design such that in combination with design of shutters covering main stationary disconnect, force required to puncture or damage shutters or breaker disconnect will become sufficiently large and readily apparent to protect against failure of shutters to open as breaker is racked in.
- (12) Primary connection (main disconnects): Connection between the removable and stationary unit made by male-and-female contacts, with the following additional requirements:
 - (a) Silver-plated high-pressure contacts.
 - (b) Automatic shutter to cover the contact orifices when the breaker is withdrawn and uncover orifices when breaker is returned to connected position.
 - (c) Automatic shutters constructed to withstand force of racking mechanism in case shutters fail to open when breaker is racked into position or shutter opening visible as breaker is racked into position.
- (13) Secondary connection (control and auxiliary disconnects): Control and interlocking-circuit connections between stationary and removable elements of switchgear made using device consisting of recessed stationary receptacle and set of self-aligning multiple-contact plugs on removable elements with sufficient number of contacts to accommodate control and interlock circuits, including spares, without resorting to auxiliary relays.
- (14) Spare auxiliary contacts for DTS: As shown to indicate closed and open positions for circuit breaker at remote location. Dry-type minimum of one NC and one NO rated 15 voltamperes, 250 volts dc, five milliseconds contact-bounce maximum and not more than 0.10-ohm contact resistance. Wired through secondary contacts to terminal blocks.
- (15) Shunt trip device.
- (16) For electrically operated breakers: Electrically powered, spring-charged, stored-energy operating mechanism, with following additional requirements:
 - (a) Voltage requirement:
 - i. Charging of stored-energy operating mechanism: 125 volts dc.
 - ii. Closing by means of closing release coil capable of operation from 100 - 140 volts dc.
 - iii. Tripping by means of shunt trip coil capable of operation from 70 - 140 volts dc.
 - (b) Closing release coil energized by means of pushbutton, control switch or automatically by interlocking/control signal.
 - (c) Shunt trip coil energized manually by pushbutton, control switch or automatically by interlocking/control signal.
 - (d) Equipped with mechanical devices on front of breaker to actuate closing and tripping operations in case of failure of control power.
 - (e) Compressed-spring stored-energy mechanism with energy storage sufficient for closing-opening operation at rated

- short-circuit current or at related required capabilities.
 - (f) Stored-energy mechanism automatically charged within 10 seconds following each closing of circuit breaker.
 - i. Stored-energy mechanism suitable for manual charging by means of removable or built-in handle in case of failure of control power.
 - ii. Automatic discharge of stored-energy mechanism prior to circuit-breaker withdrawal.
 - (g) White indicating light or flag provided on escutcheon of each circuit-breaker unit to indicate that stored-energy closing mechanism is charged.
 - (17) For manually operated breakers: Manually, spring-charged, stored-energy mechanism, with the following additional requirements:
 - (a) Built-in spring charging handle in front of breaker with indicator on escutcheon to indicate that stored-energy closing mechanism is charged.
 - (b) Closing by means of releasing stored energy by pushbutton or charging handle itself.
 - (c) Tripping by means of shunt trip coil capable of operation from 70 - 140 volts dc and by mechanical device on front of breaker.
 - (d) Compressed-spring stored-energy mechanism with energy storage sufficient for closing-opening operation at rated short circuit current or at related required capabilities.
 - (e) Automatic discharge of stored-energy mechanism prior to circuit-breaker withdrawal.
 - (18) Electrically controlled closing: On tie breakers only.
 - 5. Space heater:
 - a. Each vertical section of switchgear provided with 120-volt, single-phase, 60 Hertz heating element to facilitate drying and prevent condensation.
 - b. Heaters enclosed in grille guards with no sharp edges and located so that they are easily accessible for replacement without de-energization of switchgear bus. Heaters thermostatically controlled. Thermostat adjustable from 40F to 80F. Thermostat set in accordance with manufacturer's recommendation. Panel ammeter approximately 2-1/2 inches square, marked to indicate heater load.
 - 6. Bus bars:
 - a. General requirements:
 - (1) ASTM B187, 98-percent-conductivity copper.
 - (2) Current rating:
 - (a) Size sufficient to carry specified current and complying with applicable requirements of UL, ANSI, NEMA, IEEE and NEC.
 - (b) Bus rating for secondary main-breaker unit and bus connection to transformer sized for continuous forced-cooling rating of transformer.
 - (3) Capable of withstanding mechanical stresses and heat due to maximum short-circuit current.
 - (4) Bus contact surface silver-plated or tin-plated at connection.
 - (5) Each joint having impedance not more than that of bus bar of same length and clamped to maintain that impedance throughout life of equipment.
 - (6) Connection coordinated for proper mating with adjacent equipment terminals and enclosures. At transformer connection, flexible joint

and access plate provided for assembly and inspection of such joints.

- b. Power buses: Three-phase, four-wire copper buses, neutral bus of same rating as that of phase bus. Each bolted connection with four bolts minimum.
- c. Ground bus:
 - (1) Copper bus, not less than two inches by 1/4 inch provided throughout length of switchgear section.
 - (2) In switchgear unit where power cables enter or leave switchgear at top, copper ground bus not less than one inch by 1/8 inch extended from main ground bus to top of unit.
 - (3) Joints in ground bus made with four bolts and overlap of four inches.
 - (4) Mechanical connector provided in each unit for field connection of 4/0 through 500 kcmil ground cable to switchgear ground bus.
- d. Ground-to-neutral link provided at each ac switchgear in accordance with NEC for grounding of neutral. For services in same ac-switchboard room, single-grounding electrode connection to tie-point of neutral from each power source is permitted.
- e. Control bus:
 - (1) 125-volt dc bus; copper, No. 6 AWG minimum.
 - (2) One two-pole knife switch provided in switchgear cubicle for disconnecting the control circuit.
 - (3) UL Class J or RK-5 fuses used for control and auxiliary-service protection.
 - (4) Closing circuit fused; tripping circuit unfused.
 - (5) White light to indicate availability of dc control power.

7. Control and instrument wiring:

- a. Factory-installed.
- b. Insulation-rated, 600 volts, Type SIS, No. 14 AWG minimum copper conductor. Flexible Class C or higher stranded insulated copper wire used for wiring across hinged joints.
- c. One continuous length of wire used from terminal to terminal without splices or taps.
- d. Removable-element control wiring installed and connected according to manufacturer's standard for circuit-breaker wiring.
- e. Control wiring so designed and installed that fault in one main circuit cannot be transferred to control wiring of another main circuit.
- f. Connections made at terminals of device, on terminal blocks or on control buses. Wiring connection made using insulated-shank ring-type terminals.
- g. Interconnecting wiring between cubicles and compartments terminated on terminal blocks before being wired to components.
- h. Terminal blocks: With screw terminals, circuit-marking strips for indicating control wire number, phenolic-laminated dust cover and minimum of 10-percent spare terminal points.
- i. For each individual wire, corresponding identification used on the wiring diagrams.
- j. Internal wiring identified at each termination, with same number shown on wiring diagram, using suitable plastic sleeve attached within six inches of terminal connections.
- k. External wiring: Provision made for external control wiring to enter from bottom or top and with space allowed to terminate external multiple-conductor copper control cable. Top entrances provided with removable coverplates for field-drilling of conduit and cable entrance holes.
- l. Testing:

- (1) Check wiring for accuracy, open circuits and short-circuits, ground connections and insulation integrity by means of high-potential, continuity and operational tests.
 - (2) Subject wiring to high-potential test of 1,500 volts to ground for one minute or as recommended by the manufacturer.
 - (3) Verify that wiring is in accordance with manufacturer's wiring diagrams.
 - (4) Check wiring completely, including interconnections at shipping breaks.
8. Fuses: Current-limiting fuse installed in each control circuit except tripping circuit. Tripping control circuit to include green and red indicating lights to monitor availability of trip power with the red light in series with the trip coil to also monitor continuity of trip coil.
9. Enclosure:
- a. Dead-front, free-standing, indoor steel enclosure designed for line up with 13.8 kV to 480Y/277-volt transformer.
 - b. Steel structure with framework of welded or bolted structural steel, free from distortion and welding strain and sufficiently rigid to support equipment under normal and short-circuit conditions.
 - c. Switchgear cubicles and circuit-breaker compartment equipped with hinged front door and either hinged rear door or bolted rear covers. Bolted covers furnished with alignment studs and keyhole slots for positioning prior to bolting.
 - d. Each power circuit breaker in separate metal-enclosed compartment.
 - e. Circuit-breaker compartment door designed not to hinder movement of breaker in and out of compartment when door is open and doorstop set.
 - f. Barriers provided in bus compartment to separate bus section as follows:
 - 1) Main bus from tie bus.
 - 2) Main bus from essential bus.
 - g. Transition compartment sized as necessary with front and rear bolted covers to line up and coordinate with transformer.
 - h. Circuit-breaker compartment to provide for interchangeability of removable elements within frames of same size and operating characteristics.
 - i. Finish: Metallic surfaces degreased and finished with light-gray enamel, ANSI Z55.1, Color 61 in accordance with ANSI/IEEE C37.20.1 two mils minimum DFT.
10. Nameplate:
- a. Nameplate provided on each switchgear showing manufacturer's name and brand designation, the referenced standard, type, class and rating as applicable in accordance with reference standard.
 - b. Additional functional nameplates for each component, relay, meter, terminal block, etc. with the following requirements:
 - (1) Three-ply, laminated phenolic plates; engraved through black face to white core and attached by means of stainless-steel rivets or screws, provide on each switchgear and its components.
 - (2) Lettering: Vertical gothic using round or square cutter. V-shaped groove not acceptable.
 - (3) Each switchgear section labeled with nameplate one-inch high bearing the following inscription in letters ½-inch high: 480-VOLT SWITCHGEAR.
 - (4) Each switchgear compartment labeled with nameplate ½-inch high bearing, as appropriate one of the following inscriptions in letters 1/4-inch high: SECONDARY MAIN BREAKER, SECONDARY TIE BREAKER.

- (5) In addition to other information normally displayed on equipment, provide nameplate to show switch positions, meaning of indicator lamp and other pertinent information.
11. Ground-fault protection system:
- a. Time coordinated and with solid-state microprocessor based trip unit with the following additional requirements:
 - (1) Current-adjustment range: 100 to 1,200 amperes, with three calibration marks minimum.
 - (2) Time-adjustment band: Instantaneous and six- and 12-cycle calibration marks.
 - (3) Setting: As shown and as necessary to maximize protection and proper coordination in accordance with approved coordination study.
- B. Low-Voltage Switchgear:
- 1. Secondary main and tie cubicle: Equipped with the following:
 - a. Secondary main circuit breaker: Power circuit breaker with microprocessor-based phase-overcurrent trip device, shunt trip device, ground-fault protection, position-indicating lights, spare auxiliary contacts for DTS, accessories and interlocks.
 - b. Secondary tie circuit breaker: Power circuit breaker with microprocessor-based phase-overcurrent trip device, shunt trip device, electrical closing device, ground-fault protection, spare auxiliary contacts for DTS, position-indicating lights, accessories and interlocks. One or two tie breakers provided as shown.
 - c. Current transformers:
 - (1) ANSI/IEEE C57.13, window-type with polarity markers to operate digital power metering.
 - (2) Quantity: Three.
 - (3) Current ratio: As necessary for forced-cooling rating of distribution transformer with five-ampere secondary.
 - (4) Insulation class: 600 volts with basic-impulse insulation level of 10 kV full-wave.
 - (5) Maximum allowable temperature rise under continuous full-load above average ambient temperature of 55C.
 - (a) By winding resistance: 30C.
 - (b) By hottest spot in winding: 40C.
 - (6) Accuracy class: 0.6B - 0.5 or better.
 - d. Potential transformer:
 - (1) ANSI/IEEE C57.13, wound-type with polarity markers to operate voltage relay and meters.
 - (2) Quantity: Three.
 - (3) Voltage ratio: 480 volts primary to 120 volts secondary.
 - (4) Insulation class: 600 volts with basic impulse-insulation level of 10 kV full-wave.
 - (5) Maximum allowable temperature rise under continuous full-load above average ambient temperature of 55C.
 - (a) By winding resistance: 30C.
 - (b) By hottest spot in winding: 40C.
 - (6) Accuracy class: 0.6 W or X.
 - (7) Transformers connected WYE-WYE with three-phase and neutral potential bus.
 - e. Power metering and communication interface:
 - (1) Each switchgear equipped with a digital power meter, Cutler Hammer IQ Data Plus II, Siemen 4700. Voltage inputs provided from

potential transformers (PTs) connected to the main secondary 480-volt bus. Current inputs provided from external- mounted current transformers with five-amp secondary output, mounted to measure currents on the secondary main bus. CT and PT ratios to be field selective. Provide a communications option tied into the communication network.

- (2) Each breaker equipped with a microprocessor-based trip device provided with a data communication interface tied into a local-area communication network.
- (3) Each switchgear provided with a two-wire local-area network tied into a central monitoring system, Cutler Hammer Assemblies Electronic Monitor II (AEM II), Siemens Power Monitor. Have the monitor provide local status of all breakers, load data, metering parameters, cause of trip, min./max. values, etc. Install the local area network to mitigate problems associated from electrical fields and electromagnetic interference.
- (4) Provide a separate RS-232 (DB-9) plug and network interface/translator, panel mounted with protective dust cover, for customer interface from a Notebook- type computer (IBM Compatible). Provide networking software and any special network interface board/PCMCIA for use with Authority-furnished notebook-type computer. The user interface software to be a Windows version, providing data access to all device parameters and metering values.
- (5) Power Supply: All metering equipment control power or its external power supply(s) to be powered from 125-volt DC control power or 120-volt ac, 60 Hz provided from one of the following sources:
 - (a) Emergency panel
 - (b) Load side of secondary breaker.
 - (c) Line side of secondary main breaker with necessary equipment including auxiliary relays to ensure that control power is available after operation of transfer scheme.

f. Test switches: Provided between instrument transformers, meters and relays as listed below:

- (1) ABB Style FT-1.

2. Feeder main cubicle: Equipped with the following:

- a. Feeder circuit breakers: Each circuit breaker with microprocessor-based phase- overcurrent trip device, shunt trip, ground-fault protection, position-indicating lights and necessary accessories and interlocks.

C. Electrical Interlocks: Provide interlocks and coordination with primary-service switchgear, as applicable, for performing the following functions:

1. Modes of operation: Normal, automatic throwover, manual restoration and maintenance throwover as follows:
 - a. Normal: All power circuit breakers, except tie breaker, are closed. Tie breaker is normally open.
 - b. Automatic throwover: Automatic throwover operation occurs only when an undervoltage condition occurs in one of the primary feeders and when other secondary main breaker is closed.
 - (1) Where primary service is through 13.8 kV metal-clad switchgear, tripping of primary breaker caused by undervoltage condition automatically trips secondary main breaker and initiates closing of secondary tie breaker. Automatic throwover operation is blocked if secondary main breaker or primary breaker has tripped because of

overcurrent or ground-fault condition.

- c. Manual restoration: When proper-voltage condition has been restored, substation may be retransferred to normal mode. After primary breaker has been closed or after primary voltage has been re-established as evidenced by return to normal of transformer secondary voltage, both tie breakers are tripped first from a common tie breaker trip switch, followed by closing of secondary main breaker, all manually.
 - d. Maintenance throwover: Same as automatic but initiated manually by simulating undervoltage condition at potential test switch followed by manual restoration as specified.
2. To prevent paralleling two sources and to prevent feedback through transformer into primary lines.
 3. To trip secondary main breaker when primary breaker trips. Tripping of secondary main breaker does not trip primary breaker.
 4. To operate simultaneously two tie breakers in passenger stations having two separate ac-switchboard rooms.
 5. To allow each drawout circuit breaker in test position to be closed or tripped by local operation and to inhibit interlocking/control signals to or from breaker when in such position.
 6. To provide time coordinated ground-fault protection. In addition, ground-fault protection for secondary main and tie circuit breakers to provide reliable operation under any operating condition without nuisance tripping because of partial cancellation of stray currents flowing in neutral.
 7. In combined ac switchboard room: Ground-fault protection on secondary main and tie breakers designed to trip secondary main breaker associated with fault and to prevent nuisance tripping of other secondary main breaker.
 8. Interconnecting control wiring between two remotely located unit substations to be designed for installation in a two-inch conduit minimum.

D. General Requirements for Switchboards:

1. NEMA PB2, UL 891.
2. Ratings:
 - a. Normal voltage: 480 volts.
 - b. Frequency: 60 Hertz.
 - c. Rated continuous current: As shown.
 - d. Short-circuit rating: As shown.
3. Molded-case circuit breakers: Section 16440.
4. UL listed.
5. Bus:
 - a. ASTM B187, 98-percent-conductivity copper.
 - b. Continuous-current rating: As shown.
 - c. Capable of withstanding mechanical stresses and heat due to maximum short-circuit current.
 - d. Bus contact surfaces: Silver-plated or tin-plated at connection.
 - e. Neutral bus rating: Same as that of phase bus.
 - f. Control bus: 125-volt dc; copper, No. 6 AWG minimum; with UL Class J or RK-5 fuses for each compartment where necessary.
 - g. Ground bus secured to each vertical-section structure and extending entire length of switchboard.
6. Control wiring:
 - a. Insulation rated 600 volts, Type SIS, copper, No. 14 AWG minimum. Flexible, Class C or higher, stranded wire used for wiring across hinged joints.
 - b. One continuous length of wire used between terminals without splices or

- taps.
 - c. Connections made at terminal of device, on terminal blocks or at control bus, using tinned copper-ring compression terminals with insulated sleeve.
 - d. Interconnect wiring between compartments terminated on terminal blocks before being wired to components.
 - e. Terminal blocks: With screw-type terminals, circuit-marking strips for indicating wire number, phenolic-laminated dustcover and 10-percent minimum spare terminal points.
 - f. For each individual wire, same identification used on each terminal block marking strip.
- 7. Ground-fault protection system:
 - a. Time coordinated ground fault protection system with solid state adjustable tripping device.
 - (1) Solid-state, adjustable.
 - (2) Current adjustable range: As per manufacturer
 - (3) Time adjustment band: As per manufacturer.
 - (4) Setting: As shown or as necessary to maximize protection and coordination.
- 8. Enclosure:
 - a. Dead-front, free-standing indoor steel enclosure designed for lineup with 480-volt switchgear, where applicable.
 - b. Steel structure with framework of welded or bolted structural steel, free from distortion and welding strain and sufficiently rigid to support equipment under normal and short-circuit conditions.
 - c. Each breaker compartment equipped with hinged door or bolted cover in front and bolted rear cover. Bolted covers furnished with headed studs and keyhole slots for hanging in position before bolting.
 - d. Vertical barrier provided between feeder main cubicle and the essential switchboard.
 - e. Individually mounted feeder breakers externally operable. Highest breaker handle not more than six-feet six-inches above floor.
 - f. Interconnections between feeder-main cubicle bus and switchboard bus shall be provided by using internal busbar and rated, segregated and braced in accordance with applicable reference standards.
 - g. Spaces for future breakers to include necessary bus connections and device supports.
 - h. Finish: Metallic surfaces degreased and finished with light-gray enamel, ANSI Z55.1, Color 61, in accordance with ANSI/IEEE C37.20.1, two mils minimum DFT.
 - i. Adjustable breaker lifting device mounted on top of switchgear.
- 9. Nameplates:
 - a. Nameplate provided on each switchboard and its components in accordance with reference standards.
 - b. Three-ply, laminated phenolic plates, engraved through black face to white core and attached by means of stainless-steel rivets or screws, provided on each switchboard and its components.
 - c. Lettering: Vertical gothic using round or square cutter. V-shaped groove not acceptable.
 - d. Each switchboard cubicle labeled with nameplate one-inch high bearing, as appropriate, one of the following inscription in letters ½-inch high: SWITCHBOARD.
 - e. In addition to other information normally displayed on equipment, provide nameplate to show breaker handle positions, meaning of indicator lamp and other pertinent information.

- E. Switchboards:
1. Equipped with individually mounted circuit breaker, each with solid state trip device, with integral time coordinated ground-fault protection and space heater.
 2. Adjustable instantaneous (magnetic) trip settings: As necessary for coordination.
 3. Bus bars on load side extending to rear of cubicle.
 4. Phase, neutral and ground buses and 125-volt dc control bus.
 5. Suitable for service entrance.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install switchgear in position as shown and in accordance with the NEC.
- B. Install conduits and raceways as shown and in accordance with the Section 16130.
- C. Make power-cable and control-wire connections as shown and as follows:
 1. Make power-cable and control-wire connections to circuit breakers, current-limiting circuit breakers and integrally fused circuit breakers by means of integral mechanical connectors. If such items are not furnished with integral mechanical connectors, make connections using compression connectors in accordance with Section 16125.
- D. Make grounding connections as shown and in accordance with Section 16060.

3.02 FIELD QUALITY CONTROL:

- A. In accordance with Section 16360.

END OF SECTION

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SECTION 16440

CIRCUIT BREAKERS, PANELBOARDS AND LOAD CENTERS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies furnishing, installing, connecting and testing of circuit breakers, panelboards and load centers.
- B. Related Work Specified Elsewhere:
 - 1. Raceways, boxes and cabinets: Section 16130.
 - 2. Wire, cable and busways: Section 16120.
 - 3. Wire connection accessories: Section 16125.
 - 4. Grounding and bonding: Section 16060.
 - 5. Field painting: Section 09920.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of the jurisdictional authorities.
 - 2. NEC.
 - 3. NEMA: AB1, PB1, ST20, 250.
 - 4. ANSI: Z55.1.
 - 5. UL: 50, 67, 198C, 489, 891, Electrical Construction Materials Directory.
 - 6. ASTM: A276, B187.
 - 7. ITS: Directory of ITS Listed Products.
- B. Source Quality Control:
 - 1. Each item listed per referenced UL or ITS directory.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings.
- B. Certification.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Mark each circuit breaker, panelboard and transformer in accordance with applicable reference standard.
- B. Ship each unit securely packaged and labeled for safe handling and to avoid damage or distortion.
- C. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements:
1. Interchangeability: Components of the same type, size, rating, functional characteristics and make are to be interchangeable.
 2. Finish for enclosures for enclosed circuit breakers, panelboards, emergency-service panelboards and load centers:
 - a. Clean and degrease metallic surfaces.
 - b. Prime with zinc primer.
 - c. Finish with one coat of light-gray enamel, ANSI Z55.1, Color 61. Minimum dry-film thickness: Two mills.
- B. Circuit Breaker: NEMA AB1, UL 489, molded-case, bolt-on, quick-make/quick-break, mechanically trip-free switching mechanism, with thermal trip for inverse time-delay overcurrent protection and magnetic trip for instantaneous short-circuit protection. Shunt-trip device for tripping by ground-fault relay as shown. Frame size 225 amperes and above equipped with interchangeable thermal trip and adjustable magnetic-trip unit. Designed to carry continuous rating in ambient temperature of 40C with the following parameters as shown:
1. Number of poles.
 2. Rated voltage.
 3. Rated interrupting current.
 4. Trip setting.
 5. Frame size.
- C. Integrally Fused Circuit Breaker:
1. NEMA AB1, molded-case, quick-make/quick-break, mechanically trip-free switching mechanism.
 2. Thermal trip for inverse time-delay overload and magnetic trip for instantaneous short-circuit protection. Shunt-trip device for tripping by ground-fault relay as shown. Frame size 400 amperes and above equipped with interchangeable thermal and adjustable magnetic trips.
 3. Individually removable current limiter, internally mounted on load side of circuit breaker, with rating and time current limiting characteristics that coordinate with time current-tripping characteristics of circuit breakers to provide the following:
 - a. Interruption of circuit breaker under fault-current level up to interrupting capacity of circuit breaker.
 - b. Interruption by current limiter in conjunction with circuit breaker under fault-current level above interrupting capacity of circuit breaker.
 - c. Where necessary to protect downstream panelboard, limit fault current at branch circuit breakers below their interrupting capacity.
 - d. Where necessary to protect associated feeder/branch circuits, limit fault current below short-circuit current withstand capability of cable.
 4. Removable cover provided over current-limiter section of circuit breaker with interlock for tripping of breaker upon removal of cover and to prevent turning circuit breaker to ON position with cover removed.
 5. Equipped with common trip mechanism for tripping all breaker poles simultaneously on blowing of current limiter to prevent single phasing.
 6. Capable of interrupting minimum fault current of 100,000-rms symmetrical amperes at 480 volts ac.
 7. Circuit breaker rating:
 - a. Number of poles: As shown.
 - b. Frame size: As shown.

- c. Voltage rating: 480 volts.
- d. Interrupting capacity: As necessary to coordinate with current limiter.
- e. Trip setting: As shown.

D. Enclosed Circuit Breaker:

- 1. NEMA AB1.
- 2. Circuit breaker: As shown and as specified. Overcurrent trip device coordinated to provide selective tripping under overload conditions.
- 3. Enclosure:
 - a. Galvanized steel, surface-mounted, unless otherwise shown.
 - b. Type:
 - (1) Above-ground indoor locations and electrical rooms: NEMA 250, Type 1.
 - (2) Outdoor locations: NEMA 250, Type 3R.

E. Panelboard:

- 1. NEMA PB1, UL 67.
- 2. Enclosure:
 - a. UL 50.
 - b. Galvanized steel, surface-mounted unless otherwise shown.
 - c. Type:
 - (1) Aboveground indoor locations and electrical rooms: NEMA 250, Type 1.
 - (2) Outdoor locations: NEMA 250, Type 3R.
 - d. Gutter size:

	Main Bus Rating Amperes	Minimum Top and Bottom Gutter Size in Inches	Minimum Side Gutter Size in Inches
(1)	100 and below	4	4
(2)	225	6	4
(3)	400 and over	8	4

- e. Interior components mounted on backplate of reinforced steel for rigid support and accurate alignment.
- f. Provide latch and handle in accordance with UL 50; screw fastenings will not be accepted in lieu of latch.
- g. Provision for enclosure grounding.
- 3. Busbars:
 - a. ASTM B187.
 - b. 98-percent-conductivity copper.
 - c. Contact surface silver-plated or tin-plated.
 - d. Rating of neutral and ground bus: Equal to that of phase bus.
 - e. Neutral bus mounted on insulating block.
 - f. Neutral and ground busbars equipped with integral mechanical connectors.
- 4. AC panelboards:
 - a. Type of service: Three-phase, four-wire, 277/480 volt or 120/208 volt or as shown.

- b. Type of main: Main lugs or circuit breakers or integrally fused circuit breakers as shown, conforming to requirements specified, located at top or bottom as necessary
 - c. Branch circuit: Circuit breakers or integrally fused circuit breakers as shown, conforming to requirements specified, number of circuits as shown.
 - d. Circuit breaker: Trip device coordinated with that of upstream circuit breakers to provide selective tripping.
 - e. Suitable for service entrance where necessary.
5. DC Panelboard:
- a. Type of service: 125-volt dc, two-wire.
 - b. Type of main: Two-pole circuit breaker, 100-ampere frame, 100-ampere trip and 10,000-ampere interrupting capacity, unless otherwise shown.
 - c. Branch circuit: Two-pole circuit breakers, 100-ampere frame and 10,000-ampere interrupting capacity, in accordance with specified requirements, quantities as follows unless otherwise shown:
 - (1) With 20-ampere trip: Two minimum.
 - (2) With 30-ampere trip: Two minimum.
 - (3) With 50-ampere trip: Two minimum.
 - d. Enclosure finish: As specified under General Requirements for this section, except color to be OSHA red as specified in Section 09920.
6. Emergency-power panelboard:
- a. NEMA PB1, UL 67, fused-switch.
 - b. Enclosure:
 - (1) Galvanized steel, surface-mounted unless otherwise shown.
 - (2) Type:
 - (a) Above-ground indoor locations and electrical rooms: NEMA 250, Type 1.
 - (b) Outdoor locations: NEMA 250, Type 3R.
 - (3) Minimum of four inches side gutter and six inches top and bottom gutter.
 - (4) Mounting channel drilled and tapped to accommodate any combination of fused switch.
 - c. Busbar:
 - (1) ASTM B187.
 - (2) 98-percent-conductivity copper.
 - (3) Contact surface silver-plated or tin-plated.
 - (4) Rating of neutral and ground bus: Equal to that of phase bus.
 - (5) Neutral bus mounted on insulating block.
 - (6) Drilled and tapped to accommodate any combination of fused switch unit.
 - (7) Neutral and ground bus equipped with integral mechanical connectors.
 - d. Type of service: As shown.
 - e. Type of mains: Main lugs or fused switch unit as shown, located at top or bottom as necessary.
 - f. Branch circuit: Equipped with fused switch unit, number of circuits as shown.
 - g. Fused switch unit:
 - (1) Individually enclosed, quick-make/quick-break switching mechanism.
 - (2) Equipped with the following:
 - (a) Silver-alloy contacts.

- (b) External operating handle capable of being padlocked in ON or OFF position.
 - (3) Defeatable door interlock to prevent opening the door when operating handle is in ON position.
 - (4) Pressure-type fuse with Class J cartridge fuse conforming to UL 198C.
 - (5) Current rating and number of poles: As shown; maximum rating, 30 amperes.
 - (6) Use two-pole or three-pole switch unit if single-pole switch unit is not available.
7. Fuse time-current characteristic coordinated with upstream fuse time-current characteristic to provide selective overcurrent tripping.

F. Nameplates:

- 1. Three-ply, laminated phenolic plates, engraved through black face to white core and attached by stainless-steel rivets or screws.
- 2. Lettering: Vertical gothic using round or square cutter. V-shape groove is prohibited.
- 3. Each panelboard labeled with nameplate one-inch high bearing ½-inch high inscriptions as appropriate.
- 4. Nameplate for emergency-power panelboard to bear inscription EMERGENCY POWER.

G. Load Centers:

- 1. Enclosure:
 - a. UL 891, stainless steel, ASTM A276, Type 304, or approved equal.
 - b. Type:
 - (1) Above-ground indoor locations and electrical rooms: Non-ventilated indoor.
 - (2) Underground locations, except electrical rooms and tunnel areas: Non-ventilated outdoor.
 - (3) Outdoor locations and tunnel areas: Non-ventilated outdoor.
- 2. Transformer:
 - a. NEMA ST20, dry, self-cooled, epoxy-encapsulated, double-wound with insulated copper conductor with 185C-insulation system capable of withstanding full-wave impulse voltage of 10KV.
 - b. Five kVA load center: Single-phase, 60 Hertz, 480 volts primary to 120/240 volts secondary.
 - c. Nine kVA load center: Three-phase, 60 Hertz, 480 volts primary to 120/208Y volts secondary.
 - d. Fifteen kVA load center: Three-phase, 60 Hertz, 480 volts primary to 120/208Y volts secondary.
 - e. Maximum allowable temperature rise under continuous full load above ambient temperature of 30C and 40C maximum:
 - (1) By winding resistance: 115C.
 - (2) By hottest spot in winding: 145C.
- 3. Circuit breaker:
 - a. Bolt-on or plug-in, as specified.
 - b. Primary circuit breaker: 480 volts, bolt-on, 14,000-rms symmetrical amperes interrupting capacity, 100-ampere frame, with the following additional requirements:
 - (1) For five kVA load center: Two-pole breaker with 20-ampere trip setting.

- (2) For nine kVA load center: Three-pole breaker with 25-ampere trip setting.
 - (3) For 15 kVA load center: Three-pole breaker with 40-ampere trip setting.
 - c. Secondary main circuit breaker:
 - (1) Bolt-on, two or three poles as shown, 240 volts, 10,000-rms symmetrical amperes interrupting capacity with trip setting as follows:
 - (a) For five kVA load center: 25 amperes.
 - (b) For nine kVA load center: 30 amperes.
 - (c) For 15 kVA load center: 50 amperes.
 - d. Branch circuit breaker:
 - (1) Single-pole, plug-in, 120 volts, 10,000-rms symmetrical amperes interrupting capacity.
 - (a) For five kVA load center: Four breakers, each with 20-ampere trip setting.
 - (b) For nine kVA load center: Six breakers, each with 20-ampere trip setting.
 - (c) For 15 kVA load center: Twelve breakers, each with 20-ampere trip setting.
 - e. Nameplate: Laminated plastic, one-inch high, attached by means of stainless-steel rivets or screws, showing load-center number in 1/2-inch high white characters engraved on black background.
4. Neutral and ground bus bar equipped with mechanical connectors.

H. Current-Limiting Circuit Breaker:

- 1. NEMA AB1, UL 489, molded-case, quick-make/quick-break, mechanically trip-free switching mechanism.
- 2. Thermal trip for inverse time-delay overcurrent protection and magnetic trip for instantaneous short-circuit protection. Shunt trip device for tripping by ground-fault relay as shown.
- 3. Limit the fault current, without the use of fusible element, to provide the following:
 - a. Protect associated cable by limiting the fault let-through energy to a value below the short-circuit withstand capability of the cable.
 - b. Protect downstream panelboard by limiting fault current at branch circuit breakers within their interrupting capabilities.
- 4. Circuit-breaker rating:
 - a. Number of poles: As shown.
 - b. Frame size: As shown.
 - c. Voltage rating: 480 volts.
 - d. Interrupting capacity: Minimum 100,000-symmetrical RMS amperes.
 - e. Trip setting: As shown.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install panelboards at locations shown, with bottom not less than 12 inches above floor. Use multiple-section panelboards to meet such spacings if necessary.
- B. Mount panelboards and load centers with front straight and plumb.

- C. When feeder serves more than one panelboard or panelboard section, install separate junction box or provide adequate gutter area for termination of feeders and bus taps.
- D. Install single and/or multiple-conductor cable in accordance with Section 16120. Connect branch circuit wires as shown. Connect neutral wire of branch circuit to neutral bar in panelboard.
- E. Install load centers where shown.
- F. Make conduit connections in accordance with Section 16130.
- G. Make power cable connections to circuit breakers, integrally fused circuit breakers, fused switch units, neutral and ground bus bars in panelboard and load centers and enclosed circuit breakers by means of integral mechanical connectors. If such items are not furnished with integral mechanical connectors, make connections using compression connectors in accordance with Section 16125.
- H. Ground panelboards, load centers and enclosed circuit-breaker enclosures in accordance with Section 16060 and the NEC.
- I. Apply matching touch-up paint where necessary.

3.02 DIRECTORY OF CIRCUITS:

- A. Furnish each panelboard and load center with legibly printed circuit directory located on inside of enclosure.

3.03 FIELD QUALITY CONTROL:

- A. Furnish necessary equipment and perform the following tests:
 1. Molded-case circuit breakers: Perform pole-to-pole and pole-to-ground insulation resistance tests with 1,000V dc megger. Insulation resistance to be 50 megohms minimum.
 2. Panel boards and load centers: Perform insulation-resistance tests of each bus section phase-to-phase and phase-to-ground for one minute using 1,000V megger. Insulation resistance to be not less than manufacturer's recommended minimum or two megohms minimum.
 3. Test circuit connections in accordance with wiring diagram.
 4. Test panelboard and load-center enclosures for continuity to grounding system.
 5. Check cable connections to circuit breakers and fused switch unit for tightness.
 6. Check setting of adjustable magnetic trips for compliance with approved coordination study.
- B. Submit certified test reports.

END OF SECTION



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SECTION 16491

FUSES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
1. Cartridge fuses rated 600 V and less for use in switches, panelboards, switchboards, controllers and motor-control centers.
 2. Spare-fuse cabinets.

1.02 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 2. Let-through current curves for fuses with current-limiting characteristics.
 3. Time-current curves, coordination charts and tables, and related data.
 4. Fuse size for elevator feeders and elevator disconnect switches.
- B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. Include the following:
1. Let-through current curves for fuses with current-limiting characteristics.
 2. Time-current curves, coordination charts and tables, and related data.
 3. Ambient temperature adjustment information.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

1.04 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.05 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.06 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 20 percent of each fuse type and size, but no fewer than 5 of each type and size.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.02 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.03 SPARE-FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch-thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.

3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

- A. Service Entrance: T, fast acting.
- B. Feeders: Class RK1, time delay.
- C. Motor Branch Circuits: Class RK1, time delay.
- D. Other Branch Circuits: Class RK1, time delay.

3.03 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

3.04 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION

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SECTION 16525

INTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing lighting fixtures.
- B. Related Work Specified Elsewhere:
 - 1. Field painting: Section 09920.
 - 2. Grounding and bonding: Section 16060.
 - 3. Wire, cable and busways: Section 16120.
 - 4. Wire connection accessories: Section 16125.
 - 5. Raceways, boxes and cabinets: Section 16130.
 - 6. Wiring and control devices: Section 16145.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. UL: 496, 542, 1029, 1570, 1571, 1572, Electrical Construction Materials Directory.
 - 4. FS: FF-B-588, FF-P-395, FF-S-325C.
 - 5. MS: MIL-C-450.
 - 6. FED STD: 595.
 - 7. PEI: 1001.
 - 8. SSPC: SP-8, SP-10.
 - 9. ASTM: A53, A167, A276, A123, A507, A575, B26, B85, B117, B136, B137, B209, B221, B244, D635, D1056, D1400, D2240.
 - 10. AASHTO: M314, LTS-3.
 - 11. ITS: Directory of ITS Listed Products.
 - 12. AA: Standard finishes as designated by the Aluminum Association and referenced in NAAMM Metal Finishes Manual.
 - 13. ANSI/IEEE: C62.41.
 - 14. IEEE Publication 587.
 - 15. ANSI Standards.
 - 16. FCC Rules and Regulations, Part 15, Part 18.
 - 17. NEMA 1
 - 18. AISI.
 - 19. IES: RP-20
- B. Each lighting fixture to be labeled or listed per referenced UL or ITS directory.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Include photometric curves.

- B. Samples: One of each type of fixture.
- C. Certification:
 1. Verification that each fixture is in compliance with applicable codes, regulations, reference standards and specifications for the location at which it is to be used. Indicate requirements that each fixture meets.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Store lighting fixtures in secure and dry storage facility.

1.05 WARRANTY:

- A. Globes and Diffusers: In addition to warranty requirements of the General Provisions, furnish warranty against discoloration and distortion for a total of four years.
- B. Lamps: Warrant the life of lamps for periods specified.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements for Lighting Fixtures:
 1. Interchangeability: Components of same type, size, rating, functional characteristics and make are to be interchangeable.
 2. In accordance with UL 1570, UL 1571 and UL 1572.
 3. Materials:
 - a. Steel:
 - (1) Sheet: ASTM A507, 22-gauge minimum.
 - (2) Bar: ASTM A575.
 - b. Steel pipe: ASTM A53, Type S.
 - c. Stainless steel:
 - (1) Sheet: ASTM A167, 22-gauge minimum.
 - (2) Bar: ASTM A276, Type 316.
 - (3) Finish: AISI Alloy S30400, NAAMM Finish No. 4, unless otherwise shown.
 - d. Aluminum: Alloy as recommended by manufacturer, unless otherwise shown or specified.
 - (1) Sheet and plate: ASTM B209.
 - (2) Extrusion: ASTM B221, 0.109-inch minimum thickness, unless otherwise shown.
 - (3) Cast:
 - (a) Die cast: ASTM B85, 0.1875-inch minimum thickness, unless otherwise shown.
 - (b) Sand cast: ASTM B26, 0.1875-inch minimum thickness, unless otherwise shown.
 - (c) Color-anodized cast: Kalcolor Casting Alloy No. 2 or equal.
 4. Lamps:
 - a. In accordance with applicable ANSI Standards.
 - b. Tungsten-halogen:
 - (1) Wattage: Per WMATA requirements or match existing.
 - (2) Size: T-3.

- (3) Base: Recessed single contact.
- (4) Rated life: 4,000 hrs.
- (5) Operating voltage:
 - (a) 1,500-watt lamps: 277 volts, 60 Hertz.
 - (b) All other lamps: 120 volts, 60 Hertz.
- c. Incandescent:
 - (1) Wattage: Per WMATA requirements or match existing.
 - (2) Finish: Inside frosted unless otherwise shown.
 - (3) Base:
 - (a) Up to 200 watts: Medium screw base
 - (b) Above 200 watts: Mogul screw base.
 - (4) Operating voltage: 120 volts, 60 Hertz.
 - (5) Rated life: 2,500 hours.
 - (6) Bulb size: Per WMATA requirements or match existing.
- d. Mercury vapor:
 - (1) Watt rating: Per WMATA requirements or match existing.
 - (2) Color: Deluxe white.
 - (3) Finish: Per WMATA requirements or match existing.
 - (4) Base:
 - (a) Up to 100 watts: Medium screw base.
 - (b) Above 100 watts: Mogul screw base.
 - (5) Rated life: 24,000 hours.
 - (6) Bulb size: Per WMATA requirements or match existing.
- e. Fluorescent:
 - (1) Wattage and size: Per WMATA requirements or match existing.
 - (2) Color: Warm white.
 - (3) Type:
 - (a) PL7 compact, PL13 compact.
 - (b) F6T5/CW and F20T12WW, Preheat start.
 - (c) F32T8/WW, Rapid start.
 - (4) Rated life:
 - (a) Super-high output (SHO), very-high output (VHO) and high output (HO) lamps: 12,000 hours.
 - (b) F32T8/WW: 20,000 hours.
 - (c) PL compact lamps: 10,000 hours.
 - (5) Base:
 - (a) Super-high output (SHO), very-high output (VHO) and high output (HO) lamps: Recessed double contact.
 - (b) F32T8/WW: Medium bi-pin.
 - (c) PL7 medium.
- f. Metal-halide:
 - (1) Wattage: Per WMATA requirements or match existing.
 - (2) Size: Per WMATA requirements or match existing.
 - (3) Color: Clear unless otherwise noted.
 - (4) Lamp operating position: Per WMATA requirements or match existing.
 - (5) Base: Mogul.
 - (6) Rated life:
 - (7)
 - (a) 175 watt: 7,500 hours.
 - (b) 400 watt: 15,000 hours.
 - (c) 1,000 watt: 10,000 hours.
- g. High-pressure sodium:
 - (1) Wattage: Per WMATA requirements or match existing.
 - (2) Size: Per WMATA requirements or match existing.

- (3) Coating: Clear, unless otherwise specified.
 - (4) Base: Medium or mogul.
 - (5) Rated life: 24,000 hours.
5. Lampholders:
- a. Incandescent, mercury vapor, metal halide and high-pressure sodium:
 - (1) In accordance with UL 496.
 - (2) Black or white thermosetting phenolic compound, glazed-porcelain or neoprene base and body as shown. Neoprene unit molded in one-piece, weatherproof, oil-resistant, with vibration-absorbing socket construction.
 - (3) Incandescent: Rated 660 watts, 250 volts for medium screw base.
 - (4) Mercury vapor, high-pressure sodium and metal halide:
 - (5) Rated 660 watts, 600 volts: Medium screw base.
 - (6) Rated 1,500 watts, 600 volts: Mogul screw base.
 - (7) Provide mechanical self-retaining neoprene gasket for dust and moisture proof seal between lamp and lampholder.
 - (8) Provide vibration proof feature to prevent incandescent lamp from loosening in lampholder in S-1 fixture
 - b. Fluorescent:
 - (1) In accordance with UL 542.
 - (2) Rated 660 watts, 600 volts.
 - (3) Integral starter holder for preheat-type lamps, with starter.
 - (4) White, thermosetting phenolic-compound base and body, silver-plated phosphorous-bronze contacts, self-aligning neoprene gasket face.
 - c. Tungsten-halogen: Porcelain with silver-plated contacts, to suit RSC lamp base.
6. Ballasts:
- a. Mercury-vapor lamps, high-pressure sodium lamps and metal-halide lamps:
 - (1) UL 1029, high-power-factor type.
 - (2) Operable on 120-volt or 277-volt, 60 Hertz as shown or necessary, type and rating suitable for associated lamp.
 - (3) Capable of starting lamp at ambient temperature of minus 20F and above.
 - (4) Equip with individual fuse protection installed in ballast compartment of fixture.
 - b. Fluorescent lamps:
 - (1) FCC part 15 subpart J, UL listed Class P.
 - (2) Operable on 120-volt or 277-volt, 60 Hertz, as shown or necessary, type and load rating suitable for associated lamps.
 - (3) Capable of starting lamps at ambient temperature as follows:
 - (a) F32T8/WW lamps: Zero degree F.
 - (4) Sound rating:
 - (a) For use with F32T8/WW lamps installed in office areas: A.
 - (b) For use with F32T8/WW lamps installed in ancillary areas: B or better.
 - (5) Maximum utilization of two-lamp ballasts in public-area lighting fixtures.
 - (6) Equipped with individual fuse protection, installed in the fixture wiring channel.
7. Fixture body and housing: Shape, size and material as shown.
8. Reflector: Shape, size and material Per WMATA requirements or match existing. Aluminum or stainless steel polished to mirror finish unless otherwise specified. Minimum thickness 22 gauge unless otherwise specified.
9. Diffusers:

- a. Shape and size as shown, one-piece molded or extruded clear virgin acrylic or polycarbonate plastic having the following properties:
 - (1) Interior diffusing with smooth exterior surface.
 - (2) Self-extinguishing, in accordance with ASTM D635.
 - (3) No material color change when used with 4500K fluorescent lamp.
 - (4) No apparent yellowing after 500 hours exposure to fluorescent-lamp source under conditions similar to those existing in the lighting fixture.
 - (5) No alteration to optical properties of the fixture when finished diffuser treated with anti-static wax.
 - b. Formed by carefully controlled processes so that the finished piece retains its design contours and dimensions at normal operating temperature.
 - c. Resistance to shrinking, warping, crazing, cracking, or discoloring, either in service or when stored in the manufacturer's standard shipping containers under normal conditions.
10. Globes:
- a. Clear seamless polycarbonate or high-impact heat-resistant glass as shown.
 - b. Shape and size: Per WMATA requirements or match existing.
 - c. Minimum thickness: 0.125 inch, surface free from visible mold seam.
 - d. Reduction in strength: 10-percent maximum after five years.
 - e. Maximum haze: Two percent.
 - f. Minimum light transmittance: 88 percent.
11. Lenses:
- a. Plastic lenses: Clear polycarbonate as shown, minimum thickness 0.06 inch.
 - b. Glass lenses: 1/4-inch tempered glass, laminated glass, or 1/8-inch double-strength clear glass as shown, capable of absorbing ultraviolet rays when used with mercury-vapor or metal-halide lamps.
 - c. Refracted lenses: Heat-resistant, annealed, clear borosilicate glass, with the following additional requirements:
 - (1) Initial lumen distribution on horizontal plane evenly from zero to 90 degrees: 55 to 60 percent.
 - (2) Minimum efficiency: 85 percent.
12. Fixture wire: Section 16120.
13. Gasket:
- a. Keyed gasket: One-piece, extruded solid neoprene having Type A durometer hardness of 30 plus-or-minus five when tested in accordance with ASTM D2240.
 - b. Self-retaining gasket:
 - (1) One-piece, closed-cell sponge neoprene, soft or medium density.
 - (2) Resistant to aging, heat, ultra-violet light, water, oil, weathering and setting as determined by ASTM D1056.
 - (3) Cemented to component with resilient neoprene sealing compound compatible with finish. Adhesive not applied to diffuser.
 - c. Silicone gasket equal to neoprene, at Contractor's option.
14. Hardware:
- a. Latches, catches, release mechanisms, hinges, screws, bolts, studs, nuts, rivets, washers and springs. Heavy-duty stainless steel or bronze.
 - b. Latches and catches: Captive-type.
 - c. Operating hardware: Self-retaining type.
15. Construction:
- a. Fixture body, reflectors, wiring channels, end caps and castings formed so as to prevent buckling or distortion.
 - b. Minimum of two wire clips provided in wiring channel to support wiring. Self-cleaning air filter provided on breather ports.

- c. Seams and joints continuously welded and ground smooth.
 - d. When aluminum will be in contact with dissimilar metal, separate contact surfaces with gasket, nonabsorptive tape, or coating to prevent corrosion.
16. Finish:
- a. Baked enamel: Nonspecular finish consisting of six-stage hot-cleaning wash, phosphate coat, prime coat, and finish coat of sprayed white or other color acrylic enamel as shown, baked at 350F for a minimum of 30 minutes, with the following additional requirements:
 - (1) Dry-film thickness (DFT) per ASTM D1400: 1.25 mils minimum.
 - (2) Undercutting of enamel film from scored line after exposing to 10-percent salt spray for 1,500 hours, per ASTM B117: 0.067-inch maximum.
 - (3) Baked white enamel after 100 hours exposure to fadeometer: 86-percent minimum reflectance factors, no appreciable visual color change.
 - (4) Bronze color: FED STD 595, Color No. 20040.
 - b. Porcelain enamel: Opaque, fused vitreous surface finish, 88-percent average reflectance factor, in accordance with the following standards:
 - (1) On steel: PEI 1001.
 - (2) On aluminum alloy: PEI 1001.
 - c. Specular anodized coating: 14-stage process for permanently sealed specular or semispecular finish, as shown, in accordance with patented electrolytic process, Alzak or equal. When shown dark-bronze color, match Duranodic 313 Dark Bronze.
 - d. Clear anodic coating: AA-M22C22-A41, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot-water seal overall, tested in accordance with the following requirements:
 - (1) Coating weight: ASTM B137.
 - (2) Coating thickness: ASTM B244.
 - (3) Sealing test: ASTM B136.
 - (4) Undercutting of anodic film from scored line after exposing to 10-percent salt spray for 1,500 hours, in accordance with ASTM B117: 0.067-inch maximum.
 - e. Color-anodized finish: NAAMM AA-M22-C22A42, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot-water seal overall, tested in accordance with the following requirements:
 - (1) Coating weight: ASTM B137.
 - (2) Coating thickness: ASTM B244.
 - (3) Sealing test: ASTM B136.
 - (4) Color: Dark Bronze. Kaiser Aluminum Color, Statuary Bronze; Alcoa Color, Dark Bronze, Duranodic 313.
 - f. Zinc coating: ASTM A123.
 - g. Factory-painting: Prepare surfaces by pickling in accordance with SSPC SP-8. Apply coating of 7.0-mil total DFT as follows:
 - (1) First coat: Inorganic zinc-silicate primer, 2.5-mil DFT.
 - (2) Second coat: High-build epoxy primer, 3.0-mil DFT.
 - (3) Third coat: Aliphatic polyurethane, 1.5-mil DFT, FED STD 595, Color No. 20040.
 - h. Field painting: Section 09920.
 - i. Electrostatic-powder coating: Prepare surfaces by sandblast cleaning complying with SSPC SP-10 near-white blast cleaning, applying coating promptly after cleaning. Ground material to be coated. Apply coating as electrostatically-charged dry powder using electrostatic spray gun to produce DFT of six mils plus-or-minus two mils. Cure by heat treatment.

17. Mark each fixture and its components in accordance with applicable reference standard.
18. Conduit: Section 16130.
19. Connectors: Section 16125.
20. Fasteners: Size and type to match existing or best suited to use.
 - a. Expansion anchors: FS FF-S-325C, Group II, Type 3, Class 1, stainless steel, Type 303.
 - b. Toggle bolts: FS FF-B-588.
 - c. Powder-actuated: FS FF-P-395.
 - d. Finish: Where exposed, custom finish exposed parts to match surface being fastened.
21. Photoelectric control: Section 16145.

2.02 LIGHTING FIXTURES:

- A. Lighting Fixtures: Types per WMATA requirements, match existing and as follows:
 1. Type 1 fixture:
 - a. Open, industrial-type, fluorescent.
 - b. Lamps: Two 32-watt F32T8/WW.
 - c. Body: Aluminum or 20-gauge steel channel-shaped body, end plates, cover and reflector. Knockouts in body and end plates as shown. Attach end plates to body with noncorrosive screws. Double-strength construction for steel channel.
 - d. Finish:
 - (1) Channel, end plates, and cover:
 - (a) Steel: White baked enamel.
 - (b) Aluminum: Clear anodic coating.
 - (2) Reflector: White baked enamel for aluminum and steel.
 2. Type 2 fixture: Same as Type 1, except fixture equipped with one-piece acrylic-plastic diffuser in extruded aluminum or steel frame; with octolens surface.
 3. Type 3 fixture:
 - a. Open, strip-type, fluorescent.
 - b. Lamps: Two 18-watt F18T8/WW.
 - c. Body: Aluminum or 20-gauge steel channel, end plates and cover. Knockouts in body and end plates as shown. End plates attached to body with noncorrosive screws. Double-strength construction for steel channel.
 - d. Finish:
 - (1) Steel: White baked enamel, interior and exterior.
 - (2) Aluminum: Clear anodic coating.
 4. Type 4 fixture:
 - a. Enclosed, watertight, fluorescent, for mounting on channel inserts.
 - b. Lamp: One 32-watt F32T8/WW.
 - c. Enclosure:
 - (1) Body: Extruded-aluminum housing with die-cast aluminum end caps, flanged to provide solid seat for gasket between body and door frame.
 - (2) Door frame: Extruded aluminum, minimum of three hinges riveted to door and housing, 0.2-inch diameter stainless-steel hinge pins and minimum of three door-fastening screws.
 - (3) Door-fastening screws: Quick-turn, slotted, pan-head, captive, corrosion-resistant, location to provide uniform pressure on door gaskets.
 - (4) Diffuser: Clear, inside-ribbed polycarbonate plastic.
 - (5) Reflector: Aluminum, three-part, with portion concealing ballast flush-hinged to permit wiring connections and ballast replacement.

- d. Finish:
 - (1) Enclosure: Clear anodic coating.
 - (2) Reflector: White baked enamel.
- 5. Type 4A fixture: Two tandem-mounted Type 4 fixtures, with two lamp ballasts, as shown.
- 6. Type 5 fixture:
 - a. Enclosed fluorescent fixture.
 - b. Lamp: One 32-watt F32T8/WW.
 - c. Enclosure: Steel housing and end plates. Knockouts where shown. End plates attached to housing with noncorrosive screws. Diffuser: Clear acrylic plastic.
 - d. Finish:
 - (1) Enclosure: White baked enamel.
 - (2) Reflector: White baked enamel.
- 7. Type 6A fixture:
 - a. Enclosed, vapor-tight, compact fluorescent, for pendant mounting.
 - b. Housing: Cast aluminum, with threaded hub for 3/4-inch conduit, and cast-aluminum guard.
 - c. Globe: Clear glass with high-impact resistance.
 - d. Finish: Clear anodic coating.
 - e. Fluorescent lamp: One PL13 compact.
- 8. Type 6B fixture: Same as Type 6A, except for mounting on outlet box.
- 9. Type 6C fixture: Same as Type 6A, except bracket-type for mounting on wall.
- 10. Type 6D fixture: Same as Type 6C, except complete with outlet box.
- 11. Type 7A fixture:
 - a. Enclosed, vapor-tight, high-pressure sodium for ceiling mounting.
 - b. Housing: Cast aluminum, with ballast compartment cast aluminum, guard.
 - c. Globe: Clear glass with high-impact resistance.
 - d. Finish: Two coats of gray epoxy enamel.
 - e. Lamp: One 50-watt, clear, BT-25, high-pressure sodium.
- 12. Type 7B fixture: Same as 7A, except wall-mounted.
- 13. Type 7C fixture: Same as 7A, except pendant-mounted. Center topped and integrally counter-weighted so fixture hangs plumb.
- 14. Type 8 Fixture:
 - a. Enclosed, weatherproof high-pressure sodium for wall mounting, UL-listed "Suitable for Outdoor and Wet Locations".
 - b. Housing: Die-cast aluminum luminaire, integral ballast housing and grid guard, with tamper-resistant stainless-steel hardware.
 - c. Refractor: Pressed, clear, prismatic, single-piece, thermal/shock-resistant, borosilicate glass or polycarbonate.
 - d. Finish: Electrostatic powder-coated, FED STD 595 Color No. 20040.
 - e. Lamp: One clear, high-pressure sodium, wattage as shown.
- 15. Type 9 Fixture: Emergency trip station light:
 - a. Enclosed and gasketed weatherproof, mercury-vapor fixture mounted on steel channel and tube as shown, UL-listed as Suitable for Outdoor and Wet Locations.
 - b. Housing: Die-cast copper-free aluminum luminaire with 90-degree arm for wall mounting, integral ballast housing, grid guard and threaded globe seat, with tamper-resistant stainless steel hardware.
 - c. Globe: Thermal shock-resistant and impact-resistant blue, tempered glass with threads to ensure secure fit to housing.
 - d. Finish: Natural.
 - e. Lamp: Mercury-vapor, 40-watt B-17.

- f. Ballast: H45 type, Class H insulated, capable of starting 40-watt mercury-vapor lamp at ambient temperature of minus 20F and above, suitable for remote mounting.
 - g. Remote ballast enclosure: Fiberglass or aluminum with polyester powder paint finish, front access, weather tight construction, 3/4-inch conduit entry and exit knockouts, with mounting lugs suitable for mounting on channel inserts or on wall as shown.
 - h. Source: Hubbell catalog number VMWX-5050C-R, or approved equal.
16. Type X fixture:
- a. Exit sign for top, side, back or pendant-mounting, as needed. With directional arrows. Color of lettering and arrows to comply with jurisdictional requirements.
 - b. Lamps: Ultra-long-life light-emitting diodes (LED) mounted on a circuit board to operate on 120V or 277V, single phase, 60-Hz supply. Have LED's protected by a clear panel and special optical diffuser.
 - c. Housing: Die-cast aluminum, 0.125-inch minimum wall thickness. Concealed hinges and latching mechanism.
 - d. Door: Die-cast aluminum, 0.125-inch minimum thickness; open-face with phosphorescent-glass panel and six-inch high letters; color of letters and field as required by the jurisdictional authority, using fired-on ceramic colors.
 - e. Finish: Clear-satin anodic coating, unless otherwise shown.
- B. Other Lighting Fixtures: Types per WMATA requirements, with materials and finishes specified.
- C. Light Fixtures shall be Class 1 Division 2 type at the Blow Pit and Parts Cleaning Room.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install lighting fixtures as follows:
- 1. Mount fixtures rigidly in place. Use expansion anchors and machine screws for concrete surfaces and toggle bolts for hollow concrete-masonry surfaces. Use appropriate fasteners for attachment to other surfaces. Support lighting fixtures independent of suspended acoustical-panel ceiling systems.
 - 2. Where aluminum contacts concrete or dissimilar metal, separate contact surfaces with gasket, nonabsorptive tape or bituminous coating to prevent corrosion. Use stainless-steel fasteners.
 - 3. Mount fixtures plumb, level and in straight lines. Install stems of suspended fixtures plumb. Group-mounted fluorescent fixtures to appear as one unit.
 - 4. Install 12-inch minimum length of liquid-tight flexible conduit for connection between fixture and outlet box in accordance with Section 16130. Use fixture wire from outlet box in branch circuit to lighting fixture in accordance with Section 16120, and connect fixtures to branch circuit in accordance with Section 16125
 - 5. Install chase nipple where fluorescent fixtures are installed in continuous groups. Clean lamps, diffusers, globes, reflectors and exposed-to-view surfaces of fixtures after aiming and adjusting has been approved.

3.02 FIELD QUALITY CONTROL:

- A. Testing:

1. Furnish necessary personnel and equipment and perform tests and adjustments in the presence of the Engineer. Schedule adjustment of exterior installations to occur during hours of darkness.
2. Test lighting circuits for continuity and operation.
3. Test fixtures for continuity of grounding system.
4. Aim and adjust fixtures to provide optimal distribution pattern as needed and as approved.

END OF SECTION

SECTION 16526

LIGHTING FIXTURES AND MOUNTING POLES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section specifies providing lighting fixtures and mounting poles.
- B. Related Work Specified Elsewhere:
 - 1. Grading, excavation and backfilling: Section 02320.
 - 2. Concrete formwork: Section 03100
 - 3. Concrete reinforcement: Section 03200.
 - 4. Cast-in-place structural concrete: Section 03300.
 - 5. Field painting: Section 09920.
 - 6. Grounding and bonding: Section 16060.
 - 7. Wire, cable and busways: Section 16120.
 - 8. Wire connection accessories: Section 16125.
 - 9. Raceways, boxes and cabinets: Section 16130.
 - 10. Wiring and control devices: Section 16145.

1.02 QUALITY ASSURANCE:

- A. Codes, Regulations, Reference Standards and Specifications:
 - 1. Comply with codes and regulations of jurisdictional authorities.
 - 2. NEC.
 - 3. UL: 496, 542, 1029, 1570, 1571, 1572, Electrical Construction Materials Directory.
 - 4. FS: FF-B-588, FF-P-395, FF-S-325C.
 - 5. MS: MIL-C-450.
 - 6. FED STD: 595.
 - 7. PEI: 1001.
 - 8. SSPC: SP-8, SP-10.
 - 9. ASTM: A53, A167, A276, A123, A507, A575, B26, B85, B117, B136, B137, B209, B221, B244, D635, D1056, D1400, D2240.
 - 10. AASHTO: M314, LTS-3.
 - 11. ITS: Directory of ITS Listed Products.
 - 12. AA: Standard finishes as designated by the Aluminum Association and referenced in NAAMM Metal Finishes Manual.
 - 13. ANSI/IEEE: C62.41.
 - 14. IEEE Publication 587.
 - 15. ANSI Standards.
 - 16. FCC Rules and Regulations, Part 15, Part 18.
 - 17. NEMA 1
 - 18. AISI.
 - 19. IES: RP-20
- B. Each lighting fixture to be labeled or listed per referenced UL or ITS directory.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

- A. Shop Drawings:
 - 1. Include photometric curves.
- B. Samples: One of each type of fixture.
- C. Certification:
 - 1. Verification that each fixture is in compliance with applicable codes, regulations, reference standards and specifications for the location at which it is to be used. Indicate requirements that each fixture meets.
 - 2. Calculations: Submit calculations by a professional engineer registered in the jurisdiction where material is to be installed certifying that assemblies of foundation, anchor bolts, pole, arms and luminaire will withstand specified wind pressure, wind speed, stress, deflection, vibration and fatigue.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.
- B. Store lighting fixtures and mounting poles in secure and dry storage facility.

1.05 WARRANTY:

- A. Globes and Diffusers: In addition to warranty requirements of the General Provisions, furnish warranty against discoloration and distortion for a total of four years.
- B. Lamps: Warrant the life of lamps for periods specified.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

- A. General Requirements for Lighting Fixtures:
 - 1. Interchangeability: Components of same type, size, rating, functional characteristics and make are to be interchangeable.
 - 2. In accordance with UL 1570, UL 1571 and UL 1572.
 - 3. Materials:
 - a. Steel:
 - 1) Sheet: ASTM A507, 22-gauge minimum.
 - 2) Bar: ASTM A575.
 - b. Steel pipe: ASTM A53, Type S.
 - c. Stainless steel:
 - 1) Sheet: ASTM A167, 22-gauge minimum.
 - 2) Bar: ASTM A276, Type 316.
 - 3) Finish: AISI Alloy S30400, NAAMM Finish No. 4, unless otherwise shown.
 - d. Aluminum: Alloy as recommended by manufacturer, unless otherwise shown or specified.
 - 1) Sheet and plate: ASTM B209.
 - 2) Extrusion: ASTM B221, 0.109-inch minimum thickness, unless otherwise shown.
 - 3) Cast:
 - a) Die cast: ASTM B85, 0.1875-inch minimum thickness, unless otherwise shown.

- b) Sand cast: ASTM B26, 0.1875-inch minimum thickness, unless otherwise shown.
 - c) Color-anodized cast: Kalcolor Casting Alloy No. 2 or equal.
- 4. Lamps:
 - a. In accordance with applicable ANSI Standards.
 - b. High-pressure sodium:
 - 1) Coating: Clear, unless otherwise required.
 - 2) Base: Medium or mogul.
 - 3) Rated life: 24,000 hours.
- 5. Lampholders:
 - a. high-pressure sodium:
 - 1) In accordance with UL 496.
 - 2) Black or white thermosetting phenolic compound, glazed-porcelain or neoprene base and body. Neoprene unit molded in one-piece, weatherproof, oil-resistant, with vibration-absorbing socket construction.
 - 3) High-pressure sodium:
 - a) Rated 660 watts, 600 volts: Medium screw base.
 - b) Rated 1,500 watts, 600 volts: Mogul screw base.
 - 4) Provide mechanical self-retaining neoprene gasket for dust and moisture proof seal between lamp and lampholder.
 - 5) Provide vibration proof feature to prevent incandescent lamp from loosening in lampholder in S-1 fixture
- 6. Ballasts:
 - a. High-pressure sodium lamps:
 - 1) UL 1029, high-power-factor type.
 - 2) Operable on 120-volt or 277-volt, 60 Hertz as necessary, type and rating suitable for associated lamp.
 - 3) Capable of starting lamp at ambient temperature of minus 20F and above.
 - 4) Equip with individual fuse protection installed in ballast compartment of fixture.
- 7. Fixture body and housing: Shape, size and material as required.
- 8. Reflector: Shape, size and material as required. Aluminum or stainless steel polished to mirror finish. Minimum thickness 22 gauge.
- 9. Lenses:
 - a. Plastic lenses: Clear polycarbonate, minimum thickness 0.06 inch.
 - b. Glass lenses: 1/4-inch tempered glass, laminated glass, or 1/8-inch double-strength clear glass, capable of absorbing ultraviolet rays.
- 10. Fixture wire: Section 16120.
- 11. Gasket:
 - a. Keyed gasket: One-piece, extruded solid neoprene having Type A durometer hardness of 30 plus-or-minus five when tested in accordance with ASTM D2240.
 - b. Self-retaining gasket:
 - 1) One-piece, closed-cell sponge neoprene, soft or medium density.
 - 2) Resistant to aging, heat, ultra-violet light, water, oil, weathering and setting as determined by ASTM D1056.
 - 3) Cemented to component with resilient neoprene sealing compound compatible with finish. Adhesive not applied to diffuser.
 - c. Silicone gasket equal to neoprene, at Contractor's option.
- 12. Hardware:
 - a. Latches, catches, release mechanisms, hinges, screws, bolts, studs, nuts, rivets, washers and springs. Heavy-duty stainless steel or bronze.
 - b. Latches and catches: Captive-type.

- c. Operating hardware: Self-retaining type.
13. Construction:
- a. Fixture body, reflectors, wiring channels, end caps and castings formed so as to prevent buckling or distortion.
 - b. Minimum of two wire clips provided in wiring channel to support wiring. Self-cleaning air filter provided on breather ports.
 - c. Seams and joints continuously welded and ground smooth.
 - d. When aluminum will be in contact with dissimilar metal, separate contact surfaces with gasket, nonabsorptive tape, or coating to prevent corrosion.
14. Finish:
- a. Baked enamel: Nonspecular finish consisting of six-stage hot-cleaning wash, phosphate coat, prime coat, and finish coat of sprayed white or other color acrylic enamel, baked at 350F for a minimum of 30 minutes, with the following additional requirements:
 - 1) Dry-film thickness (DFT) per ASTM D1400: 1.25 mils minimum.
 - 2) Undercutting of enamel film from scored line after exposing to 10-percent salt spray for 1,500 hours, per ASTM B117: 0.067-inch maximum.
 - 3) Baked white enamel after 100 hours exposure to fadeometer: 86-percent minimum reflectance factors, no appreciable visual color change.
 - 4) Bronze color: FED STD 595, Color No. 20040.
 - b. Clear anodic coating: AA-M22C22-A41, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot-water seal overall, tested in accordance with the following requirements:
 - 1) Coating weight: ASTM B137.
 - 2) Coating thickness: ASTM B244.
 - 3) Sealing test: ASTM B136.
 - 4) Undercutting of anodic film from scored line after exposing to 10-percent salt spray for 1,500 hours, in accordance with ASTM B117: 0.067-inch maximum.
 - c. Color-anodized finish: NAAMM AA-M22-C22A42, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot-water seal overall, tested in accordance with the following requirements:
 - 1) Coating weight: ASTM B137.
 - 2) Coating thickness: ASTM B244.
 - 3) Sealing test: ASTM B136.
 - 4) Color: Dark Bronze. Kaiser Aluminum Color, Statuary Bronze; Alcoa Color, Dark Bronze, Duranodic 313.
 - d. Zinc coating: ASTM A123.
 - e. Factory-painting: Prepare surfaces by pickling in accordance with SSPC SP-8. Apply coating of 7.0-mil total DFT as follows:
 - 1) First coat: Inorganic zinc-silicate primer, 2.5-mil DFT.
 - 2) Second coat: High-build epoxy primer, 3.0-mil DFT.
 - 3) Third coat: Aliphatic polyurethane, 1.5-mil DFT, FED STD 595, Color No. 20040.
 - f. Field painting: Section 09920.
 - g. Electrostatic-powder coating: Prepare surfaces by sandblast cleaning complying with SSPC SP-10 near-white blast cleaning, applying coating promptly after cleaning. Ground material to be coated. Apply coating as electrostatically-charged dry powder using electrostatic spray gun to produce DFT of six mils plus-or-minus two mils. Cure by heat treatment.
15. Mark each fixture and its components in accordance with applicable reference standard.
16. Conduit: Section 16130.

17. Connectors: Section 16125.
18. Anchor bolts, nuts and washers:
 - a. AASHTO M314, hot-dip galvanized.
 - b. Bolts hooked, unless otherwise shown or recommended by manufacturer of pole or structure being anchored.
 - c. Two nuts and one washer for each anchor bolt for plumbing pole or leveling structure.
 - d. Finish: Where exposed, custom finish exposed parts to match surface being fastened.
19. Mounting poles:
 - a. Steel or aluminum, straight or tapered as required. Complete assembly of anchor bolts, pole, arms and luminaire designed to withstand wind pressure (P) developed by wind speed (V) of 80 MPH in accordance with AASHTO LTS-3. Pole assembly to fully comply with AASHTO requirements for permissible stresses, deflection, vibration and fatigue. Ratio of deflection to pole height under action of applicable static loading not to exceed 1/60.¹¹
 - b. Base assembly: Steel base plate, designed to withstand full-bending movement of shaft and welded to shaft; anchor bolts; and base cover.
 - c. Handhole size: As required, with 12-gauge steel sheet coverplate.
 - d. Polygonal-shaped poles fabricated with sharp bends.
 - e. Longitudinally welded with welds continuous and ground smooth.
20. Grout: Section 03300, nonshrink. Where recommended by manufacturer, prime surfaces to be grouted.
21. Concrete base, including forms and reinforcement: Division 3, Sections 03100, 03200, and 03300.
22. Bituminous coating: MS MIL-C-450.
23. Photoelectric control: Section 16145.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install lighting fixtures as follows:
 1. Mount fixtures rigidly in place.
 2. Where aluminum contacts concrete or dissimilar metal, separate contact surfaces with gasket, nonabsorptive tape or bituminous coating to prevent corrosion. Use stainless-steel fasteners.
 3. Mount fixtures plumb, level and in straight lines.
- B. Installation of Pole-Mounted Fixtures:
 1. Prepare and compact that earth foundation for mounting in accordance with Section 02320. Form and reinforce concrete base as required and in accordance with Sections 03100 and 03200. Mix and place concrete in accordance with Section 03300. Use finish Number 2 for exposed surfaces. Use templates for setting anchor bolts.
 2. Install mounting pole at locations determined by design. Use double nuts to erect poles plumb. Pack void between concrete base and pole with grout in accordance with Section 03300.
 3. Install conductors in accordance with Section 16120, leaving three-foot minimum lengths of conductors for fixture connections; tape or otherwise secure in place pending final connection.
 4. Install lighting fixtures in accordance with approved shop drawings.
 5. Connect wiring using connectors in accordance with Section 16125. Tape connections.
 6. Install photoelectric controls as required or in accordance with fixture manufacturer's instructions and in accordance with Section 16145.

7. Ground lighting fixtures and mounting poles in accordance with NEC and Section 16060.
8. Apply touch-up paint where necessary in accordance with Section 09920.

3.02 FIELD QUALITY CONTROL:

- A. Ensure that earth foundation for mounting poles is prepared and compacted in accordance with Section 02320.
- B. Testing:
 1. Furnish necessary personnel and equipment and perform tests and adjustments in the presence of the Authority Representative. Schedule adjustment of exterior installations to occur during hours of darkness.
 2. Test lighting circuits for continuity and operation.
 3. Test fixtures and mounting poles for continuity of grounding system.
 4. Aim and adjust fixtures to provide required distribution pattern.

END OF SECTION

SECTION 16700

SCOPE OF WORK - COMMUNICATIONS

1.01 SUMMARY:

- A. General communications requirements shall include design of the communications systems to support new tracks, new shop facilities, and necessary connections to the operating system and OCC at Greenbelt, Brentwood, and Shady Grove Yards in accordance with WMATA Design Criteria, and WMATA Standard Specification Sections. They shall include procurement of all necessary material, installation, provisions for support and test equipment, initial spares, training of operators and maintenance personnel, provision of as-built drawings, technical manuals and Operations and Maintenance manuals, installation testing, and inspection and punch list correction of the finished system.
- B. The new communications must interface with the existing yard and operating system communications, and must be installed on a not to interfere basis with yard or mainline operations.

1.02 Tasks:

- A. Prepare designs in accordance with WMATA Design Criteria and other contract documents or references:
 - 1. Survey the existing systems at the yard with the understanding that , wherever practicable, the existing systems should be expanded rather than replaced.
 - 2. Provide the specification sections and drawings for the procurement, installation, extension, integration, testing and cut-over of yard communications systems for the new facilities, and for necessary modifications to existing systems. Include provisions for Carrier Transmission System, Fiber Optics System, Yard Public Address System, Talk Back System, Telephone System, Radio System, Fire and Intrusion Alarm System, Closed Circuit Television System, Mobile Radio extension to cover the interior of the new shops, communications power distribution system, control consoles, elevator emergency communications, network facilities, other miscellaneous communications systems as required, and equipment, spares, ancillary equipment, technical documentation, and related items.
 - 3. Provide specification sections and drawings for any necessary modification to the communications systems, and existing yard buildings and other facilities communications.
 - 4. Include any necessary modifications or additions in the Jackson Graham Building communications equipment room.
 - 5. Prepare drawings, specification sections and other information required to fully integrate the systems to be installed in the new facilities for the yards with the already existing systems.
 - 6. Provide conduit requirements including line diagrams, schedules and details as necessary for construction.
 - 7. Develop installation space, HVAC and electrical requirements for the normal and emergency communications in the new shops.
 - 8. Coordinate requirements with other systems and coordinate design with train control, trackwork, elevator, traction power and electrical service power designs.
 - 9. Prepare test procedures and test plans for the integration, cut-over and acceptance of the new communications systems.
- B. Procure required equipment and material:
 - 1. Furnish fiber optic cable, coaxial cable and copper wire as necessary for the various communications items.
 - 2. Furnish all telephone, public address, talk-back, data transmission, carrier transmission, fiber optics, fire alarm, CCTV and other components and equipment

- required for the communications systems.
3. Furnish or update communications system control consoles as required.
4. Furnish -48VDC, 120VAC and other electrical equipment for communications system power.
5. Furnish all test equipment necessary to maintain the communications systems.
6. Furnish initial spares required for maintenance of the new communications systems.

C. Construction:

1. Fabrication and installation of the new and modified portions of the yard communications, including testing, integration, and qualification of all items and sub-systems.
2. The above construction is all encompassing and includes all pertinent related items and appurtenances associated with the communications system.
3. During the renovation process support the demolition, relocation, and restoration of all yard facilities to ensure continuing operation of all critical communications systems.
4. Include in-progress and final inspection of all new or modified communications systems.

D. Acceptance:

1. Provide final integration, cut-over and testing of all new and affected existing communications systems.
2. Conduct Substantial Completion Inspection in conjunction with the Authority's Representative.
3. Correct all punch list items.
4. Provide training to operation and maintenance personnel for the new communications systems.
5. Provide as-built documentation, including manuals and as-built drawings, for all items furnished and installed.
6. Provide as-built updates to support new yard emergency response maps.
7. Provide as-built updates to Gatehouse Data Files.

2.01 Design-Builder RESPONSIBILITIES:

- A. The Design-Builder shall design the communications to support the new S & I shop expansion and renovations to include the systems listed below in updating the communications to support the Greenbelt, Brentwood, and Shady Grove facilities. The Design-Builder shall make all necessary connections so that the new and existing equipment information is relayed back to the Jackson Graham Building without interruption of WMATA's communications systems.

2.02 CARRIER TRANSMISSION SYSTEM

A. General Requirements

1. The Carrier Transmission System (CTS) is an integral part of the WMATA telecommunications network used to multiplex voice and data transmissions of the WMATA Rail Rapid Transit System into a trunked digital carrier. The CTS uses a T1 digital format to transmit trunked information between the CTS hub at the Jackson Graham Building and terminal locations (passenger stations, yards and selected buildings) along the WMATA right-of-way.
2. The principal means of transmitting trunked (T1) information within the WMATA network is Optical Fiber.
3. This Section covers the installation of T1 terminals and/or related equipment in the Yards and the Jackson Graham Building.

4. The Design-Builder shall upgrade the existing Carrier Transmission System as necessary to support the Yard upgrades.
5. The Design-Builder shall only use equipment fully compatible with the existing system. If the existing system can not be expanded, the Design-Builder shall provide for new CTS channel bank design and install between the appropriate Yard and the Jackson Graham Building for voice/data communications.
6. The CTS shall be interfaced to the existing WMATA FOS available at the appropriate main line station, or at the appropriate Yard, as directed by the WMATA Representative .

B. Yard Specific Requirements

1. No major interface to the existing Carrier Transmission System is anticipated as part of this project. The Design-Builder is responsible to survey total requirements to ensure that the existing systems can accommodate all new requirements.

2.03 FIBER OPTIC SYSTEM

A. General Requirements

1. The Fiber-Optics System (FOS) will provide the transmission medium for multiplexed voice and data signal transmissions between the Jackson Graham Building and the Yards. The Carrier Transmission System (CTS) is utilized to multiplex voice and data signals.
2. The Backbone Fiber-Optic System at the relevant Yards is in place and will require no upgrades as part of this program.

B. Yard Specific Requirements

1. No major interface to the existing Carrier Transmission System is anticipated as part of this project. The Design-Builder is responsible to survey total requirements to ensure that the existing systems can accommodate all new requirements

2.04 YARD PUBLIC ADDRESS SYSTEM

A. General Requirements

1. The Public Address System shall provide for announcements to be made in all Yard buildings.
2. The Public Address System shall consist of loudspeakers, including enclosures and baffles, and paging horns. A Telephone Access Paging System, power amplifiers, distribution panels and jack field panels shall be provided in the Communications Equipment Room.
3. The loudspeakers of the Public Address System shall be grouped into individual zones. The Public Address System shall be configured to permit announcements to be made to the speakers in an individual zone, or simultaneously to a combination of any and all zones (ALL PAGE) by dialing the appropriate zone code(s).
4. The Telephone Access Paging System shall accept an audio input from the existing Telephone System and provide the appropriate dialed zone decoding and audio routing of the announcements to the desired zone amplifiers, which provide audio

amplification for announcements to each zone circuit. The audio inputs and outputs of the Telephone Access Paging System shall be connected to a distribution panel.

5. Jack field panels shall provide audio test points for the Public Address System. Each Public Address Loudspeaker circuit shall be wired through a jack field panel to a loudspeaker distribution panel. In addition, the loudspeaker distribution panels shall provide single point ground connections for the Public Address System cabling.
6. The Design-Builder shall upgrade the existing Public Address System if found inadequate to support the new Yard shop facilities, renovations, and relocations.
7. The Design-Builder shall determine how to upgrade the existing Public Address System to provide coverage for the new Yard shop facilities. If the existing system is inadequate to provide coverage the Design-Builder shall use Specification 16823, attached in this RFP as a Reference on the scope of work, installation and example of equipment for procurement.

B. Yard Specific Requirements

1. The requirements for Yard S&I shop Public address System and Telephone Access Paging System are applicable to all Yards in this project.

2.05 YARD TALK BACK SYSTEM

A. General Requirements

1. Provide voice paging from the Yard Communications Console located in the Yard Control Room, to personnel located track side (via nearby loudspeaker/talkback stations) or to the Gatehouse Building console.
2. Provide the ability for track side personnel or Gatehouse personnel to verbally answer a page or signal the Yard Communications console that they want to talk to the Yard dispatcher.
3. Broadcast an emergency tone, originating from the Communications Console, to the loudspeaker/talkback stations located track side.
4. Broadcast an "All Call" verbal message, originating from the Communications Console, to all of the loudspeaker/talkback stations located track side.
5. The Yard Talkback System (also known as the Talkback System) will provide paging and talkback service between the Yard Communications Console located in the Gatehouse and the talkback stations located along the tracks throughout the yard area.
6. The Yard Talkback System includes a master control panel in the Yard Communications Console from which the Yard Dispatcher can call the talkback stations located in the vicinity of track switching points throughout the Yard. This panel gives the dispatcher the ability to select a specific Yard talkback station, to select all talkback stations simultaneously, to broadcast an emergency tone and/or identify and listen to an incoming call from a Yard talkback station.
7. The Yard talkback stations provide trackside personnel with the ability to hear a voice page over loudspeakers (they only have to be in the vicinity of the station, not directly in front of it); the ability to verbally respond by talking toward the loudspeaker(s); or to signal the Yard Communications Console, by pushing a button, when they want to talk to the dispatcher.

B. Yard Specific Requirements

1. There are no plans to upgrade the Yard Talkback System. The Design-Builders responsibility is limited to the repair of collateral damage to the existing system. If additional information is required see Section 16840 of these specifications.

2.06 YARD TELEPHONE SYSTEM

A. General Requirements

1. The Yard Telephone System is part of the WMATA Telecommunications Network. Its purpose is to provide telephone service to WMATA personnel working within the Yard limits.
2. Telephone instruments associated with the Yard Telephone System shall also be capable of accessing the Yard Public Address System.
3. The Yard Telephone System shall provide automatic Dual Tone Multiple Frequency (DTMF) tone telephone service in the Yard S & I shop and other yard facilities. All telephone instruments shall be wired to the existing S&I Shop Communications Room using dedicated CAT 5 cable and tie cables as required. All telephone instruments (with their own station number) shall be cross connected to the appropriate demark point.
4. Digital feature telephone instruments shall be installed in most Yard administrative areas where telephone service is required. In some ancillary structures and shop areas, analog single-line ruggedized wall telephones shall be installed.
5. Analog single line telephone instruments shall be installed in Emergency Trip Station (ETS) enclosures.
6. The Yard Telephone System shall include an interface to the Yard Public Address System. Personnel within the yard shall be able to access and make voice communications over the Yard Public Address System, by dialing a restricted four (4) digit access code.
7. Intercom calling capability will be available between telephone instruments located throughout the yard, via the existing Yard Telephone System. Intercom calls can be expedited by programming telephone extension numbers, which are frequently called, into the memory (auto-dial) feature of telephones equipped with this function.
8. The Design-Builder shall upgrade the existing Yard Telephone System to provide service as required to all new, renovated, or relocated shop facilities.

B. Yard Specific Requirements

1. Greenbelt Yard - The primary Telephone System interface at this location is a ROLM 8000 Satellite PABX located in the existing S&I Shop Communications Room. This PABX will require expansion and all administrative telephone instruments must be digital and compatible with this system.
2. Brentwood Yard - The primary Telephone System interface at this location is a ROLM 8000 Satellite PABX located in the existing S&I Shop Communications Room. It is not anticipated that this PABX will require expansion, however the Design-

Builder must review pre and post renovation service requirements to determine final PABX design. All administrative telephone instruments must be digital and compatible with this system.

3. Shady Grove Yard - The primary Telephone System interface at this location is an Avaya, Inc digital key system. This key system can accommodate limited expansion. The Design-Builder must survey this facility to determine final system requirements. If necessary an additional or replacement digital key system must be provided. All administrative telephone instruments must be digital and compatible with the existing key system.
4. All Yards - At all yards a category 5 data cable must be run with each administrative telephone cable and terminated in dual jack with the telephone cable for LAN/WAN use.

2.07 YARD MOBILE RADIO SYSTEM

1. The Yard Mobile Radio System consists of two subsystems; the Yard Dispatcher's Mobile Radio Subsystem and the Yard Gatehouse Radio Subsystem.
 2. The WMATA Yard Dispatcher's Mobile Radio Subsystem (hereinafter referred to as ("Yard Dispatcher's Radio Subsystem")) shall provide two-way voice communications between a base station and WMATA Yard personnel (with portables), between the base station and transit trains within the confines of the yard and lead track areas.
 3. The WMATA Yard Gatehouse Mobile Radio Subsystem (hereinafter referred to as the ("Yard Gatehouse Radio Subsystem")) shall be used to communicate with the Transit Police and Security network (MTPD) within the yard area on the primary MTPD frequency.
- B. Yard Specific Requirements
1. All Yards - The Design-Builder shall evaluate coverage of the Yard Dispatchers Radio Subsystem in the interior areas of existing, renovated, and new S&I Shop facilities. If necessary the Design-Builder shall provide off-the-air antennas, wide band amplifiers, and antennas within the shop areas to enhance coverage.

2.08 YARD CLOSED CIRCUIT TELEVISION

- A. General Requirements
1. The Closed Circuit Television (CCTV) System consists of two independent CCTV Systems.
 2. The Gatehouse CCTV System shall provide the Gatehouse attendants with surveillance of major parking bays and the yard perimeter. The primary use of this system is for the purpose of surveillance and security.
 3. The Yard Operations Control CCTV System shall provide the Yard Tower attendants with surveillance of interlocking switching track areas. The primary use of this system is to facilitate yard operations.
- B. Yard Specific Requirements
1. Greenbelt Yard - This Yard Tower has an existing CCTV and monitoring capability.

No additional facilities are anticipated as being required under this project.

2. Brentwood Yard - This Yard Tower has an existing CCTV and monitoring capability. No additional facilities are anticipated as being required under this project.
3. Shady Grove Yard - This Yard Tower has no existing CCTV capability. Construction of the new S&I Shop addition will obstruct the attendants view of key interlockings. The Design-Builder shall provide a CCTV System to support yard operations for this Control Room. The system must provide views of all yard interlockings and include PT&Z capability for all cameras. The system shall include monitors, switchers, PT&Z control panel, power supplies, and all other equipment to provide an integrated independent system.
4. No improvements are anticipated for the Gatehouse CCTV System. The Design-Builder is responsible for the repair and restoration due to collateral damage during construction. This responsibility includes the possible obstruction of camera fields of view.

2.09 YARD ELECTRICAL POWER DISTRIBUTION SYSTEM

- A. The Yard Electrical Power Distribution System provides power distribution from the 3-phase, 4-wire, 120/208 VAC, primary power feed, to the Yard communication systems. This system shall be tied in to the S & I shop facilities at all yards.
- B. The Electrical Power Distribution System described herein includes the following facilities:
 1. 110/120 VAC Emergency Power (from existing UPS) for communications equipment in the Yard Operations Building Communications Equipment Room, Bell/ITSV (Data) Room, Yard Control Room and the Gatehouse.
 2. -48 VDC power for communications equipment in the Communications Equipment Room.
- C. The 120 VAC Emergency Power Distribution System described herein includes but is not limited to the following components:
 1. In the Communications Equipment Room;
 - a. Power Distribution Panelboard
 - b. AC Power Receptacles
 - c. AC Power Disconnect Switches
 2. In the Bell/ITSV (Data) Room;
 - a. AC Power Disconnect Switch
 - b. AC Power Receptacles
 3. In the Yard Tower
 - a. AC Power Disconnect Switch
 - b. AC Power Receptacles
 4. In the AC Switchboard Room
 - a. Power Transformer
 5. In the Gatehouse
 - a. Emergency AC Power Disconnect Switch
 - b. Emergency Power Distribution Panelboard
 - c. AC Power Receptacles
 6. In the S & I shop
 - a. AC Power Disconnect Switch
 - b. AC Power Receptacles
 - c. Required conduits and fittings, junction boxes, feeder wires, and branch circuit wiring and cabling to apportion the 120 VAC power to the communications systems and facilities equipment.

- D. The -48 VDC Power Distribution System described herein includes but is not limited to the following components:
 - 1. In the Communications Equipment Room;
 - a. -48 VDC Power Supply
 - b. -48 VDC Power Distribution System Status Panel.
 - 2. The -48 VDC Power Distribution System provides fail safe service by load-sharing several power supplies. Power supplies may be removed from the active -48 VDC Power Distribution System for repair, or added for increased capacity without disrupting communications services.
- E. The Status Panel provides voltage and current metering for the -48 VDC Power Distribution System. The Status Panel also distributes -48 VDC power to the Carrier Transmission (CTS), and Fiber Optic (FOS) Systems equipment racks and, as needed, to any other communications equipment racks requiring a source of -48 VDC powers. The -48 Vdc shall be run and connected to the S & I shop communications room.
- F. Yard Specific Requirements
 - 1. The Design-Builder shall determine the additional electrical loads at each yard location and add or reconfigure power distribution equipment to accommodate the communications system expansions and additions.

2.10 YARD CONSOLES

- A. General Requirements
 - 1. All WMATA yards have a Communications Console in the yard Gatehouse and the YardTower.
- B. Yard Specific Requirements
 - 1. At Greenbelt and Brentwood Yards no Communications Console modifications or upgrades are anticipated under this project.
 - 2. At Shady Grove the Design-Builder will be responsible for integrating the Yard Operations Control CCTV System controls into the existing Yard Tower Console.

2.11 YARD FIRE ALARM SYSTEM

- A. General Requirements
 - 1. The Design-Builder shall expand the existing Yard Fire Alarm systems as necessary to support the coverage of the new and renovated S & I shop facilities in accordance with all applicable codes and regulations. The reporting features shall be displayed in the Gatehouse, Yard Control Room, and the Jackson Graham Building. Where expansion is impracticable, the expansion area shall be covered as necessary by a new Fire Alarm system.
 - 2. Yard Intrusion Alarms at all yards has recently been updated by WMATA and is now an independent system from the Fire Alarm System. All new intrusion detection or access control must interface to this system.
 - 3. Each S&I Shop location must have a new or updated Graphic Annunciator Panel showing all zones in that facility.
 - 4. The Design-Builder is responsible for coordination with the appropriate local jurisdiction for approvals and occupancy permits. Submittals to local jurisdictions for

approval must be reviewed by WMATA prior to submission.

B. Yard Specific Requirements

1. Greenbelt Yard - The new S&I Shop at this yard will require a new Fire Alarm system and Graphic Annunciator Panel. This system shall provide a summary alarm to one of the zone modules of the existing Kiddie 1000 Fire Alarm Panel located in the communications room of the existing S&I shop. This will fulfill the requirement for reporting to the Gatehouse, Control Room, and Jackson Graham Building.
2. Brentwood Yard - This facility will require the rezoning and rewiring necessary to support the renovations of existing yard facilities. Fire Alarm System capacity should not be an issue at this facility.
3. Shady Grove Yard - This facility is served by a Kiddie 1000 Fire Alarm System that is presently utilized at full capacity. The new S&I Shop Addition will require a new Fire Alarm System. The Design-Builder will also be required to provide rezoning and rewiring necessary to support renovations within the existing S&I Shop. If a zone can be freed in the Kiddie 1000 Panel during this process, then connecting the new system to this zone will fulfill reporting requirements to the Gatehouse, Control Room, and Jackson Graham Building.
4. All Yards - A new Intrusion System has recently been installed in all yards which includes Edwards EST -3 panels. The Design - Builder may wish to consider integrating the Fire Alarm System upgrades into this panel subject to the Authority Representative's approval.

2.12 DATA COMMUNICATION SYSTEM

A. General Requirements

1. The Yard Data Communications System is part of the WMATA computer network. Its purpose is to accommodate present and long term requirements of WMATA Information Technology Services (ITSV) for the transmission of digital data between WMATA facilities. Initially, ITSV requires the transmission of data between the existing Mainframe computer in the Jackson Graham Building, and Terminals and Personal Computers to be installed by others in the Yard Buildings.

B. Yard Specific Requirements

1. Greenbelt Yard - At this yard the Data Communication System will require a multi-fiber tie cable(s) from the new S&I Shop to the yard Operations Building communications room. This cable(s) shall include a minimum of 18 multi-mode and 6 single mode fibers. Routing shall be to the existing S&I Shop communications room. Fiber termination equipment and SC patch panels shall be provided and installed in the Communications Room at both locations. The new cable(s) is to remain un-terminated with 100 feet coiled in each Communications Room. In the new S&I Shop the Design-Builder shall run and terminate in wall jacks and patch panels CAT 5 data cable to all administrative telephone locations and other selected locations within the shop area. In addition the Design-Builder shall support the moves and changes required during renovation of existing S&I Shop facilities.
2. Brentwood Yard - The effort at this location will primarily involve support and restoration of Data Communications during the S&I Shop renovation process. CAT 5 cable shall be run to all administrative telephone locations and be terminated in wall jacks and patch panels.

3. Shady Grove Yard - At this location the Design-Builder must provide new CAT 5 cable distribution and termination to support the new S&I Shop additions. CAT 5 cable shall be run to all administrative telephone locations and be terminated in wall jacks and patch panels.

3.0 MAJOR ITEMS ESTIMATED QUANTITIES:

- A. The Design-Builder is responsible for determining the actual quantities of communications system major items, components and cabling. Major items shall be interpreted to include incidental items, not specifically mentioned, but required for complete and proper system operation.

3.01 CARRIER TRANSMISSION SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
Major Interface	NONE	NONE	NONE

3.02 FIBER OPTIC SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
Major Interface to Backbone System	NONE	NONE	NONE

3.03 YARD PUBLIC ADDRESS SYSTEM

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
Telephone Access Page System	1ea	NONE	1ea
Power Amplifier	3ea	NONE	3ea
Paging Horn	60ea	NONE	70ea
Recessed and Surface Loudspeakers	55ea	NONE	40ea
Jackfield, Distribution Panel, and Terminal Blocks	As Required	NONE	As Required
Moves and Changes (Existing Facilities)	30	50	20

3.04 YARD TALK BACK SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
New Stations	NONE	NONE	NONE

3.05 YARD TELEPHONE SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
PABX or Key System Expansion Cards	As Required	NONE	As Required
Rugged Telephone Instruments	10ea	NONE	18ea
Digital Feature Telephone Wall Phone	25ea	NONE	15ea
Digital Feature Telephone Desk	30ea	NONE	15ea
Digital Full Feature Desk Telephone	5ea	NONE	5ea
ETS Telephone	NONE	NONE	NONE
Misc Terminal Blocks, Jacks, Cabling etc.	As Required	As Required	As Required
Moves and Changes (Existing Facilities)	20	40	15

3.06 YARD MOBILE RADIO SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
External Antenna	1ea	NONE	1ea
Internal Antenna	2ea	NONE	2ea
Bi-Directional Line Amplifier	1ea	NONE	1ea
Coax	As Required	NONE	As Required

3.07 YARD ELECTRICAL POWER DISTRIBUTION SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
Support New and Relocated Systems	As Required	As Required	As Required

3.08 YARD COMMUNICATIONS CONSOLES:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
GATEHOUSE	NONE	NONE	NONE
YARD CONTROL ROOM	NONE	NONE	NONE

3.09 YARD FIRE AND INTRUSION SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
New and Relocated Systems	As Required by Code	As Required by Code	As Required by Code

3.10 DATA COMMUNICATION SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
Administrative Data Jacks	40ea	NONE	35ea
Moves and Changes (Existing Facilities)	10	15	5
Fiber Optic Tie Cable	NONE	NONE	1ea

3.11 YARD CLOSED CIRCUIT TELEVISION SYSTEM:

ITEM DESCRIPTION	GREENBELT YARD	BRENTWOOD YARD	SHADY GROVE YARD
PT&Z Cameras	NONE	NONE	4ea
CCTV Monitor	NONE	NONE	3ea
Video Switcher/ Control System	NONE	NONE	1ea
Camera Power Distribution Panel	NONE	NONE	1ea

END OF SECTION

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SECTION 16701

DEFINITIONS OF COMMUNICATION SYSTEM TERMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Standard Definitions
 - 1. Definitions pertaining to the communication design and equipment description shall conform to the standard definitions promulgated by the following organizations unless otherwise specified in this Section (16701)
 - a. Current versions of the Association of American Railroads (AAR)
 - b. Electronic Industries Alliance (EIA)
 - c. The Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 - d. The National Fire Prevention Association (NFPA)
 - e. Local and state building and fire procedure codes not superseded by provision of the "Fire Protection Equipment and Life Safety Agreements" executed between WMATA and local jurisdictions.

- B. Order of Priority
 - 1. Where definitions conflict, the order of priority shall be:
 - a. Definitions of Communications Systems Terms (Section 16701)
 - b. Current versions of the Association of American Railroads (AAR);
 - c. EIA;
 - d. IEEE.
 - e. NFPA

- C. Glossary of Communication Terms Used in These Communication Specifications

1.01 RELATED SECTIONS

All Sections in the 16700 and 16800 Series.

1.02 REFERENCES

- A. Current versions of the Association of American Railroads (AAR)
- B. Electronic Industries Alliance (EIA)
- C. The Institute of Electrical and Electronics Engineers, Inc. (IEEE)
- B. "Fire Protection Equipment and Life Safety Agreements" executed between WMATA and local jurisdictions

1.04 GLOSSARY OF COMMUNICATION TERMS

Words, terms, and phrases used in these Communication System Specifications are defined as follows:

AAR:

Association of American Railroads
50 F Street, N.W.
Washington, D.C. 20001-1564

Absorption Losses:

(Fiber Optics) Reduction in light amplitude or strength caused by impurities in the optical fiber and by the scattering of light from the optical fiber.

AC Service Room:

Room housing equipment and facilities for the distribution of ac power throughout an installation such as a passenger station or shop building.

Alarm:

An alerting signal indicating an abnormal condition.

Alphanumeric:

Alphabetic and numeric representation, letters, numbers, and symbols.

Amplitude Modulation (AM):

The process of varying the amplitude of a carrier wave in accordance with the instantaneous value of a modulating signal.

Ambient:

Typical of the environment. Specifically used to designate properties of the surroundings which are measurable and distinguishable from absolute zero energy levels.

Angstrom:

(Fiber Optics) A unit of optical wavelength historically used in the field of optics, but not an International System unit. 1 Angstrom=0.1 nanometer.

American Standard Code for Information Interchange (ASCII):

Consists of 10 or 11 bits per character - one start bit, seven information bits, one parity bit, one or two stop bits.

Ancillary Building:

A room, area or structure which is not considered typical to all Metrorail passenger stations.

Annunciator:

An audible signaling device which usually includes signal lights, each one indicating the conditions that exist or have existed in an associated circuit.

ANSI:

American National Standards Institute
1819 L Street, NW
Suite 600
Washington, DC 20036

Armored Cable:

A cable provided with a wrapping of metal primarily for the purpose of mechanical protection. The armor is sometimes used as an electrical shield.

ASTM:

American Society for Testing and Materials
100 Barr Harbor Drive
West Conshohocken, Pennsylvania 19428-2959

At-Grade:

That portion of the system which is constructed at the approximate elevation of the adjacent ground surface.

Attenuation:

1. A decrease in the amplitude of a signal as it travels along or through a transmission medium, usually expressed as a ratio or in dB.
2. (Fiber Optics) A measure of the decrease in energy transmission (loss of light) expressed in dB/km. In optical waveguides it is primarily due to absorption losses and scattering losses.

Attenuation Distortion:

Distortion caused by the non-uniform attenuation or gain of a system, with respect to frequency, under specified terminal conditions.

Audio Frequency:

Frequency range approximately equal to 15 Hz to 20,000 Hz (i.e. frequencies typically audible by human ears).

Authority, The:

Washington Metropolitan Area Transit Authority (WMATA).

(The) Authority Representative

Wherever, on the Information Drawings or in the Specifications, the term "Authority Representative" is used, it shall mean the duly authorized representative of the Contracting Officer.

Auto Scan:

The automatic scan of the TV cameras in the horizontal (pan) plane.

Automatic Fare Collection (AFC):

Computer controlled system for the collection of fares, control of access, and associated functions.

Automatic Frequency Control (AFC):

Means whereby the frequency of a circuit is automatically maintained, within specified limits, with respect to a reference frequency.

Avalanche Photodiode (APD):

(Fiber Optics) One type of receiver or detector used in the receiving portion of Fiber-Optics terminals or repeaters. It is called a detector or receiver, since it detects and converts the light signal to a copy of the original electrical signal.

Bandwidth:

1. Limiting frequencies between which the performance of a device or system falls within specified limits.
2. (Fiber Optics) The capacity of an optical fiber to transmit information, expressed in bits of information transmitted per specific time period for a specific length of optical waveguide. Bandwidth is limited by pulse spreading or broadening due to dispersion, so that adjacent pulses overlap and cannot be distinguished.

Ballast:

1. Crushed rock or stones placed between, under, and at the ends of railroad ties.
2. (Electronics) A device utilized to limit current flow.

Battery:

An assembly of cells electrically connected for producing electric energy. In telephone systems, it usually refers to centralized dc source, located in the central office, nominally -48 volts.

Baud:

1. Unit of signaling speed equal to the number of discrete signal events per second.
2. Binary Coded Decimal (BCD)
3. A notation in which each individual decimal digit is represented by a pattern of "ones" and "zeros."

Bit:

A binary digit, 0 or 1 in number representation, with the radix 2.

Bus:

A conductor, or group of conductors, that serve as a common connection for two or more circuits.

Cable Binder:

A wrapping of tapes or cords around several conductors of a multiconductor cable used to hold them together which may be color coded to designate the group of conductors enclosed.

Cable Tray:

1. A tray or rack used for the installation and support of cable.
2. Cable Trough
3. A trough used for the installation, support, and protection of cable.

Call:

The act of establishing and completing a telephone connection from one telephone instrument to another.

Called Party:

The telephone instrument at the "distant end" being called.

Calling Party:

The telephone instrument that originates the call.

Cardioid (Pattern):

A heart-shaped pattern obtained as a response or radiation characteristic of certain directional antennas, or as the response characteristic of certain types of microphones.

Cassette:

A small reel-to-reel tape magazine on which is recorded analog or digital information.

Cassette Recorder:

A tape recorder used to record or playback cassettes.

CCS:

Hundred-Call-Seconds - A measure of communications traffic equal to one hundred seconds of communicating. In practice, "CCS" is used for hundred call seconds per hour.

Central Office:

Equipment in a telephone system that provides centralized switching, battery, and supervision for a group of subscribers or terminals (i.e. a Main PABX or Satellite PABX Equipment Room).

Channel:

A path for transmitting electrical signals.

Character:

A combination of bits denoting a specific alphanumeric symbol.

Chromatic or Material Dispersion:

(Fiber Optics) This refers to "colors" or wavelengths in a lightwave source. Light rays with different wavelengths travel along a fiber at different speeds. The broader the range of wavelengths emitted, the more light pulse will spread as it traverses the length of the fiber.

Circuit:

1. A conductor or system of conductors through which an electric current is intended to flow.
2. A network providing one or more closed paths.

Cladding:

(Fiber Optics) The low refractive index material which surrounds the core of the fiber and protects against surface contaminant scattering. The cladding may be glass or clear plastic. In interoffice telecommunication systems, glass cladding is used.

C-Message Weighting:

Noise weighting used in a noise measuring set to simulate use of the Type 500 telephone (which has characteristics that are typical of most modern telephone instruments in commercial use in this Metropolitan area).

Combined Distribution Frame (CDF):

A distribution frame which, in addition to the functions of an MDF, provides for the cross-connection of the PABX subscriber line multiple and the subscriber line circuits.

Command Message:

Digital message transmitted from the Mobile Radio System control console to base stations to query status or to direct action.

Command Message Enable:

Message used to cause selected base station(s) to be ready for two-way voice operation.

Command Message Station Connect:

Message used to restore a base station(s) to service in the system in a quiescent mode with its receiver in a monitoring condition with squelch operating.

Command Message Station Disconnect:

Message used to intentionally remove a base station(s) from service in the system.

Commercial Telephone Network:

The public telephone system. In the WMATA area, usually Bell Atlantic for local public network and special services cable connections.

Communications Equipment Room:

Room housing centralized communications equipment for an installation such as a Metrorail passenger station or yard.

Communications Ground:

An earth ground connection of 5 ohms or less resistance that is provided in the Communications Equipment Room in each passenger station and yard for the sole purpose

of grounding communications equipment. The Communications Ground in the Communications Equipment Room at Jackson Graham Building has a resistance of 1 ohm or less to earth.

Compondor:

A combination of a compressor at one point in a communications path for reducing the amplitude range of signals followed by an expander at another point for a complementary increase in the amplitude range. The purpose is to improve the ratio of the signal to the interference entering the path between the compressor and the expander.

Compartmental Cable:

A multiconductor cable with its core divided into two compartments, a transmit section and a receive section, which are separated by an insulated metallic divider.

Conduit:

A tube-like structure for electrical wires or cables. Conduit may be either rigid or flexible, metallic or non-metallic, as specified.

Conduit Stub Out:

A short length of conduit that is joined as a branch to a conduit run and, as used in these Specifications, is the termination of a conduit run.

Console:

A panel or cabinet on which are mounted switches or lamps for use by a human operator in monitoring and controlling equipment and functions.

Contact Rail:

A bus bar alongside a track that carries electric energy for the propulsion of trains.

Core:

(Fiber Optics) The light conducting portion of the optical fiber, defined by the high refractive index region. The core is normally in the center of the optical fiber, bounded by the cladding material.

Coverage:

Inclusion within the range of a communications device, equipment unit, system or medium.

Crosstalk:

Undesired signal coupling between two different communications channels or signal components.

Data Acquisition and Display System (DADS):

A system for the collection, recording, consolidation, and display of fare collection data at the passenger stations.

Enhanced Data Acquisition and Display System (EDADS):

An upgraded version of the DADS System.

Data Transmission System (DTS):

The bi-directional, non-vital digital communications system between Central Control and the Train Control Room. The DTS utilizes a channel of the CTS as a transmission medium.

Decibel (dB):

1. Unit used to express the ratio between two amounts of electrical power, P₁ and P₂, defined as:

$$\text{dB} = 10 \log_{10} \frac{P_1}{P_2}$$

2. Also used to express voltage and current ratios, defined as: (Voltages and currents must be measured with identical impedances.)

$$\text{dB} = 20 \text{Log}_{10} \frac{V_1}{V_2} = 20 \text{Log}_{10} \frac{I_1}{I_2}$$

3. Also used to express intensity of sound; defined as equal to 20 times the common logarithm of the ratio of the sound pressure of a wave to a reference pressure of 0.0002 dyne per square centimeter.

dBm:

Measure of absolute electrical power in decibels referred to one milliwatt.

dBm0:

A measure of power, with reference to zero dBm, at the reference transmission level point (RTLTP).

dBnc0:

A measure of noise power in dB above one picowatt measured with a C-message weighting network referred to or measured at an RTLTP.

Delay Distortion:

Distortion caused by differences in transit time for different frequencies within a specified system bandwidth.

(The) Design-Builder:

1. The person, partnership, corporation, or joint venture that is awarded the prime contract to complete the design and provide the facilities, equipment, and installations described in these Specifications. The usage of this term in these Specifications also includes subcontractors, suppliers, vendors, and employees thereof, except as otherwise stated (subject at all times to the Contractor's responsibility therefore).
 2. The person or company who is awarded a contract to complete the design and provide all the facilities, equipment, and installations described in these Specifications.
- Desk Telephone:
A telephone instrument designed for desk top use.

Detector:

A device used to sense a particular condition - smoke, temperature, open circuit, received signal, etc.

Dial:

Normally, a face plate which has been graduated into arbitrary units. As a special case, in telephony, the hand operated device used to generate pulses or tones for establishing connections over a telephone switching system.

Dialing:

The act of operating a dial - specifically, a telephone dial. As used in this document, includes the act of operating a telephone instrument "touchtone" pad.

Diode Auctioneering:

A method of obtaining redundancy in use of power supplies by utilizing diode coupling from each power supply to a common load.

Direct Burial:

A method of installing cable underground, not in conduit or duct, in such a manner that it cannot be removed without disturbing the soil.

Dry Contact:

An electrical contact through which no direct current flows.

Duct Bank:

An arrangement of conduit providing more than one duct to accommodate and protect cables between two points.

DTMF:

Dual Tone Multifrequency audio signaling scheme utilized as the standard subscriber line tone signaling method in the USA. Also known as Touch-tone dialing, which is a copyrighted Bell Telephone Company term for such signaling. (Utilized for some other remote control devices also.)

Duplex:

Type of operation that permits simultaneous communications in both directions.

EIA:

Electronic Industries Alliance
2500 Wilson Boulevard
Arlington, Virginia 22201

E&M Signaling:

A signaling system characterized by the use of separate paths for the signaling and voice signals. The M lead transmits battery or ground to the distant end of the circuit while incoming signals are received as ground or open on the E lead.

E&M Trunk:

An audio trunk circuit utilizing E&M signaling.

Electro-Mechanical:

An electrical device with moving parts.

Elevated:

That portion of the Metrorail System which is constructed above the adjacent ground surface.

Emergency Power:

Electrical power provided to operate essential equipment during periods of failure of primary power source.

Emergency Trip Station (ETS):

An enclosure containing an emergency telephone and an electric switch to de-energize a section of the contact rail.

ETS Telephone:

An emergency telephone generally located along Metrorail R.O.W. and collocated with or enclosed in Emergency Trip Station boxes in most instances.

(The) Engineer:

Wherever, on the Information or Contract Drawings or in the Specifications, the term "Engineer" is used, it shall mean the "Authority Representative" or other duly authorized representative of the Contracting Officer.

Engineering Services:

Engineering Service to be provided, as detailed in Article 3.1, Article 3.20, and as required elsewhere in these Specifications and Contract Drawings.

Entrance Escalator:

Escalator from street level to a passenger station.

Environment:

The universe within which the system must operate, the elements over which the designer has no control.

Error Rate:

The ratio of the number of characters of a message(s) received incorrectly to the total number of characters of the message(s) received.

Factory Test:

Test of equipment at the manufacturer's plant.

Failure:

An inability to perform an intended function.

Fare Gates:

Gate in stations through which passengers pass separating FREE (UNPAID) and PAID areas.

FCC:

Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554

Fiber Buffer:

(Fiber Optics) A material that may be used to protect an optical fiber from physical damage, thus providing mechanical isolation and/or protection.

Fiber Bundle:

(Fiber Optics) In a fiber optics cable, a group of parallel optical fibers over which a loose-fitting jacket (fiber buffer) has been extruded. (As used in "loose tube" type fiber optic cables, for example).

Fiber Optics:

(Fiber Optics) The branch of optical technology concerned with the transmission of radiant power through fibers made of transparent materials such as glass, fused silica, or plastic.

Fiber Optics Cable:

A cable made up of several optical fibers incorporated into an assembly of organic materials arranged for providing the necessary tensile strength, external protection, and handling properties. (Communications cables usually utilize "loose tube" or "open channel" type internal construction.)

Fire Zone:

A portion of a building, installation or area designated for fire detection by a specific circuit.

Flutter:

Cyclic deviation of signaling power (with a period in the neighborhood of 10 Hz for audio, for example).

Foot Lambert (fl):

The amount of light energy reflected from an object or scene equal to the product of illumination in footcandles and the luminous reflectance of the object or scene.

4-Wire Terminating Set:

A hybrid set for interconnecting a four-wire and a two-wire circuit (usually refers to audio frequency devices).

Free (Unpaid) Area:

Area of passenger station to which public has access prior to passing through fare gates.

Frequency Modulation (FM):

The process of varying the instantaneous frequency of a sine wave carrier by an amount proportional to the instantaneous value of a modulating signal.

Frequency Response:

The measure of effectiveness with which a circuit or device receives or transmits a range of frequencies.

Frequency Shift Keying (FSK):

The form of frequency modulation in which the modulating wave shifts the output frequency between predetermined values, and the output wave has no phase discontinuity (usually accomplished at audio frequencies).

Fuse:

An overcurrent protective device with a circuit-opening part that is heated and severed by the passage of overcurrent through it.

Fuse Alarm:

A circuit which produces a visual or audible signal to indicate a blown fuse.

Fusion Splice:

(Fiber Optics) A splice accomplished by the application of localized heat sufficient to fuse or melt the ends of two lengths of optical fiber, forming a continuous, single fiber.

Gallery Place:

A Metrorail passenger station located at the junction of Routes B, E, and F, which is a secondary hub of the WMATA Rail Rapid Transit System.

Gatehouse:

A building at the entrance to a Metrorail train yard, from which control of pedestrian and vehicular (other than trains) access to the yard is exercised.

Graded-Index:

(Fiber Optics) An optical fiber type wherein the core refractive index decreases almost parabolically radially outward toward the cladding. This type of fiber combines high-bandwidth capacity with moderately high coupling efficiency.

Ground:

A conducting connection, whether intentional or accidental, by which an electric circuit or equipment is connected to the earth, or to some conducting body of relatively large extent that serves in place of the earth. A common return to a point of zero potential. (Intentional grounding for WMATA projects providing low resistance current return paths to the earth.)

Half Duplex:

A method of operation in which two-way communication is possible, but only one way at a time.

Handset/Speaker Station:

A self-contained terminal station of the paging-intercom subsystem of the Yard Public Address System.

Hardware:

Physical entities such as computers, equipment, and instruments. Also parts made of metal such as fasteners, straps, clamps, and anchors.

Harmonic Distortion:

Non-linear distortion of a system or transducer characterized by the appearance in the output of harmonics, other than the fundamental component, when the input wave is sinusoidal.

Hertz (Hz):

Unit of frequency equal to one cycle per second.

ICEA:

Insulated Cable Engineers Association
PO Box 440
South Yarmouth, Massachusetts 02664

Identifying Digits:

Alphanumeric digits that identify each passenger station and yard.

Idle:

In communications systems, indicates a circuit, device or system is not in active use (i.e. in the quiescent state).

Idle Noise:

That noise which is inherent in a circuit or device and is not contingent upon modulation.

IEEE:

Institute of Electrical and Electronics Engineers, Inc.
345 East 74th Street
New York, N.Y. 10017

Impedance:

The opposition in an electrical circuit to the flow of alternating current.

Impulse Noise:

Noise characterized by transient disturbances separated in time by quiescent intervals.

Inbound Track:

Track that is normally used by trains traveling toward Metro Center passenger station in the A, B, C, D, G, and K routes; and towards the Gallery Place passenger station in the E, F, and L routes.

Incident Scene Illumination:

The amount of light expressed in foot-candles which is actually falling on an object.

Index of Refraction:

(Fiber Optics) The relative index of refraction is a fraction or ratio of the velocity of light in one medium, compared to the velocity of light in another medium.

Infrared:

(Fiber Optics) The region of the electromagnetic spectrum between the long-wavelength of the visible spectrum (about 750nm) and the shortest microwaves (about 1300nm). Infrared is used extensively in the transmission of light through optical waveguides.

Injection Laser Diode:

(Fiber Optics) A laser employing a forward-biased semiconductor junction as the active medium. Light is emitted from the diode edge.

Insertion Loss:

The loss resulting from the insertion of a transducer or other device in a transmission system.

Install:

When used in these Specifications, the verb install shall signify that the Contractor shall furnish, install, and test the equipment and materials specified, unless specifically indicated differently in the text.

Interface:

A shared boundary. The interconnection between two pieces of equipment or systems/facilities.

Interlocking:

An arrangement of signals and signal appliances interconnected so that their operations must succeed each other in proper sequence, thereby permitting train movements over controlled routes, only if safe conditions exist.

Intermodulation Noise:

That noise which is contingent upon modulation and results from any non-linear characteristic in the path or device.

Interphone:

Equipment used to provide telephone communications between personnel at various locations within a defined space. As used in these Specifications, provides communications between the Station Manager in the Kiosk and the public.

Intrusion Zone:

A portion of a building, installation or an area designated for detection of intrusion by a specific circuit.

Jacket:

A thermoplastic or thermosetting covering, sometimes fabric reinforced, applied over the insulation, core, metallic sheath or armor of a cable.

Jackfield:

An arrangement of telephone jacks, usually grouped on a mounting strip, to provide convenient access to lines and equipment for testing.

Joint Electron Device Engineering Council (JEDEC):

Cooperative effort of Electronic Industries Alliance (EIA) and National Electrical Manufacturers Association (NEMA).

Key Telephone System (KTS):

Assemblage of telephone relay or electronic equipment which provides switching and control of telephone service within a localized area. KTS equipment is differentiated from PABX equipment primarily by more limited switching functions. Insofar as external telephone trunks are concerned, KTS equipment is generally limited to applications requiring less than 100 subscriber lines and the provision of service that is generally limited to a single building or area of a building.

Kiosk:

A booth-like structure within Metrorail passenger stations which contains station monitoring and control facilities and from which an attendant may provide information and assistance to passengers.

Laser:

(Fiber Optics) A device that produces optical radiation using population inversion to provide Light Amplification by Stimulated Emission of Radiation and (generally) an optical resonant cavity to provide positive feedback.

Light Emitting Diode (LED):

A pn junction semiconductor device that emits incoherent optical radiation when biased in the forward direction.

Main Distribution Frame (MDF):

Provides for the termination and cross connection of outside lines entering a building, including electrical protection devices, internal subscriber lines, and terminal equipment.

Manhole:

A subsurface chamber or opening in the route of a conduit or duct run that provides facilities for splicing, testing, and maintaining cables and conductors.

Manual Pull Box:

Specifically refers to FIRE alarm switch which, when operated manually, initiates a FIRE alarm.

MDF/Protector Cabinet:

Specifically refers to a cabinet located in passenger stations and yard buildings containing MDF and cable protection facilities.

Major Items:

Major Items are defined as items listed in Estimated Quantities Tables 3.1-X.X.

Mechanical Splice:

(Fiber Optics) An optical fiber splice accomplished by fixtures or materials, rather than by thermal fusion. Index matching material may be applied between the two fiber ends.

Metro Center:

A Metrorail passenger station located at the junction of routes A, B, C, and D which is the major hub of the WMATA Rail Rapid Transit System.

Microbar:

Unit of pressure equal to one dyne per square centimeter.

Millisecond (ms):

A unit of time equal to one one-thousandth of a second.

Mobile Radio Unit:

A radio transmitter/receiver designed for installation in a vehicle or train.

Modal Dispersion:

(Fiber Optics) The component of pulse spreading caused by differential optical path lengths in a multimode fiber.

Modem:

A modulator and demodulator housed in a common assembly.

Multi-Mode Fiber:

(Fiber Optics) An optical fiber that will allow more than one mode to propagate. May be either a graded index or step index configuration.

Multiline Telephone:

A telephone instrument with the capability of being connected to more than one line.

Multiplexer (MUX):

A device which combines several inputs into a single output.

Muting:

The action of reducing a sound level.

NEMA:

National Electrical Manufacturers Association
1300 North 17th Street
Suite 1847
Rosslyn, Virginia 22209

Noise:

Any undesired, interfering signal contained in a communications channel or circuit.

Noise Weighting:

An amplitude-frequency characteristic of a noise measuring set. C-Message weighting is so designed as to give numerical readings which approximate the amount of transmission impairment, due to noise, that an average listener experiences using a specific commonly utilized modern class of telephone subset. "Flat" weighting and other wideband weighting may be utilized to measure noise on data channels. Meters designed to measure ambient noise (environmental) utilize other weighting networks (to obtain readings in dBa, for example).

Numerical Aperture:

(Fiber Optics) Measure of light acceptance of an optical fiber.

OCC:

Operations Control Center (now in the Jackson Graham Building which was previously designated as the OCC Building - OCCB on some WMATA documentation). The operational center for the WMATA Metrorail and Metrobus systems (includes centralized operations and communications functions). Also known as Central Control and Command Center.

OCCS:

Operations Control Center - Security. Usually refers to the consoles in the Security Center for the WMATA system.

Off-Hook:

A telephone line condition or the signal indicating that the circuit is in use (i.e., the handset is off its switch-hook).

Omni-Directional:

1. (Antenna) An antenna having essentially non-directional pattern in azimuth but that may have a directional pattern in elevation in many instances.
1. (Microphone) A microphone, the response of which is essentially independent of the direction of sound input.

On-Hook:

A telephone line condition or the signal indicating that the circuit is idle - not in use.

On-Site Test:

Test of equipment or system after installation in its operational location.

Open:

A break or discontinuity in a circuit which normally passes a current.

Optical Fiber:

(Fiber Optics) Any filament or fiber, made of dielectric material, that guides light.

Outbound Track:

Track normally used by trains traveling away from Metro Center passenger station in the A, B, C, D, G, and K routes, and away from Gallery Place passenger station in the E, F, and L routes.

Override:

A communications trunk feature whereby one call has a greater priority of using a common facility over another call.

PABX:

A designation used in the national telephone system to denote a privately owned telephone switching center which operates by the use of dialing (i.e. Private Automatic Branch Exchange). PABXs can be differentiated from KTS systems by their generally more extensive trunk and remote line switching capability, and by the fact that they generally handle 60 or more subscriber lines.

PABX Extension:

A telephone instrument connected to a PABX.

PAID Area:

Area of passenger station to which the passengers have access after passing through fare gates.

Paging-Intercom:

A system which provides for public address type paging and telephone type intercom service.

Parity:

Used in digital code formats for self-checking in which the total number of 1s or 0s in an acceptable code is always odd or always even, depending on whether an odd or even parity check is used.

Passenger Station:

A location which provides the public access to the WMATA Rail Rapid Transit System (Metrorail System). Provides facilities for payment of fares, train information, entrance and exit of passengers.

Phase Modulation (PM):

The process of varying the angle of a carrier from its reference value by an amount proportional to the instantaneous value of a modulating signal.

Pin Photodiode:

(Fiber Optics) A diode with a large intrinsic region sandwiched between p-doped and n-doped semiconducting regions. A commonly used detector or receiver in fiber systems.

Plug-In Unit:

A communications device so designed that connections to the device may be completed through pins, plugs, jacks, sockets, receptacles or other forms of ready connectors.

Portable Radio:

A radio transmitter/receiver designed to be carried by or on a person.

Power Distribution Panel:

A facility which provides for the distribution of power circuits and overload protection for those circuits.

Power Supply:

A unit for converting power from an ac or dc source into ac or dc power at voltages suitable for supplying power to equipment.

Pre-empt:

A communications trunk feature whereby one call takes a common trunk facility away from another call.

Primary Cable:

Specifically refers to the normally on-line cable of the dual redundant communications cable facility of the Fiber Optics/Carrier Transmission Systems.

Protection Tube:

An expulsion arrester or glow-discharge cold cathode tube that employs a low-voltage breakdown between two or more electrodes to protect circuits against over-voltage.

Pulse Dispersion:

(Fiber Optics) The separation or spreading of the input characteristics of the optical signal that appears along the length of the optical fiber and limits the useful transmission bandwidth of the fiber. Expressed in time and distance as nanoseconds per kilometer. Three basic mechanisms for dispersion are the material effect, the waveguide effect, and the multimode effect.

PT&Z Camera(Pan, Tilt, Zoom):

A television camera with facility for remote control of azimuth, elevation, and zoom.

Public Address System:

A system which provides transmission, amplification, and reproduction of speech with high communications band fidelity and sufficient power to make sound simultaneously available, and fully intelligible, to large numbers of people.

Pulse Code Modulation (PCM):

A modulation process involving the conversion of a wave form from analog to digital by means of coding. Usually a form of pulse modulation in which a code is used to represent quantized values of instantaneous samples of the signal waves.

Push-To-Talk (Operation):

Voice communications on a circuit in one direction at a time requiring activation of a switch prior to and during transmission.

Quench:

An action whereby an active circuit is stifled or inhibited.

Radio Base Station:

A complete assemblage of equipment for radio transmission and reception including antenna(s) and control devices or interfacing equipment accommodating remote control devices.

Rail Rapid Transit System:

The portion of the WMATA transportation system that is a third-rail electrified system, as distinguished from the motor bus operations.

Rapid Battery Charger:

Electrical device used for rapidly charging storage batteries.

Redundancy :

The existence in a system of more than one means of accomplishing a given function, for the purpose of increasing security or reliability.

Reliability :

The probability of performing a specified function, without failure and within design parameters, for the period of time intended under actual operating conditions.

Redundant Cable:

Specifically refers to the secondary cable of the dual cable facility of the Fiber Optic/Carrier Transmission Systems.

Reference Transmission Level Point (RTLTP):

In a communications system it is an arbitrarily chosen point to which the levels at all other points in the system are referenced. It is frequently the input to the 2-wire side of the 2-wire/4-wire terminating set at the transmitting end of a telephone channel.

Remote Building:

An area or structure (frequently containing support equipment, such as: Fan shafts, chiller plants, substations, and tie breaker stations) generally within or along the WMATA right-of-way, but not part of a passenger station or yard. Remote buildings may also include MRS Two-Way Line Drivers, Fire and/or Intrusions alarm detectors, wayside telephones, etc.

Relay Contact Types:

1. FORM-A: SPNO (Single-Pole, Normally Open) Contact
2. FORM-B: SPNC (Single-Pole, Normally Closed) Contact
2. FORM-C: SPDT (Single-Pole, Double-Throw) Contact

Remote Terminal Unit (RTU):

A modem installed at each ATC field control location (usually at passenger station TCRs) to act as the interface unit between the Data Transmission System (DTS) and the local ATC and support system functions.

Response Message:

Digital message transmitted from base station(s) of the Mobile Radio System to the control console with information in reply to a command message initiated at the control console.

Revenue Service:

The transportation of passengers who have paid a fare.

Revenue System:

The portion of the METRO System on which revenue service is conducted.

Right-of-Way (R.O.W.):

1. The land or structure surface occupied by the Metrorail Transit System, especially for its mainline. Also, the land or structure surface used by another transportation facility such as a railroad or highway.
2. The right of traffic on a given route to take precedence.

Ringdown:

A method of signaling in which ringing current is transmitted over a circuit to operate a device or circuit to produce a steady signal.

Ringing:

The audible or visual signal produced by an alternating or pulsating current to signal a telephone station, central office or other terminating equipment.

Root Mean Square (rms):

The square root of the mean of the squares of the sum of instantaneous voltages or currents during a complete cycle.

Rotary Hunting Group (RHG):

A group of telephone lines which are accessible under a common calling number and are used sequentially as calls are received.

Scene Highlight Brightness:

The amount of illumination which is reflected off an object of interest expressed in foot lamberts.

Seize:

In communications signaling terminology, to take control of a connecting circuit.

Sensitivity:

The degree to which a component, circuit or system is affected by some condition.

Sensor:

A device for detection of a condition or change in condition - such as smoke, temperature, humidity, light level, open circuit, closed circuit.

Service and Inspection (S&I) Yard:

Yard which provides for the make-up, cleaning, maintenance, inspection, and repair of trains.

Shield:

A housing, screen or other object, usually conductive, that substantially reduces the effect of electric or magnetic fields on one side and upon devices or circuits on the other side.

Shop Building:

Building within a Metrorail yard or elsewhere which houses repair facilities.

Short Circuit:

An abnormal connection of relatively low resistance between two points of different potential in a circuit.

Simplex:

A method of operation in which communications takes place in one direction only.

Singing Point:

The point at which the gain is just sufficient to make the circuit break into oscillation.

Single Mode Fiber:

(Fiber Optics) An optical fiber in which only the lowest order mode can propagate at the wavelength of interest.

Slotted Coaxial Cable:

A coaxial cable with slots cut into the outer conductor, thereby permitting radio frequency radiation into and from the cable.

Software:

Computer programs and routines; a collection of related utility, assembly, and other programs that are desirable for proper utilization of a device or equipment; detailed procedures, documents, manuals, drawings, and diagrams relating to a device, equipment or system.

Solid State:

A device or system whose operation is dependent upon a combination of optical, electrical or magnetic phenomena occurring within a solid. Functions are performed by semiconductors and wholly static components, i.e., resistors, capacitors, etc.

Span Section:

A span section is defined in these Specifications as a transmission segment of the Fiber Optic System or Carrier Transmission System that extends from the Control Center to and including the passenger station, yard or other intermediate repeater or terminal of the span.

Spare:

Equipment, assemblies or components, complete or in parts, on hand for repair or replacement.

Speech-Plus:

Method of operation that permits the simultaneous transmission of speech and telegraph signals over a single voice channel.

Sound Pressure Level (SPL):

A measure, in dB, of acoustic loudness, usually designated to be the effective rms sound pressure referenced to 0.0002 dyne per square centimeter.

Squelch:

An action whereby a signal is completely cut off, unless a predetermined threshold level is attained.

Stationing:

A system for establishing reference points along the Rail System. Civil stationing is used in initial design and development of the Rail Right-Of-Way. Train Control Stationing is later established as a permanent reference for operation of the Rail System.

Storage and Inspection Yard:

A Metrorail yard which provides for the make up of trains and for the cleaning and minor maintenance of cars. No major repair facilities are provided.

Sub-Ballast:

Crushed rock or stone that is placed between the ballast and the sub-grade.

Subscriber Loop:
A circuit that is formed by the subscriber's telephone, the cable pairs and other conductors, and the telephone central office, PABX or other terminating equipment.

Substation, Traction Power:
Building housing equipment and facilities for providing electrical energy to the trains via the contact rail.

Subway:
That portion of the system which is constructed beneath the ground surface (i.e. underground Metrorail facilities).

Supervision:
The process of monitoring the condition of a circuit to determine its status.

Supervisory Alarm Subsystem (SAS):
A subsystem of the Technical Control Facility which provides for the transmission of alarm information from a remote terminal in passenger stations and yards to the Control Center.

Talkback System:
A system of the yard which provides two-way voice communications between the Yard Communications Console and the track areas.

Talk Path:
In a telephone or radio system, the circuit or channel which provides for the transmission of voice signals.

Terminal Strip (Board):
An insulating base equipped with terminals for connecting wires.

Third Rail:
See contact rail.

Tie Breaker Station:
Building housing power switching equipment for the purpose of sectionalizing contact rail power.

Tone Call:
A system of exchanging calling or alerting signals and acknowledgment signals between mobile radio units and base stations that utilize modulated tones in the voice band.

Tone Dialing:
The transfer of digital information from a telephone instrument to a central office or other terminal device utilizing multi-frequency tones. (Typically by standard DTMF tone signaling)

Tone Generator:
A device for providing audio frequency currents suitable for signaling purposes.

Total Harmonic Distortion (THD):
A measure of the total effect of the various higher order harmonics of a sinusoidal signal.

Trackbed:
The area and material directly under the track which provides support to the track. It includes ties, ballast or other supporting material.

Train Control Contractor:
The contractor who has been awarded a contract to provide Automatic Train Control System.

Train Control Room:
A room located in a passenger station or at some other strategic point to house wayside ATC equipment including a Remote Terminal Unit. A major wayside control point for the ATC system.

Trunk:
A one or two-way channel connecting two telephone central offices, or a central office and an individual terminal.

Vehicular Radio:
Radio transmitter/receiver and associated equipment designed to be installed in and operated from vehicles.

Voltage Standing Wave Ratio (VSWR):

The ratio of the highest to the lowest voltage of a standing wave at a feed through point.
Wayside Telephone System:

A subsystem of the WMATA Telephone System.

Wet Contact:

An electrical contact through which direct current flows.

WMATA:

Washington Metropolitan Area Transit Authority

Headquarters Building:

Jackson Graham Building

600 Fifth Street, N.W.

Washington, D.C. 20001

WMATA Configuration:

The arrangement of hardware or software, wiring, etc. within the equipment, equipment racks, rooms, or systems utilized by WMATA.

WOW:

The slow cyclic deviation of audio signaling power with an approximate period of 0.5 Hz.

Yard:

A system of Metrorail tracks and buildings within defined limits provided for the make-up of trains, storage of cars, and for cleaning, maintenance, inspection, and repair of trains.

Yard Control Room:

The room in the yard which contains the yard train control console.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

THIS PAGE NOT USED

SECTION 16703

COMMUNICATIONS STANDARD SPECIFICATIONS - ENGINEERING SERVICES

PART 1 - GENERAL

1.01 DESCRIPTION OF ENGINEERING SERVICES

The Design-Builder is required, under WMATA Communications Systems Specifications, to design, furnish, install, test, and document communications systems that conform to WMATA operational, performance and other requirements outlined therein. Standard Specifications apply where more specific requirements are not included in other (specific systems) specifications.

1.02 SECTION INCLUDES

Standard Specifications for Design-Builder-furnished engineering services. These Specifications apply to all engineering services and to all equipment furnished unless otherwise specified elsewhere in this Contract (i.e. conflicting Specification requirements found in other Specification sections or on Information Drawings take precedence over Standard Specifications in this section).

1.03 REFERENCES

- A. Federal Communications Commission (FCC) - (Specifically Parts 15, 90 and other applicable regulations)
- B. National Electrical Code (NEC)
- C. Underwriters Laboratories (UL)
- D. American National Standards Institute (ANSI)
- E. Rural Electrification Administration (REA)
- F. Insulated Cable Authority's Representatives Association (ICEA)
- G. Electronic Industries Alliance (EIA)
- H. National Electrical Manufacturers Association (NEMA)
- I. Institute of Electrical and Electronic Authority's Representatives , Inc. (IEEE)
- J. Association of American Railroads (AAR)
- K. WMATA General Provisions and Standards Specifications for Construction Projects.

1.04 ENVIRONMENTAL

- A. The communications system/facility shall be such that, when operating within the specified environmental limits, the maximum temperature attained by any component shall be lower than that which will adversely affect the life or performance of equipment.
- B. Unless otherwise specified, equipment shall be fully operable without damage or functional degradation under any combination of the following:

1. Ambient Temperature -18°C to 55°C.
 2. Relative Humidity 0 percent to 95 percent. (This requirement does not apply to equipment installed at the Jackson Graham Building).
- C. Permanently mounted equipment, exclusive of the equipment installed and operated in the Jackson Graham Building, shall be so constructed or installed that it will remain fully operative while being vibrated with simple harmonic motion having an amplitude of 0.005 inch (total excursion of 0.01 inch), with the frequency varied uniformly from 10 cycles to 55 cycles per second for a period of 30 minutes in each of three mutually perpendicular planes.
- D. All moving contacts (including relay contacts, jack contacts, switch contacts) shall be protected from dust.
- E. Equipment panels shall be furnished with dust covers. Proper internal air flow shall be provided when dust covers are in position during operation of the equipment.
- F. Unused mounting spaces in equipment racks, equipment cabinets, kiosk cabinetry and consoles shall be provided with blank panels which are consistent with the arrangement of the assembly.
- G. The circuitry of kiosk equipment panels, yard console equipment panels, and other custom-developed equipment shall be completely enclosed to protect against moisture and dust.
- H. Each system, facility, and subsystem element will generally be operated in the unfavorable electrical environment of a rail rapid transit system characterized by heavy direct-current and chopper-controlled pulsating direct-current propulsion equipment, which will cause electrostatic, electromagnetic, and radiated interference. Suitable effective engineering techniques and installation practices shall be incorporated to eliminate the effects of such interference on the performance of the systems, equipment, and devices furnished or installed by the Design-Builder, and those provided by others for use within or outside of the Metrorail System.
- I. Some sources of interference are: 60 Hz ac system, dc traction power system, propulsion power contact shoe and third rail arcing, rotating machinery, lightning discharges and high energy level, chopper-controlled propulsion systems. The arcing between the transit car contact shoe and the third rail which is supplying up to 780 volts dc is a major source of electrical noise. The noise spectrum includes harmonics which vary in amplitude with the change in loading of the section. Relatively high amplitude noise impulses occur throughout the spectrum.

1.05 INTERCHANGEABILITY

- A. Standard commercial products shall be furnished whenever such equipment and materials will satisfy the stated Specifications. Suitable modified standard commercial devices shall be furnished when required to satisfy Specification requirements. Custom developed and fabricated equipment units and devices shall be confined to those items for which suitable off-the-shelf commercial products are not available to guarantee compliance with the Specifications. When custom design, fabrication, or assembly is required, every effort shall be made to minimize the number of different modules, solid-state devices, etc. used.
- B. With each system, subsystem and facility, two or more like functions shall be performed by identical units. In no case shall the equipment or hardware used in one portion of a system, subsystem or facility be different from that used in another portion to perform the same function under similar operating and environmental conditions.

- C. Insofar as possible equipment shall be physically and plug compatible with recent versions of existing Authority equipment performing similar functions and used for comparable applications elsewhere in similar WMATA facilities. The use of adapter plugs, interface boxes, and replacement mounting brackets or enclosures that fit available space and mounting holes may be allowed by the Authority's Representative to maintain interchangeability, when competitive products that do not require such devices are determined to be unavailable (applicable to off-the-shelf major equipment items only). Custom designed and custom fabricated equipment must be fully interchangeable without requiring the use of such devices. If a determination is made to allow use of such devices, the Design-Builder shall provide all necessary adapters and interface devices with each item of equipment furnished, at no additional cost to the Authority.
- D. Major items of equipment furnished by the Design-Builder shall be within the physical size and configuration limitations specified in provisions of this Contract. If such specifications are not included in the provisions of this Contract, major items of equipment shall be of a physical size and configuration closely comparable to equipment currently in use for comparable applications elsewhere in similar WMATA facilities.
- E. Exception: Lighter weight and smaller sized, more modern versions of equipment are sought by the Authority where their use presents significant advantages. The use of new generations of equipment that differ in size and are not fully interchangeable will be considered for approval by the Authority's Representative, in order to take advantage of significant technological improvements developed by industry.

1.06 MAINTAINABILITY AND RELIABILITY

- A. The physical and mechanical configurations of equipment and rack assemblies shall give a high priority to the ease with which units may be inspected and removed.
- B. Except as otherwise specified, rack mounted equipment shall be mounted on standard equipment racks or in standard equipment cabinets. Each rack and cabinet configuration shall present a neat and orderly appearance and shall be uniform for like systems/facilities at all Communications Equipment Rooms.
- C. Equipment units or subassemblies shall be easily removable from rack, cabinet, or equipment cases without the need to disturb unit rack/cabinet/case wiring.
- D. Equipment units shall utilize plug-in printed circuit cards or plug-in assemblies whenever the quantity, equipment, size and weight of the components lend themselves to this technique
- E. Printed circuit cards in rack mounting equipment units shall plug into either card files or card drawers, whenever feasible and practical.
- F. Printed circuit cards shall be keyed to prevent incorrect interchange of cards. However, cards performing a given function in a subsystem or subsystem element shall be interchangeable with cards of another subsystem element performing the same function whenever practical.
- G. The replacement of a printed circuit card plug-in subassembly, or component by a new unit shall not require compensating adjustments of devices other than the circuit card or component replaced.
- H. Equipment and installation engineering services and designs shall incorporate accepted industry standards and good engineering practices selected to enhance maintainability and

reliability.

- I. Test points shall be provided for printed circuit cards to permit detection of a failure without removal of wiring. Go/No-Go techniques shall be used to localize failures where possible. Card extenders may be used for this purpose.
- J. Test points shall be readily accessible and clearly designated, and shall be capable of accepting probes and connectors furnished with standard test equipment. All testing shall be performed at the front of racks whenever practical.
- K. Appropriate equipment, electrical test points, fuses, and adjustment controls shall be available at the front panel.
- L. Equipment units shall be of ample capacity and of proper arrangement to perform the functions specified, under the conditions specified, and shall operate in accordance with the specified reliability criteria.

1.07 CUSTOM DEVELOPED AND Design-Builder MODIFIED OFF-THE-SHELF EQUIPMENT

- A. The construction, panel and chassis layouts, circuit arrangements, components, graphics, and component layouts of custom-developed equipment shall be approved by the Authority's Representative. Drawings detailing all aspects of the developed equipment shall be submitted for preliminary review and comment. The submitted drawings shall include details of the required external connections. After incorporating the comments and obtaining acceptance by the Authority's Representative, the Design-Builder shall fabricate prototypes of the custom-developed equipment (one for each custom-developed item) in accordance with the approved configurations. The prototypes shall be submitted for evaluation, inspection, testing, and acceptance or rejection by the Authority. Production models shall not be manufactured until the acceptance of the corresponding prototype by the Authority's Representative (including incorporating any additional comments). Only production models shall be furnished to fulfill the requirements of these Specifications.
- B. Design-Builder modified "off-the-shelf" commercial product major items shall be subject to the same review, and all prototype requirements specified above for custom developed equipment, except as otherwise directed by the Authority's Representative. Relief from these requirements will be considered in instances where only minor modifications are proposed.
- C. At the discretion of the Authority's Representative, equipment developed and manufactured specifically to fulfill a WMATA requirement, although considered by the manufacturer as "off-the-shelf," shall be considered as developed equipment and shall comply with the requirements specified herein.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16704

COMMUNICATIONS STANDARD SPECIFICATIONS - INSTALLATION

PART 1 -GENERAL

1.01 SECTION INCLUDES


Standard Specifications for Design-Builder-furnished installation services. These Specifications apply to all Design-Builder installation services, unless otherwise specified elsewhere in this Contract (i.e. conflicting Specification requirements found in other Specification sections, or on Information Drawings take precedence over Standard Specifications in this section). Unless otherwise specified, communications, electronics and electrical installations shall be governed by the provisions of the "National Electrical Code, Standard of the National Board of Fire Underwriters for Electrical Wiring and Apparatus." All provisions of this code must be considered applicable, whether specifically mentioned in the body of these Specifications or not. In no case shall the installation in one portion of the system be different from the installation in other portions for similar configurations under similar operating and environmental conditions, unless specified.

1.02 REFERENCES

- A. Federal Communications Commission (FCC) - (Specifically Parts 15, 90 and other applicable regulations)
- B. National Electrical Code (NEC)
- C. Underwriters Laboratories (UL)
- D. American National Standards Institute. (ANSI)
- E. Rural Electrification Administration (REA)
- F. Insulated Cable Engineers Association (ICEA)
- G. Electronic Industries Alliance (EIA)
- H. National Electrical Manufacturers Association (NEMA)
- I. Institute of Electrical and Electronic Engineers Association, Inc. (IEEE)
- J. Association of American Railroads (AAR)
- K. WMATA General Provisions and Standards Specifications for Construction Projects

1.03 CONDUIT PLANT

- A. Unless otherwise specified, all wiring in structures and tunnels that is external to equipment enclosures and racks, shall be installed in suitable Intermediate Metal Conduit (IMC), or shall be installed in existing cable tray, underfloor duct, or racked to existing channel inserts on tunnel walls, if space is available and assigned by the Authority's Representative. All conduit and cable installations shall be subject to the approval of the Authority's Representative.

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- B. Available embedded conduit will be assigned for use by the Design-Builder when not reserved for other requirements. Conduit cleaning, the construction of conduit extensions or rearrangements, cable rerouting, and the construction of conduit plant to enclose all remaining wiring shall be furnished by the Design-Builder. Surface conduit construction shall not be permitted in most public areas of stations or in a few other places. Core boring of structures may be required to obtain means of passage during conduit plant construction.
 - C. Inside diameters of conduit shall be determined by the Design-Builder, based on the NEC, using the appropriate fill factors for the class of service and number and size of conductors. The proposed conduit sizes shall be submitted to the Authority's Representative for approval. Conduits smaller than 0.75 inch shall not be used.
 - D. All exposed conduit runs shall be installed parallel to walls, floors and ceilings, whenever possible, except where pitch is required for proper drainage. Conduits shall be rigidly supported at intervals not to exceed eight feet. Standard one-hole, malleable iron galvanized pipe straps of the proper size shall be used for single conduit runs on concrete surfaces. Where conduits are supported on concrete surfaces, machine-bolt type expansion shields and bolts of the proper size shall be used. All screws, bolts and fittings for conduit supports shall be galvanized or cadmium plated. Stainless steel 304 conduit spacers shall be used for conduits running on flat surfaces. Standard conduit elbows or field bends are permitted; they shall not be less than the minimum radius, as required by the NEC.
 - E. Conduits shall be connected to equipment metal enclosures using two locknuts and a bushing, except where conduit hubs are provided. Where enclosures, fittings with openings, or boxes of any type are installed in locations determined by the Authority to be subject to moisture, watertight conduit fittings shall be used. Watertight covers with seals shall be provided, and approved sealant applied to openings to effectively prevent the entry of moisture.
 - F. All conduit entering Communications Equipment Rooms of passenger stations and yards shall be covered and sealed. Watertight conduit and cable seals shall be used where the building or structure penetration is at a lower elevation than the manhole or below the water table.
 - G. All terminal ends of conduits shall be provided with insulated metallic bushings.
 - H. Whenever a conduit or exposed cable enters or leaves a box, it shall be permanently tagged, external to the box, with a plastic tag approved by the Authority's Representative. The tags shall be permanently stenciled with a number which shall identify the conduit or cable with an assigned circuit.
 - I. All conduits installed shall be free of burrs and other sharp edges throughout the entire length. Conduit fittings or boxes shall be installed in conduit runs, where required, to limit the number of bends to a maximum of three 90-degree bends or equal. All conduits used shall be thoroughly cleared by pulling through a mandrel tool, and shall be blown clean by forcing compressed air through the run before wires or cables are pulled.

1.04 CUTTING AND PATCHING

- A. All necessary cutting and patching of existing construction shall be provided by the Design-Builder for the installation of the equipment and cables.

- B. All cuttings shall be of the appropriate required sizes and shapes for the materials, cables and equipment to be installed. All cuttings shall be performed using the appropriate type of tools and equipment for the corresponding surfaces and material. The locations, sizes, shapes, and methods of performance for all cuttings shall be subject to approval by the Authority.
- C. All patching shall match existing adjacent construction to the satisfaction of the Authority, using the best possible workmanship of the various trades involved. All required material, compounds, sealants and hardware for all patching shall be provided. Fire wall integrity shall be maintained in appropriate construction.
- D. Services shall be provided by the Design-Builder for the removal and reinstallation of all necessary existing items (i.e., platform tiles, manhole covers) to accomplish the installations. Replacement shall be provided for any removed items that are damaged or missing during the performance of work, at no additional cost to the Authority. Replacements shall be identical in manufacture and type to the damaged or missing items.
- E. All existing items and construction (i.e., platform tiles, plenums, ceilings, floors, lighting fixtures, junction boxes, structures, and finishes) that are damaged, changed, or modified in the performance of work shall be restored to their original condition and/or surfaces. Appropriate required material, hardware, paints, finishes, and compounds shall be provided. Any items that are damaged, which are determined to be unrepairable, are to be replaced at no additional cost to the Authority. Replacements shall be identical in manufacture and type to the damaged items.

1.05 JUNCTION BOXES

- A. Junction boxes shall be furnished and installed for terminating cable runs and for pulling of cables. Boxes provided in conduit runs, to minimize the number of 90-degree bends in a run, shall be considered junction boxes, although used only for the pulling of cable.
- B. All boxes shall be mounted plumb and level and shall be rigidly anchored to the supporting surface. Machine bolt type expansion anchors shall be used to fasten boxes to concrete surfaces where inserts are not otherwise provided. In no case shall bolts of less than 0.25-inch diameter be used. Stainless steel spacers shall be used on bolts to provide a 0.25-inch air space between boxes and mounting surfaces.
- C. All boxes shall have a number stenciled on the cover. Numbers shall identify the service of the circuits in the box, as approved by the Authority's Representative.

1.06 CABLE TRAYS

- A. Unless otherwise specified, cable tray construction shall be allowed only in Communications Equipment Rooms and other equipment rooms assigned for the installation of significant quantities of communications-related equipment. Tray supports shall be located on eight-foot centers, maximum, and shall be subject to the approval of the Authority's Representative. Sufficient supports shall be provided to keep the loaded cable tray deflection to 0.25 inch maximum at mid-span. Tray supports and trays shall be mounted plumb and level.
- B. Tray supports, angle iron, or prefabricated channels shall be anchored to ceilings or walls by machine-bolt type expansion anchors and 0.5-inch minimum diameter bolts. Where cable tray fittings occur in a run, trays shall be supported immediately adjacent to, and on both sides of, the fittings.

- C. Trays shall be bolted to support members. Precautions shall be taken to prevent anchoring bolts from damaging cables placed in the trays.
- D. Cable tray fill shall not exceed 75 percent of the cross-sectional area of the tray, assuming an area of each cable to be equal to the square of the cable diameter.

1.07 EQUIPMENT MOUNTING

Unless otherwise specified, equipment shall be anchored to the concrete walls, floors, or ceilings by machine-bolt type expansion shields and 0.5-inch minimum diameter bolts. The number of bolts shall be adequate to provide a rigid and safe support. Where required, concrete bases or pedestals shall be provided by the Design-Builder with anchor bolts cast in place for the mounting of equipment. All equipment shall be mounted plumb and level.

1.08 PAINTING

All painted areas damaged in route to, or at the installation site, shall be repainted with matching colors by the Design-Builder. The surfaces of equipment and material not accessible after mounting shall be painted prior to installation.

1.09 WIRE AND CABLE

- A. Powdered soapstone or other suitable lubricating medium non-injurious to insulation shall be used, if required, when pulling wires or cables in conduits or ducts.
- B. Each conduit, duct and pipe shall be cleaned before installing cables therein. The conduits, ducts and pipes shall be maintained in a clean and dry condition during the installation process up to and including the time which each conduit, duct, and pipe is sealed
- C. Wires shall not cross one another when they are pulled into a conduit nor shall the conductors be pulled tight or kinked in conduit fittings or boxes.
- D. Cables shall be laid, not pulled, into trays or in troughs provided by others. Cables shall be installed with a minimum amount of crossover in the trays and troughs and shall not be placed tightly around bends. Where cables enter or leave trays via conduits, such conduits shall be rigidly affixed and supported at their ends by suitable brackets and conduit straps from the sides of the trays.
- E. Wires and cables shall be permanently tagged with plastic tags at each entry to and exit from all equipment terminal blocks. Tags shall be permanently marked to identify the system in which the wire or cable is used. Tags and markings shall be subject to the approval of the Authority's Representative.
- F. All cable pairs, including spares, shall be terminated on connectors, protectors, or line terminating blocks on the MDF.
- G. Solder with a minimum of 60 percent tin and 40 percent lead with non-corrosive flux shall be used in soldering wires and cables.
- H. The Design-Builder shall seal all openings through which cable, conduit and cable trays pass. The material used to seal the openings shall be furnished and installed by the Design-Builder.

It shall be a fire retardant, non-toxic material and shall comply with the local fire prevention code.

- I. All exposed wires and cables entering or leaving equipment housing or junction boxes shall be protected from abrasion by sharp metallic edges. Chase nipples shall be provided in openings having conduit hubs. Chase nipples and locknuts shall be provided in drilled or punched openings.
- J. The Design-Builder shall seal all openings in equipment enclosures and junction boxes where exposed cables enter the enclosure or box. A pliable sealing compound made expressly for the purpose shall be furnished and installed after the cables are in place.
- K. Nylon straps shall be furnished and installed for bundling and cabling of conductors where two or more single conductors of the same circuit are run exposed in cable trays or in cable troughs. Straps shall be installed approximately every five (5) feet along the cable run. Wires of multi-conductor cables exposed by the stripping of the cable jacket for termination shall be trimmed in a neat, workmanlike manner and tied approximately every three inches with nylon straps. Care shall be taken in terminating or splicing cable. Removal of insulation shall be done in a manner which does not nick the conductor material. In no case shall the conductor be kinked or bent at sharp angles. Smooth bends shall be utilized.
- L. Appropriate exposed cables entering or leaving equipment enclosures and junction boxes shall be protected from abrasion by sharp metallic edges. Chase nipples shall be provided in openings having conduit hubs. Chase nipples and locknuts shall be provided in drilled or punched openings.
- M. All cables and wires installed in environmental air plenums, cable vaults, and under passenger station platforms shall be placed in appropriately sized electrical metallic tubing (EMT) unless otherwise specified.
- N. Appropriate channel inserts, arms and insulators shall be provided to support cables in the manholes of the duct bank.
- O. Dewatering and removal of all dirt and trash from trenches, manholes, pull chambers, cable troughs, surface trenches, conduit and duct banks shall be provided prior to, and maintained during, the installation of cables.
- P. Cables shall be permanently tagged with plastic tags at each entry to and exit from all junction boxes, cable trays, cable ladders, equipment enclosures, conduits, ducts and pipe. Appropriate identification shall be permanently marked on each tag. These plastic tags shall be provided in two forms: Sleeve and flat. The sleeve form shall be of the heat shrinkable type and shall be properly sized to fit the cable for which it is intended. The sleeve form type may be used on cables with an outer diameter of 1/2 inch or less. The flat form type shall be made of flat sheet stock with slots for installation with nylon tie-wrap fasteners. The markings on the tags shall be provided in a color that will contrast sharply with the color of the associated tags. The plastic tags shall be properly installed.
- Q. Low-smoke, low-toxicity (not PVC) plenum rated wire and cable shall be utilized throughout installations of equipment in the Jackson Graham Building Communications Equipment Room (i.e., for cables extending outside of equipment enclosures, for inside plant cables extending to other rooms and floors, but not for outside plant cables extending to areas outside of the building), unless otherwise specified. Exceptions may be allowed by the Authority's

Representative when such plenum rated cable is not commercially obtainable only from equipment manufacturers, and when appropriate to avoid potential electrical signal mismatching, or to otherwise improve system performance or reliability.



1.10 DIRECT FIXATION IN TUNNEL AREAS

- A. Unless otherwise directed, cables shall be installed along the tunnel walls in an organized fashion within the area allotted for communications cables. Cable crosses shall be kept to a minimum.
- B. Channel inserts have been provided by others, mounted on approximately four-foot centers, in the tunnel walls. Stainless steel type fasteners or mounting devices shall be provided to secure the cables to the channel inserts. Cables shall be individually mounted to the channel inserts. Cable shall be secured to each channel insert. The fasteners or mounting devices shall be properly sized to the cable, or shall be adjustable to the proper size to support the cable without undue compression. Prior to cable installation, the channel inserts shall be cleaned and foreign material shall be removed, where necessary.
- C. Unless otherwise specified, cables shall be installed on the channel inserts in the space allocated for communications cables.
- D. In those areas where the specified locations for cables within the tunnels do not coincide with the channel inserts provided by others, or when channel inserts are not available for communications cables, and as necessary to secure MRS antennas, and other cables, appropriate type cable ladder with hardware, cement anchors, fasteners, and mounting devices, shall be provided to secure cables to the tunnel structure. Appropriate type cement anchors, fasteners, and mounting devices, shall also be provided to secure cables to the tunnel structure when routed to equipment, equipment housings, junction boxes, terminals, and conduits.
- E. Sufficient slack shall be provided in the cables between fasteners and mounting devices to allow for expansion and contraction of the cables without damage to the cables or the fasteners and mounting devices.
- F. The Authority is installing Tunnel Ventilation Barriers in the tunnels between passenger stations in the vicinity of some fan shafts. The Design-Builder shall install communications cables running along the tunnel walls through the cable openings that are provided in the Tunnel Ventilation Barrier structures. Openings are either provided on the side near the cable runs or at the top near the ceiling area of the tunnel.

1.11 CABLE TROUGHS ALONG THE TRACK RIGHTS-OF-WAY

- A. Cable troughs along the track rights-of-way are utilized for the installation of Communications cables, Automatic Train Control cables and Traction Power Substation (TPSS) control cables.
- B. A vertical metal divider has been installed throughout most of the length of the track right-of-way cable troughs to separate the TPSS control cables from the Automatic Train Control and Communications cables. In some locations, the metal divider has been omitted in favor of a small TPSS-control-cable trough mounted within the regular cable troughs.
- C. The following conditions and potential problems with the track rights-of-way cable troughs are noted:

1. The covers for the cable troughs may not be of uniform length of drilling, i.e., each cover section should be regarded as unique to that particular section of trough.
 2. The pressure of ballast on the outside of all metallic constructed cable troughs may cause the outer side to deflect somewhat when the top covers are removed, a condition which may interfere with reinstallation of the trough covers.
 3. The covers are not watertight.
- D. The following required installation services shall be provided by the Design-Builder when installing cables in the track rights-of-way cable troughs:
1. Removal of snow, ice, dirt and debris from the metal trough covers to obtain access.
 2. Removal of all the metal trough covers.
 3. Removal of fluids, snow, ice, dirt and debris from the troughs.
 4. Protection of all cables already installed in the cable troughs.
 5. Provision for access to conduits entering the cable troughs (possibility of shifting already installed cables).
 6. Proper reinstallation of the trough covers when cable installation is completed.

1.12 FIBER-OPTIC COMMUNICATION CABLE

- A. Splicing of single mode fiber-optic communications cable is authorized only at designated cable terminal locations and in Communications Equipment Rooms (splicing trays or enclosures) at passenger stations and transit yards, and in other approved locations, only when essential to join the ends of one or more standard or larger sized full reels of cable together with one partial reel of cable. Only low loss (0.20 dB or less) fusion type splicing and splicing to factory installed pigtailed connectors will be authorized. Approval of the exact location and methods utilized to make and protect each splice shall be obtained from the Authority's Representative prior to commencing field work.

1.13 COPPER INSIDE PLANT CABLE

- A. Splicing is not authorized in cables within the passenger station limits, or within ancillary structures, garages, parking lots, and transit yard S&I Shop and Operations Buildings.

1.14 COAXIAL, TRIAXIAL AND SPECIAL PURPOSE CABLE

- A. Splicing is not authorized in coaxial and triaxial cables, or in cable or cable harnesses designated by equipment manufacturers or the Authority's Representative as "special purpose cable." Properly installed and protected connectors shall be used in lieu of splicing.

1.15 COPPER OUTSIDE PLANT CABLE

- A. Outside plant cables extending beyond passenger station limits shall be free of splices, unless approval for splicing is obtained from the Authority's Representative. Approval may be granted for splice(s) in cable runs or CTS cable spans, only if the following conditions exist:
- B. No more than one splice in each individual cable run (or individual CTS cable span) shall be authorized except where deemed necessary to join two or more standard sized full reels plus one partial reel of cable together to make up the required length for an individual cable run (or individual CTS cable span) which extends between two cable end terminations.
- C. Exception:

1. Splicing of multi-pair copper CTS cables shall not be allowed within 400 feet of either end of the span.

1.16 SPLICE CASE TYPES

- A. Highly durable, watertight splice cases shall be furnished and installed in accordance with the manufacturer's instructions, when splicing is authorized. Filled splice cases shall be utilized when splicing filled cable (REA PE-39 telephone and CTS cable, for example).

1.17 SPLICE CASE (AND FIBER-OPTIC CONNECTOR) TECHNICAL SPECIFICATIONS

- A. Splice case (and fiber-optic connector) technical specifications and samples must be submitted to the Authority's Representative for review and approval prior to installation.

1.18 SPLICE CASE PHYSICAL PROTECTION

- A. Splice cases must be protected from physical damage and must be accessible (i.e. in manholes, hand-holes, cable troughs, terminal or junction boxes, or other protected locations readily accessible for maintenance purposes.) Splices shall not be placed in conduit.

1.19 MAINTENANCE OF FIBER-OPTIC AND COPPER CONDUCTOR IDENTIFICATION

- A. When multi-conductor copper or fiber-optic cables are spliced, the same color code, number and group identification shall be maintained throughout the entire cable run. Conductors and individual fibers shall be clearly identified at both end terminals (or cable ends - if not terminated).

1.20 SIGNAL ATTENUATION, CONTINUITY, CROSSTALK AND GROUNDING

- A. Splicing shall be accomplished in such a manner that optical or electrical signal attenuation, discontinuities, or cross-talk, do not appreciably increase as a result of such splicing. Cable shields, armor, and all other metallic elements shall be bonded across splices with copper straps and clamps or other approved hardware, to maintain electrical continuity with less than 0.2 ohm increase in resistance. Grounding for electrical protection shall be accomplished as specified or as approved by the Authority's Representative (or, if not specified or detailed in the Authority's Representative's approval, in accordance with applicable NEC provisions).

1.21 AS-BUILT RECORD DRAWING REQUIREMENTS

- A. The Design-Builder shall clearly indicate the location, size, and type of all splices and terminals on As-Built Record Drawings.

1.22 EQUIPMENT ENCLOSURES AND JUNCTION BOXES

- A. All equipment enclosures and junction boxes shall be mounted plumb and level, and shall be rigidly anchored to the supporting surface. Appropriate type expansion anchors and bolts shall be used to fasten the enclosures and boxes to support surfaces. An adequate number of bolts of the proper diameter with lock washers shall be used, but in no case shall bolts of less than 0.25 inch diameter be used. Stainless steel 304 spacers shall be used on bolts to provide a 0.25-inch air space between all enclosures/boxes and mounting surfaces.

- B. Where equipment enclosures and junction boxes are to be mounted on walls of material other than concrete, the method of mounting and the hardware to be used shall be approved by the Authority.
- C. All junction boxes and equipment enclosures shall have a unique identification stenciled on one exposed accessible surface and on the exterior of the cover. The painted stencil markings shall be applied with a procedure that produces clear, legible letters/numbers without voids and without paint running between the stencil and the surface being marked. The marking paint shall provide a definite contrast with the surface on which it is applied.

1.23 BURIED CABLES

- A. When direct burial of cable is specified, the following shall apply:
 - 1. Only cable and wire specified by the manufacturer to be for direct burial shall be buried.
 - 2. Cable shall be buried not less than 42 inches below grade and shall be below the frost line. The cable trench shall have a minimum width of 12 inches or three times the cable diameter, whichever is greater. The trench floor shall be free of rock, roots and debris, and shall provide a smooth bed for the cable. A minimum of four inches of sand shall be placed on the trench floor. The cable shall be placed in the trench, on the top of the sand, with slack and without kinks or bends. The cable shall be covered with four inches of sand before backfilling. If the trench spoil is used for backfill, it shall be free of rock, stone and debris. The backfill shall be compacted and leveled at specified grade. At no time shall a communications cable or wire be buried within 12 inches of a power conductor.
 - 3. The Design-Builder shall provide all shoring required. The Design-Builder shall mark the cable trench for future location and identification.
 - 4. No digging below the ties within the trackbed shall be permitted. The trackbed is defined as the area along the track extending one foot beyond the end of each track tie.
 - 5. When it is necessary to drive conduit under the trackbed, Authority approval shall be obtained for each case prior to commencement of work. The request for approval shall include details on the type of conduit, depth below surface and method.
 - 6. All wires and cables shall be tested after installation as detailed in Table 3.22-1 and other applicable specification provisions. Installation Completion Tests shall verify that cable shields and armor are bonded across each splice or junction box authorized (if any), and that twisted pairs maintain their identity and continuity end-to-end without crosses, shorts, opens, transpositions or splits. Insulation resistance tests shall be made either with an insulation resistance test set or a dc megohm meter utilizing a test voltage of 250 Vdc or greater, and shall be made in the presence of the Authority's Representative's designee.

1.24 SPECIAL REQUIREMENTS FOR STAINLESS STEEL CORROSION RESISTANT HARDWARE

- A. Except as otherwise specified, equipment enclosures, cabinets, boxes and hardware of all types in tunnels, tunnel crossovers, along the surface rights-of-way, and in all ancillary structures that are open to tunnels (vent shafts, fan shafts, pumping stations, etc. - excluding rooms within these areas that are heated/air conditioned) shall consist of stainless steel 304 material. Also, except as otherwise specified, equipment enclosures, cabinets, boxes and hardware of all types; in platform plenums (and including track side walls and under-platform slab and extensions into service rooms); along station train room safety walks, in stairways, corridors, and plenums that are not heated/air conditioned; and in all shafts to the surface and

dome reliefs, escalator well ways, elevator pits and surface elevator shafts, shall consist of stainless steel 304 material.

- B. Exception: Galvanized conduit may be used with stainless steel 304 mounting hardware. Electronic equipment connectors, and other relatively small sized specialty items that are not available in Stainless Steel 304 material may be allowed by the Authority's Representative as exceptions (Ref. Article 3.1 Request for Approval Of Minor Technical Specification Deviation).
- C. Unless otherwise specified, stainless steel equipment enclosures, cabinets, and boxes with dull gray colored epoxy paint applied shall be utilized in areas where surface glare may be visible to rail car operators, to avoid glare.
- D. Definitions: "Hardware" includes bolts, screws, clamping devices, anchoring devices, threaded rods, nuts, washers, hangers, covers/wall plates etc. "Boxes" includes junctions boxes, outlet boxes, disconnect switch boxes, circuit breaker boxes, and terminal boxes, etc. "Cabinets" includes terminal cabinets, equipment cabinets, MDF cabinets, and power distribution panelboards. (Note: Definitions include, but are not limited to, the items listed herein.)

TABLE 3.22-1

INSTALLED CABLE AND WIRE CONTINUITY
INSTALLATION RESISTANCE AND MISCELLANEOUS TEST REQUIREMENTS

<u>Application</u>	<u>Type(s)/ Characteristics</u>	<u>Continuity</u> Conductor loop resistance, each pair:	<u>Required Minimum Reading</u>	
(Tunnel, wall shaft, duct bank and direct burial outside plant applications - terminal-to-terminal, including extensions through entrance conduits and to inside terminal(s)).	Jacketed, armored, shielded, filled, twisted multipair cable with or without compartmentalized core	Shield resistance, each:	<u>Calculated Value</u>	
		Armor resistance, each:	+7%	
		<u>Insulation Resistance</u>	+15%	
		Conductor to Conductor (all):	+20%	
		Conductor (all) to core separator and shield:	<u>Megohms</u>	
		Shield to armor:	500	
	With Compartmentalized Core	Without	Armor to ground:	500
			Shield to armor:	500
			Armor to ground:	50
		Compartmentalized Core	Conductor loop resistance, each pair:	100
			Shield resistance, each:	<u>Calculated Value</u>
			Armor to ground:	+10%
Jacketed, shielded, filled or nonfilled, twisted multipair cable	Jacketed coaxial cable, single center conductor plus shield(s)	Shield to shield(s) - if applicable:	+20%	
		Outer shield to ground:	<u>Megohms</u>	
		Conductor resistance, each:	100	
	Insulated wire, 600 volt or less rating	Shield resistance, each:	<u>Calculated Value</u>	
		<u>Insulation Resistance</u>	+10%	
		Conductor to shield:	+20%	
	Insulated wire, 600 volt or less rating	Shield to shield(s) - if applicable:	<u>Megohms</u>	
		Outer shield to ground:	100	
		Conductor resistance:	100	
		<u>Insulation Resistance</u>	30	
		Conductor to Conductors (all) - if applicable:	<u>Calculated Value</u>	
		Conductor (each) to ground:	+10%	
			<u>Megohms</u>	
			10	
			10	

Measurement Description

NOTES:

1. Additional tests may be required in accordance with other applicable Specification provisions.
2. The Authority may require the testing, or may elect to re-test, the insulation resistance of tunnel wall, duct bank, or direct burial outside plant cable during periods of high dampness or high ground water. Any single failure to obtain the minimum required readings shall be considered conclusive in determining that defects requiring Design-Builder repair or replacement are present.
3. Disconnect grounded and terminated cable elements as necessary to facilitate testing.
4. Full information concerning the type, application, to/from terminal destinations, junction boxes/splices (if any), size, conductor size, and actual installed length, must be included on test data sheets for each cable tested.
5. Notwithstanding manufacturers specifications or REA standards, cable(s) that does not meet minimum readings specified shall be replaced by the Design-Builder, at no additional cost to the Authority.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 16705

COMMUNICATIONS STANDARD SPECIFICATIONS - EQUIPMENT AND MATERIAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

Standard Specifications for Design-Builder-furnished equipment and materials. These Specifications shall apply to all equipment and materials furnished, unless otherwise specified elsewhere in this Contract (i.e. conflicting Specification requirements found in other Specification sections or on Information Drawings take precedence over Standard Specifications in this section).

1.02 REFERENCES

- A. Federal Communications Commission (FCC) (Specifically Parts 15, 90 and other applicable regulations).
- B. National Electrical Code (NEC)
- C. Underwriters Laboratories (UL)
- D. American National Standards Institute (ANSI)
- E. Rural Electrification Administration (REA)
- F. Insulated Cable Engineers Association (ICEA)
- G. Electronic Industries Alliance (EIA)
- H. National Electrical Manufacturers Association (NEMA)
- I. Institute of Electrical and Electronic Engineers Association, Inc. (IEEE)
- J. Association of American Railroads (AAR)
- K. WMATA General Provisions and Standards Specifications for Construction Projects.

PART 2 - PRODUCTS

2.01 EQUIPMENT RACKS

- A. Construction - Open Frame, Aluminum 3-Inch X 1.410 Channel, 1/4 Inch Thick.
- B. Panel Mounting Size - Standard 19-inch or 23-inch panels
- C. Finish - Baked Enamel
- D. Color - ANSI 61 Gray
- E. Hole Spacing - Standard EIA 1.75-inch vertical rack mounting spaces

- F. Hole Size - No. 12-24
- G. Base Width - 20.25 inches for 19-inch panels and 24.25 inches for 23-inch
- H. Base Depth - 15-inches.
- I. Base Mounting Holes - Front-to-back, centers of 12.5-inches and side-to-side centers of 16.0-inches and 20.0-inches.
- J. Rack Height - Maximum 7.5 feet.
- K. Equipment racks shall have a ground bus bar, bolt mounted near the top of the rack, consisting of a 6.0-inch by 0.25-inch by 0.5-inch copper bar drilled and tapped for six connections. The ground bus bar shall be electrically connected to the equipment rack.

2.02 EQUIPMENT CABINETS

- A. Construction - Assembled frame with a flush frame base, suitable side panels and top panel, a front door and a rear door.
- B. Assembled frame - Zinc plated 14-gauge steel and shall have the required front-to-back stiffeners to distribute the equipment load.
- C. Base - Zinc plated 14-gauge steel or greater.
- D. Panel Mounting Rails - Drilled and tapped in accordance with EIA Standard RS-310-C.
- E. Front Door and Rear Door - 16-gauge steel with a lockable handle.
- F. Ventilation - Louvers front door and/or the rear.
- G. Finish - Baked enamel/acrylic, gray color.
- H. Cabinet Height - Maximum 7.5 feet.
- I. Equipment cabinets shall have a ground bus bar, bolt mounted near the top of the rack, consisting of a 6.0-inch by 0.25-inch by 0.5-inch copper bar drilled and tapped for six connections. The ground bus bar shall be electrically connected to the equipment cabinet.

2.03 DISTRIBUTION FRAMES

- A. All systems distribution frames, including the Main Distribution Frame (MDF)/Protector Cabinet, shall consist of the required multisection cable terminal housings, top and bottom assemblies for each housing, a hinged end section at both ends of the distribution frame, a lift-out door for each housing, and a fungus resistant solid plywood backboard in each housing. Each housing of the distribution frame shall contain four distribution rings to permit neat installation of wires and cables within the housing.
- B. Finish - Baked enamel gray color.
- C. Multi-section cable terminal housings shall have a ground bus bar installed near the bottom on the plywood backboard, consisting of a 6.0-inch by 0.25-inch by 0.5-inch copper bar. The ground bus bar shall be drilled and tapped for the required ground connections within the housing. The ground bus bar shall be electrically isolated from the distribution frame enclosures.

2.04 JUNCTION BOXES

- A. Junction boxes shall be constructed of 12-gauge sheet steel, except for sizes 24-inch x 36-inch and smaller, which shall be constructed of 14-gauge sheet steel. Boxes shall have all seams welded. The boxes shall be finished to be a NEMA Type 4 rating with the door/cover gasket with an oil resistant gasket material and adhesive. Boxes shall be either galvanized, and painted with ANSI 61 gray paint after priming or shall be a phosphatized surface with ANSI 61 gray polyester powder coating applied. Associated hardware shall be constructed of stainless steel. Junction boxes shall be sized to provide ample space for terminating the wires and cables installed at each location, including terminal blocks and considering the minimum bending radii of cables. Junction boxes exposed to the weather shall have all wire entrances protected from weather and dust with a pliable sealing compound, and shall be equipped with a drain plug.
- B. Junction boxes shall be furnished and installed complete with terminals, fittings, mounting brackets, cable supports and all other necessary hardware. All conductors within a junction box (including spares) shall be terminated on terminal blocks. Junction boxes to be used only for the pulling of cable do not require terminals.
- C. Where the Design-Builder furnishes and installs junction boxes as means of terminating cables, cable supports shall be provided in the boxes.
- D. The Design-Builder may request a waiver to use outlet boxes in lieu of junction boxes for specific application(s) in specific locations. The request must be approved by the Authority prior to the purchase of material or the beginning of installation.

2.05 CONDUIT PLANT

- A. All conduit, except as noted, shall be intermediate metal conduit (IMC). The rigid metal conduit shall conform to UL Standard Number 6, Rigid Metal Conduit and National Electric Code Article 345 Intermediate Metal Conduit. The exterior surface shall be thoroughly and evenly coated with metallic zinc applied directly to the surface of the steel (electroplated zinc coating). The conduit furnished shall be supplied in nominal 10-foot lengths, threaded on each end with one coupling attached. The intermediate metal conduit, elbows, coupling, and fittings shall be protected by corrosion protection when subject to severe corrosive influences. Conduit fittings selected for removable covers shall be complete with gaskets and blank covers.
- B. Flexible conduit shall be provided only where specifically required by these Specifications or where, at the request of the Design-Builder, its use has been approved by the Authority Representative and allowed by the National Electrical Code. The flexible conduit shall be constructed of interlocking spiral strip steel of the best quality. The flexible conduit shall be thoroughly annealed and fully coated with metallic zinc. The flexible conduit shall conform to Underwriters Laboratories standards and Federal Specification WW-C-5568. The flexible conduit shall have an extruded liquid-tight neoprene jacket in those locations where the conduit will be exposed to a wet environment, or required by the Authority Representative for an approved installation. Appropriate type and sized connectors, couplings and fittings supplied or recommended by the manufacturer for the specific flexible conduits shall be provided.
- C. Rigid non-metallic conduit shall be provided only where specifically required by these Specifications or where, at the request of the Design-Builder, its use has been approved by the Authority's Representative and allowed by the National Electrical Code. Unless otherwise specified, the rigid non-metallic conduit shall be classified as heavy wall type construction.

Appropriate type and sized connectors, couplings and fittings supplied or recommended by the manufacturer for the rigid non-metallic conduit shall be provided.

- D. The Design-Builder shall furnish systems and facilities and select equipment with features that will allow for the utilization of cables sized to fit existing conduit (if any), or the Design-Builder shall be required to furnish and install suitable conduit to Authority standards to accommodate the communications cables required.

2.06 CABLE TRAYS

- A. Cable trays shall be prefabricated aluminum, open ladder type, approximately 3 inches in depth and shall conform to NEMA Standard VE-1. The width of cable trays shall be determined by the Design-Builder, but shall be a minimum of 6 inches. Cable tray bottoms shall have rungs on 4-inch centers. Where applicable, a cantilevered single "wall support" type of tray shall be used.
- B. The cable trays shall support a 100 pound per linear-foot load, with a maximum mid-span deflection of 0.25 inch when considered as a simple beam with supports on eight-foot centers.
- C. Appropriate type and size curved sections, cross sections, tee sections, fittings, accessories and supports shall be furnished in accordance with the manufacturer's recommendations.

2.07 CABLE LADDERS

- A. Cable ladders shall be prefabricated aluminum, open ladder type, approximately three (3) inches in depth and shall conform to NEMA Standard VE-1. The width of cable ladders shall be determined by the Design-Builder to support cables in cable vault or mounted on wall when conduit is not available or conduit is not suitable for installation.

2.08 HARDWARE

- A. Unless otherwise specified, all mounting hardware shall be galvanized. Appropriate type mounting hardware shall be provided for the corresponding supporting surfaces.
- B. Unless otherwise specified, brackets for the mounting and supporting of equipment and material in passenger station areas, yard buildings and other facility buildings shall be painted. Unless otherwise specified, brackets installed in tunnel or outdoor areas shall be galvanized after fabrication in accordance with ASTM A386.
- C. All bolts, nuts and washers for mounting and supporting of equipment within equipment enclosures shall be cadmium plated.

2.09 PAINTING

- A. Equipment furnished and installed by the Design-Builder other than galvanized, copper, plastic and electrical contact surfaces shall be factory painted internally and externally, except as otherwise specified.
- B. Paint colors shall be selected to match existing equipment, where applicable, and shall be subject to the approval of the Authority's Representative.

2.10 SPECIAL REQUIREMENTS FOR STAINLESS STEEL CORROSION RESISTANT HARDWARE

- A. Except as otherwise specified, equipment enclosures, cabinets, boxes and hardware of all types in tunnels, tunnel crossovers, along the surface right-of-way, and in all ancillary

structures that are open to tunnels (vent shafts, fan shafts, pumping stations, etc. - excluding rooms within these areas that are heated/air conditioned) shall consist of stainless steel 304 material. Also, except as otherwise specified, equipment enclosures, cabinets, boxes and hardware of all types; in platform plenums (and including track side walls and under-platform slab and extensions into service rooms); along station train room safety walks, in stairways, corridors, and plenums that are not heated/air conditioned; and in all shafts to the surface and dome reliefs, escalator well ways, elevator pits and surface elevator shafts, shall consist of stainless steel 304 material.

- B. Exceptions: Galvanized conduit may be used with stainless steel 304 mounting hardware. Gray colored fiberglass boxes may be utilized for Emergency Trip Station(ETS) Telephones (Ref. Article 3.7 for product specifications). Non-metallic mounting hardware may be utilized for tunnel and passenger station Mobile Radio System (MRS) antenna cable mounting (Ref. Article 3.13 for product specifications). Electronic equipment connectors, and other relatively small sized specialty items, that are not available in Stainless Steel 304 material, may be allowed by the Authority's Representative as exceptions (Ref. Article 3.1, Request for Approval Of Minor Technical Specification Deviation).
- C. Unless otherwise specified, dull "powder gray" colored Original Equipment Manufacturer (OEM) factory painted exterior surfaces of stainless steel 304 equipment enclosures, cabinets, and boxes shall be utilized in areas where surface glare may be visible to rail car operators, or the Design-Builder shall neatly apply dull colored epoxy paint to surfaces to avoid glare. McMaster-Carr Supply Company (New Brunswick, NJ) Catalog No. 7892T78 (from Cat. #98) gray primer (or approved equal) shall be utilized for the Design-Builder applied paint.
- D. Definition: "Hardware" includes bolts, screws, clamping devices, anchoring devices, threaded rods, nuts, washers, hangers, covers/wall plates etc. "Boxes" includes junction boxes, outlet boxes, disconnect switch boxes, circuit breaker boxes, and terminal boxes, etc. "Cabinets" includes terminal cabinets, equipment cabinets, MDF cabinets, and power distribution panelboards. (Note: definitions include but are not limited to the items listed herein.)

2.11 ELECTRICAL

- A. All electrical and electronic components furnished in accordance with this Contract shall be:
 - 1. New and free of manufacturing defects;
 - 2. Free of storage and handling damages;
 - 3. Clearly and permanently labeled with value or identification type;
 - 4. Rated to operate at power, voltage, and current levels exceeding, by at least 20 percent, those which the components will be subject to in service, unless otherwise noted;
 - 5. Commercially available;
 - 6. Capable of operating in the environment specified in these Specifications;
 - 7. Identical, if performing the same function; and
 - 8. Selected with tolerance limits such that the equipment fabricated from the components shall not malfunction over the specified system/facility or equipment operating range.
- B. The selection of the electrical and electronic components shall be such as to provide maximum convenience and safety to personnel in installing, operating and interchanging a complete assembly or component part. Provisions shall be made to prevent personnel from accidentally coming into contact with hazardous voltages. Components shall be selected to prevent reversed assembly or installation of connectors and cables. Cables shall be suitably identified with their mating connections.

- C. Any deviation from these requirements and the requirements detailed herein, including those inherent in standard production equipment, shall be subject to the approval of the Authority's Representative.

2.12 TRANSISTORS AND DIODES

- A. All transistors and diodes shall carry a Joint Electronic Device Engineering Council (JEDEC) number, shall be available from at least two manufacturers, and shall be silicon. Specially selected transistors and diodes within a type number shall not be permitted.
- B. Resistors shall have a maximum tolerance of plus-or-minus 5 percent and shall be rated to dissipate a minimum of 1.5 times the maximum power they will be required to dissipate in operation.
- C. Zener diodes used for voltage regulation or reference levels shall be of such rating that they will not be damaged if the entire load is removed abruptly, and shall have a Zener voltage tolerance of plus-or-minus 5 percent or better.
- D. Zener diodes used for transient protection shall be of such a rating that they will not be damaged in performing their function within all actual conditions encountered in the operating system/facility.

2.13 CAPACITORS

- A. Wet electrolytic capacitors shall not be used. Only dry electrolytic capacitors shall be provided.
- B. Capacitors shall have a maximum tolerance of plus-or-minus 10 percent and shall be rated for at least 1.5 times the maximum peak voltage they will be subjected to in operation.

2.14 OTHER SEMICONDUCTORS

- A. All other semiconductors shall carry a Joint Electronic Device Engineering Council (JEDEC) number and shall be available from at least two manufacturers. All other semiconductors shall be of the silicon type, unless otherwise approved, in writing, by the Authority's Representative.

2.15 INTEGRATED CIRCUITS

- A. All integrated circuits (ICs) shall be available from at least two manufacturers. The Design-Builder shall take all necessary precautions to ensure that no system or facility using ICs shall malfunction in any fashion due to internally or externally generated noise or cross-talk.
- B. Integrated circuits shall not be damaged by the failure or partial failure of any one or any combination of the various supply voltages. Integrated circuits shall not be damaged by overvoltage of 1.4 times the normal supply voltage, or by short circuits on their inputs and/or outputs.

2.16 TRANSFORMERS

- A. All transformers provided under this Contract shall be of air-cooled, dry type, unless otherwise approved by the Authority's Representative.

- B. Unless otherwise specified, all transformers shall have minimum interwinding and winding to core breakdown voltage of 600 Vdc. Transformers used in electronic circuitry are an exception.
- C. Unless otherwise specified, all transformers shall conform to the following requirements:
 - 1. Core laminations shall be grain oriented silicon steel. Maximum flux densities shall be substantially below saturation level. The core volume shall allow efficient transformer operation at 10 percent above the highest tap voltage. All laminations must be core plated or annealed, free of burrs and firmly butted. The core laminations shall be tightly clamped and compressed to provide quiet operation. Transformers shall not emit audible noise in excess of 50 design-Builder referenced to .0002 dynes per sq. cm., at a distance of three feet, while operating at rated voltage and load.
 - 2. Coil conductors shall be continuous with terminations brazed or welded without auxiliary flux material. The entire core and coil assembly shall be pre-dried by heat, impregnated with varnish or other approved compound, and cured at a minimum of 350 degrees F to reduce hot spots and seal out moisture. Coils shall be protected with an outer layer of glass tape or similar quality insulation.
- D. Unless otherwise specified, all transformers provided under this Contract shall be equipped with suitably insulated screw terminals for all primary and secondary lead wires. Transformers used in electronic circuitry and video isolation transformers are an exception. Appropriate type video connectors shall be provided for the input and output leads of video isolation transformers.

2.17 POWER SUPPLIES

- A. Unless otherwise specified, all power supplies shall have the characteristics and meet the requirements listed herein.
- B. Power supplies shall be for continuous duty and shall be rated at a minimum of 120 percent of maximum load at 50 degrees C.
- C. Power supplies shall be selected for mounting in a standard 19-inch equipment rack and shall be housed in a metal panel-chassis combination with no exposed electrical connections or wires. Appropriate type terminals shall be provided on the rear of the chassis for the connections of all external input and output power leads. An appropriate sized power cord (internally connected) may be provided for the input power leads.
- D. Power supplies shall be selected for natural convection cooling. No supplementary fans or other cooling devices will be allowed.
- E. The power supplies shall not be damaged by a sustained input voltage varying from 0 to 150 percent of the rated input voltage. Power supplies shall have current limiting, which shall protect the power supplies from damage due to overload or short circuits. Overvoltage protection shall be contained on those power supplies driving solid-state circuitry.
- F. Each power supply shall have an output voltmeter, an output ammeter, and a normally illuminated power light (lamp or LED) mounted on its front cover. All panel mounted indicating, adjusting, and protective devices, or openings for such devices, shall be legible and permanently labeled.
- G. Each power supply shall be equipped with a failure alarm device, which shall detect any internal failure that will impair the ability of the power supply to deliver its full rated load. This device shall be normally energized by a small percentage of the rated load current of the

power supply. Upon detection of a failure, the failure alarm device shall provide an independent contact closure for an external alarm indication circuit. The contacts shall be wired to appropriate type terminals on the rear of the chassis. In addition, the failure alarm device shall extinguish the normally illuminated power light on the front cover, when a failure is detected.

- H. Unless otherwise specified, all redundant power supplies shall be diode coupled to the loads with the corresponding main power supplies.

2.18 CONNECTORS

- A. Connectors shall be provided on wires, multi-conductor cables, coaxial cables, and triaxial cables, when required to permit the connection to or removal of equipment items for maintenance, as determined by the Authority's Representative. In-line connectors shall be provided only where specifically required by these Specifications or where, at the request of the Design-Builder, its use has been approved by the Authority's Representative. Appropriate type and size connectors shall be provided for the joining, splicing, and terminating of all coaxial cables and triaxial cables.
- B. Unless otherwise specified, connectors shall not be required for the termination of wires and cables to those equipment items which contain screw type terminals as the interface connection for wires and cables. Connectors shall not be provided in system distribution frames. Appropriate type mating connectors, recommended by the manufacturers, shall be provided for those equipment items requiring connectors for the interfacing of wires and cables. Appropriate type connector assemblies and mating connectors shall be provided to interface wires and cables to all equipment (including system control panels) in the Kiosk and yard consoles.
- C. Appropriate type, size, and rated power connectors (plugs) shall be provided to interface equipment power cords and cables to ac power receptacle strips, ac power outlet assemblies, and ac outlets.
- D. Unless otherwise specified, all multi-conductor cable connectors (including those provided for custom-made equipment and control panels) shall consist of a molded plastic connector block equipped to hold the required number of contacts, a protective shell (plastic or metal), a mechanical keying device, a device to grip the external wiring firmly in order to prevent strain on the contacts, and the required solderless contacts (pins or sockets). The pin and socket contacts shall be fabricated from commercial bronze or brass and have a minimum 0.00003-inch gold plating over nickel underplate. The pins and sockets shall be appropriately sized to interface the corresponding conductor sizes that are to be terminated to the connector. Connectors provided on equipment for the interfacing of wires and cables shall be firmly secured to the chassis.
- E. All connector assemblies shall be easily connected and disconnected by hand. Tools used to apply connector contacts to wires and cable conductors shall be of the size and type recommended by the manufacturer of the connector.
- F. Each connector shall be marked in such a manner that its mating half shall be distinctly identified as being related to each other, but to no other connector within the immediate area. These identification markings shall be applied in such a manner that they will not be obscured or worn off in normal use.
- G. All conductors (including spares) within a cable that interfaces with a connector shall be terminated in the connector.

- H. All in-line connectors installed in wires and cables located inside structures, within tunnel areas, and all connectors installed to equipment which are not located within rooms of passenger stations, ancillary buildings and yards shall be protected by silicon sealer coating, enclosed by heat shrinkable tubing (sleeves). This requirement shall be excluded for all connections with a weatherproof classification.
- I. All in-line connections installed in manholes, hand-holes, cable troughs or cable trenches (direct burial) shall be enclosed in filler splice cases, utilizing products and methods approved by the Authority's Representative.
- J. In-line connection shall not be allowed in conduits, ducts, pipes and cable trays.
- K. All locations of in-line connections shall be documented on As-Built drawings.

2.19 RELAYS, SWITCHES AND PUSHBUTTONS

- A. All electromagnetic relays shall be plug-in type and secured to their corresponding socket to reduce the effects of shock and extreme vibration. Where applicable, retaining wire springs shall be provided with the relays. The contacts of the electromagnetic relays shall be palladium, silver, or gold plated, or shall be mercury-wetted. All contacts shall be bifurcated and shall have a wiping action. The coil and contacts of each electromagnetic relay shall be enclosed in a protective dust cover. Unless otherwise specified or required for a specific function within the associated circuitry, all double throw contacts shall be break-make type (Form "C").
- B. All solid-state relays shall be completely encapsulated in a rugged epoxy case. A minimum of 2500-Vrms isolation shall be provided between the input and the output of all solid-state relays.
- C. All relays shall be of the appropriate type (Vac or Vdc operation) and be of the required input control rating for their intended use. The contacts of the electromagnetic relays and the isolated outputs of the solid state relays shall have ratings that equal or exceed the corresponding connected load requirements (voltage and current).
- D. Arc suppression circuits shall be provided for all relays used in electronic circuitry. Arc suppression may be built into the relays or provided on the printed circuit cards on which the relays are mounted. All time delay relays shall have solid-state timing circuits.
- E. All switch and pushbutton contacts shall be palladium, silver or gold-plated. The contacts shall have a wiping action and shall be rated for their intended use. All switches and pushbuttons shall have a long life expectancy of more than 10,000 operations.
- F. Unless otherwise specified, the types of switches (rocker, toggle, etc.), the operation of the pushbuttons and switches (momentary action, maintained action, etc.), and the configuration of the pushbuttons and switches on developed equipment shall be determined by the Design-Builder and approved by the Authority's Representative. Unless otherwise specified, all pushbuttons and switches on developed equipment shall contain LEDs, if indicators are required. Mechanical interlocking shall be provided when required. Full guard bezel which surrounds the button to help prevent accidental operation and barriers between pushbuttons and switches shall be provided, upon request by the Authority.
- G. All switches and pushbuttons on equipment shall be permanently labeled. Labeling of the switches and pushbuttons shall either be provided on the surface of the equipment to which they are mounted or provided on the switches and pushbuttons themselves. All graphics on pushbuttons and switches shall be hot stamped in a color that will contrast with the color of the buttons (lenses).

2.20 TEST POINTS

Test points shall be provided for each major function. Labeled test points on printed circuit boards and other plug-in modules shall be accessible while the device is in operation.

2.21 PRINTED CIRCUIT BOARDS

- A. All printed circuit boards (cards) shall be constructed of fire-resistant glass epoxy material of NEMA quality FR4 or better. Cards shall have sufficient thickness to permit easy insertion and removal without buckling or breaking and shall be keyed to prevent incorrect interchange. All circuits on the printed circuit boards shall be formed by etching. Conductor material shall be copper and shall be protected from exposure to air.
- B. Boards shall be produced with plated through holes, for component mounting and connecting, and for interfacial connections. If all interconnecting circuitry is confined to one side of the board, the board may be produced with unsupported holes for mounting the components which will be soldered to the pattern side of the board.
- C. Printed circuit boards shall be coated with an approved moisture-proofing compound after assembly, except when this requirement is waived by the Authority's Representative, due to non-availability from manufacturers of approved off-the-shelf dust protected equipment units.
- D. Each printed circuit board shall be permanently and legibly marked with a unique number identifying that type of circuit board (i.e., model number). In addition, each printed circuit board shall be permanently and legibly marked with a unique serial number.

2.22 LED AND INDICATING LAMPS

- A. All indicating lights (LEDs and lamps) shall have a life expectancy of 25,000 hours minimum. All indicating lights shall be operated between 85 percent and 95 percent of their rated voltage.
- B. All indicating lights on equipment shall be permanently labeled. Labeling of the indicating lights shall either be provided on the surface of the equipment to which they are mounted or provided on their associated lenses. All graphics on the lenses shall be hot stamped in a color that will contrast with the color of the lenses.
- C. Unless otherwise specified, all indicating lights (LEDs and lamps) shall be replaceable from the front of the light assemblies.
- D. Unless otherwise specified, all numeric and alphanumeric displays shall be solid state LED display or liquid crystal display. Numeric characters shall be 7-segment type display and alphanumeric characters shall be 14-segment type display. However, a dot matrix display will be considered upon request by the Design-Builder. Unless otherwise specified, all character displays shall be a minimum of ½-inch. Appropriate filters and windows shall be provided.

2.23 METERS

- A. Unless otherwise specified, traditional meter movements shall have a full scale accuracy of ± 2 percent.
- B. All meters shall be of the appropriate type for their intended use; i.e., a meter with an ampere scale shall not be acceptable for the measurement of milli-amperes. All meters shall be legible and permanently labeled.

2.24 TERMINAL BLOCKS

- A. All terminal blocks and terminal strips shall be rated for service at 300 volts minimum. All terminal blocks and terminal strips shall be of the appropriate current rating for corresponding terminated circuits. All terminals of the terminal blocks and terminal strips shall be sized to accept corresponding terminated wire and cable conductor sizes (gauges). Resistance of the terminals shall not exceed 0.0002 ohms.
- B. Unless otherwise specified, terminal blocks and terminal strips provided in junction boxes, equipment enclosures, system distribution frames, equipment cabinets, and termination facilities shall be of the modular, feed-thru type mounted to a metal channel or be of the single molded construction barrier type.
- C. Unless otherwise specified, the modular, feed-thru type terminal blocks and terminal strips shall have pressure clamp contact terminals suitable for solid and stranded wire. Appropriate sized (length) continuous mounting channel shall be provided for each terminal block and terminal strip. Appropriate accessories (end sections, channel clamps, partitions, mounting hardware, etc.) shall be provided for each terminal block and terminal strip. Disconnect apparatus (without removing wires) shall be provided in the terminal assemblies of those terminal blocks and terminal strips, which are utilized in conjunction with protector block assemblies, or otherwise specified within these Specifications.
- D. The barrier type terminal blocks and terminal strips shall be constructed of molded fire-retardant thermoplastic with double row terminals. The terminals shall consist of binding head screws, with the two screws associated with each terminal electrically connected with a brass strip. Appropriate mounting hardware shall be provided for each terminal block and terminal strip.

2.25 PROTECTOR BLOCKS

- A. Unless otherwise specified, each protector block shall be selected for the termination of two pairs (four conductors). The base of each protector block shall be constructed of molded fire-retardant thermoplastic and shall be equipped with four binding posts and four related screw-in arrester units. The four binding posts shall be connected internally to the corresponding arrester units. Each binding post shall be equipped with two nuts and four beveled washers. A ground plate shall be provided on the face of the base of each protector block between the arrester units. The arrester units shall be 2-electrode gas type and provide 400 Vdc fail-short protection.
- B. Multiple protector blocks (two pair type) shall be provided and installed adjacent to each other (vertical rows) for the termination of multi-conductor cables containing more than two pairs.
- C. Appropriate length brass or copper mounting and ground bar assemblies shall be provided for the installation and grounding of the protector blocks. Each mounting and ground bar assembly shall have a minimum of two binding posts with appropriate nuts and washers for the termination of ground wires. Appropriate hardware shall be provided to secure and ground the protector blocks to the mounting and ground bar assemblies. Appropriate mounting hardware shall be provided to install the mounting and ground bar assemblies.
- D. Unless otherwise specified, all wires and cables that enter/exit the Communications Equipment Rooms of passenger stations and yards to/from the WMATA right-of-way shall be terminated on protector blocks in the Communications Equipment Room. All wires and cables that enter/exit equipment within the WMATA right-of-way and enter/exit remote ancillary buildings shall be terminated on protector blocks at the equipment and in the remote ancillary buildings. All wires and cables that enter/exit yard buildings and other special buildings shall be terminated on protector blocks in the yard buildings and special buildings.

All wires and cable conductors (including spares) shall be terminated on protector blocks at each location. Coaxial cables and triaxial cables are exceptions.

2.26 FUSES AND CIRCUIT BREAKERS

All equipment shall be protected by fuses or circuit breakers of the appropriate size. Fuses and circuit breakers shall be readily accessible, surface mounted, on all equipment. Fuse wire within the equipment shall not be acceptable.

2.27 WIRES AND CABLES

- A. Only continuously extruded outer jackets free of polyvinylchloride (PVC) and PVC-based compounds shall be furnished on cables provided in these Specifications. Exceptions may be allowed by the Authority's Representative when such cable is not commercially obtainable only from equipment manufacturers, and when appropriate to avoid potential electrical signal mismatching, or to otherwise improve system performance or reliability.
- B. All single conductor wire and individual conductors of multi-conductor cables shall be copper and shall be insulated.
- C. Multi-conductor cable shall be made by assembling individual or twisted pairs of insulated conductors into a tight cylindrical form. Individual conductors or twisted pairs in a cable having more than two wires shall be assembled helically and with adjacent layers wound in opposite directions. Twisted pairs shall consist of two individually insulated conductor cables with a length of lay as short as good construction will permit, but not longer than ten inches. Where more than one twisted pair is included, length of lay of adjacent pairs shall differ by at least one-half inch.
- D. Unless otherwise specified, all multi-conductor cables installed within the WMATA right-of-way shall contain a metallic shield and a corrugated metallic tape armor. The shield and armor shall be separated by an inner jacket.
- E. Multi-conductor cables containing more than two conductors shall contain 20 percent spare conductors, or two spare conductors (two spare pairs if composed of twisted pairs), whichever is greater.

2.28 HOOK-UP-WIRE

- A. All wiring within electronic equipment selected, or wired by the Design-Builder shall have passed the Underwriters Laboratories VW-1 Vertical Flame Test. The wire size shall be commensurate with the application.
- B. All wires within electronic subassemblies and assemblies shall be identified by adequate color-coding, in accordance with best commercial practices.

2.29 GROUNDING

- A. Communications systems and facilities, equipment and cables shall be grounded using a single-point grounding scheme. Each Communications Equipment Room will have a separate isolated ground bus bar, provided by others, designated as "communications ground."
- B. Unless otherwise specified, the shields of all single shielded communications cables, the shields of multi-conductor cables that have individually shielded pairs, and the inner shield of all double shielded communications cables and communications cables with separate shield and armor, shall be grounded only at a single point and only to the "communications

ground." These shields shall be electrically continuous throughout the cable length by bonding across all splices and terminations in equipment enclosures and junction boxes.

- C. The outer shield of all double shielded communications cables and the armor of all communications cables with separate shield and armor shall be grounded only at a single point in each cable section. The single point ground shall be located at the end of the cable section nearest to the associated Communications Equipment Room. Cable sections originating at Communications Equipment Rooms shall have the outer shield or armor grounded to the "communications ground."
- D. The Information Drawings show details of the cable grounding scheme.
- E. Equipment racks and equipment cabinets shall be electrically isolated from the building structure, adjacent equipment racks and equipment cabinets. Minimum resistance between adjacent equipment racks and equipment cabinets, and between equipment racks and equipment cabinets and the building structure, shall be 10 megohms. Each equipment rack and equipment cabinet shall be individually wired to the communications ground, via the copper ground bus bar on the equipment rack and equipment cabinet, by a No. 6 AWG, stranded, insulated wire, Type XHHW.
- F. Each copper ground bus bar in the multi-section cable terminal housings of the MDF/Protector Cabinet and the systems distribution frames shall be wired to the communications ground by a No. 6 AWG, stranded, insulated wire, Type XHHW.
- G. All power conductors shall be electrically insulated from equipment racks and equipment cabinets, and power ground shall be separate and isolated from communications ground. Conduit containing power conductors running from ac distribution boxes to equipment racks, equipment cabinets, ac receptacle boxes on equipment racks and equipment cabinets shall be insulated from the equipment cabinet or equipment rack by means of short lengths of non-conducting conduit.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Adjacent equipment racks and equipment cabinets shall have a 0.25-inch separation between upright members. They shall be mechanically secured to each other by 0.25-inch nylon bolts and spacers.
- B. Adjacent equipment racks and equipment cabinets shall use rigid non-metallic conduit for interconnecting wiring.

END OF SECTION

THIS PAGE NOT USED

SECTION 16706

COMMUNICATIONS SYSTEM SUBMITTALS & SERVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Submittal procedures
- B. Construction progress schedules
- C. Proposed Products list
- D. Product Data
- E. Shop Drawings
- F. Contract Record Drawings
- G. Spare Parts
- H. Samples
- I. Design data
- J. Test reports
- K. Certificates
- L. Manufacturer's instructions
- M. Manufacturer's field reports

1.02 REFERENCES

AGC (Associated General Contractors of America) publication "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry."

1.03 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Authority Representative accepted form.
- B. Sequentially number the transmittal form - Revise submittals with original number and a sequential alphabetic suffix.
- C. Identify Project, Design-Builder, Subcontractor or supplier, pertinent drawing and detail number, and specification section number, as appropriate.
- D. Apply Design-Builder's stamp, signed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.

- E. Schedule submittals to expedite the Project, and deliver to Authority's Representative. Coordinate submission of related items.
- F. For each submittal for review, allow 30 days excluding delivery time to and from the Design-Builder.
- G. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.
- H. Provide space for Design-Builder and Authority's Representative review stamps.
- I. When revised for resubmission, identify all changes made since previous submission.
- J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

1.04 PROPOSED PRODUCTS LIST

- A. Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.
- C. The Design-Builder shall use the major products described in the Communications Sections when practical, to avoid increasing WMATA's maintenance requirements.
- D. If "equal" products are proposed by the Design-Builder, he shall insure that the proposed products will interface and operate properly with other Design-Builder-supplied products, subsystems and systems, and with existing communications products, subsystems, and systems.
- E. Whenever the Design-Builder proposes a new major product (one where salient characteristics have been described in any Communications Section) that has not been previously used on the Transit System, the Design-Builder shall include that new product in his training program to be conducted for WMATA operations and maintenance personnel.

1.05 PRODUCT DATA

- A. Product Data For Review:
 - 1. Submitted to Authority's Representative for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
 - 2. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article above and for record documents purposes.
- B. Product Data For Information:
 - 1. Submitted for the Authority Representative's review.
- C. Product Data For Project Close-out:
 - 1. Submitted for the Authority's benefit during and after project completion.
- D. Submit the number of copies that the Design-Builder requires, plus two copies that will be

retained by the Authority's Representative.

- E. Mark each copy to identify applicable products, models, options, and other data. Supplement the manufacturers' standard data to provide information specific to this Project.
- F. Indicate Product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- G. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents.

1.06 SHOP DRAWINGS

- A. The Design-Builder shall, unless otherwise directed, submit of all communications system shop drawings to the Authority's Representative for approval. Drawings developed for this project shall be 11" x 17".
- B. The Design-Builder shall develop an Engineering Drawing Index which shall be submitted to the Authority's Representative for review and approval. The drawing index shall include descriptive titles, drawing numbers, revision numbers, and the dates of completion of drawings for communications systems and facilities covered in these Specifications and for all Design-Builder-furnished equipment. The Engineering Drawing Index shall be definitive as to the availability and content of subsequent drawings. It shall be compatible in format and drawing number sequence with Authority Drawing Index for previous Communications Contracts and subject to approval. The Authority's Representative shall assign the drawing number sequence. The drawing number sequence shall be 15XXX. The Design-Builder shall be responsible for maintaining, revising and updating the Engineering Drawing Index for the duration of the Contract. The Engineering Drawing Index shall be revised and updated quarterly, or as required by the Authority's Representative. A completed Final Drawing Index shall be provided to the Authority's Representative at the conclusion of the Contract.
- C. Shop drawings shall be complete, detailed and dimensioned. All necessary shop drawings shall be provided for use in fabricating, assembling, handling, erecting, installing, connecting, trouble-shooting, testing, and maintaining each complete system/facility, all changes to existing systems, facilities and equipment, and all equipment furnished, as follows:
 - 1. Equipment installation drawings, including sections, elevations, and floor plans showing dimensions necessary for installation, equipment base or mounting details, and location of entrance/exit for cable(s).
 - 2. Outline drawings indicating overall dimensions, aisle space requirements, locations of all devices mounted on equipment racks/cabinets and panels, locations of all terminal blocks or connectors for connections to external cable, and removable plates for cable entry; sufficient detail shall be provided to show accessibility for maintenance.
 - 3. Complete detail system/facility block and level diagrams for each system/facility and for all equipment that is provided by the Design-Builder; each block shall represent one specific function, and each apparatus shall be divided into as many blocks as required. Such system/facility diagrams shall also include existing equipment details.
 - 4. Complete cable/wire plan and riser diagrams for each system/facility and all equipment that is provided by the Design-Builder; including designations, destinations, color codes, and termination details for the conductors of each cable and wire.
 - 5. Separate and complete schematic and logic functional diagrams for circuits of equipment furnished by the Design-Builder; circuits which are repetitive may be shown as a single schematic and/or logic functional diagram with identical parts indicated.

- All variations in circuitry must be clearly shown on individual diagrams for each subsystem. Notes which indicate exceptions to typical layout schematics or logics will not be acceptable. Schematic and logic diagrams shall indicate signal flow for all inputs and outputs, bus connections, and all terminal points for external connection. These shall be clearly identified and in agreement with corresponding terminal points on the wiring diagrams. Functional blocks plus their module schematic diagrams on separate drawings will be acceptable for solid-state portions of the logic servicing a specific function. Logic diagrams and schematic diagrams shall conform to the applicable IEEE standards or to alternate approved standards.
6. Interconnecting wiring drawing(s) for each piece of equipment, indicating all terminal points for external cable connections, including cable designations, wire colors or designations; the number of conductors in each cable; and the destination of each cable, by reference to the appropriate unit and Design-Builder's drawing number or point device and drawing number as provided in the Information Drawings.
 7. Wiring drawings with all terminals, relays, modules, and other devices shown in their relative physical locations shall be provided. Each drawing shall indicate exact point-to-point connections between interconnected devices and between devices and terminals for external connections. Wire lists and cable running lists will be accepted if they include a description and a diagram of the system/facility. The Design-Builder shall be responsible for the accuracy of the wiring, terminal point identifications, device identifications, and device designations which shall be in exact agreement with schematic functional diagrams accepted by the Authority's Representative.
 8. Schematics and wiring diagrams for all printed circuit boards with all electronic components and test points shown in their relative locations.
 9. Both the schematic functional diagrams and the wiring drawings shall indicate all the points essential for troubleshooting, with their respective operating voltage levels, logic state, current, or other applicable measurable parameters.
 10. Fabrication and assembly drawings for developed equipment, including panel and chassis layouts, circuit designs, components, graphics, component layouts and list of material.
 11. Additional requirements specified in the various Communications Sections.
- D. Groups of associated drawings shall be submitted together, so that Authority reviewers can evaluate the composite design and interface considerations involved for specification compliance. Submissions not in compliance with the foregoing requirement may be returned by the Authority without action.
- E. Separate drawings shall be furnished for each Yard Communications System for each of the respective WMATA Yards and Shops. Site specific drawings shall be developed for each system. Notes which indicate exceptions to a typical drawing shall not be acceptable.
- F. During construction, (after Shop Drawing approval) the Design-Builder shall maintain for inspection by the Authority's Representative a record set of Shop Drawings annotated to show all authorized changes incorporated as work progresses. Three set of annotated Shop Drawing shall be submitted not later than three working days after changes are authorized by the Authority's Representative. Information shall include, but not be limited to, the following:
1. Field changes of any type.
 2. Changes accomplished by Change Orders (Change Orders may also specify requirements for the prior submission and approval of Shop Drawings before work commences).
- G. Before Substantial Completion Inspection (SCI), the Design-Builder shall furnish to the Authority's Representative Shop Drawings for the record, all clearly revised and completed and brought up to date, showing the permanent construction as actually accomplished. Not later

than 15 calendar days after Substantial Completion, updated shop drawings shall also be submitted on electronic media using the latest version of AutoCad (.DWG) or other Authority approved drawing file formats.

- H. Work in the Contract requires modifications, reconfigurations and connections of various existing communications systems and facilities in the transit yards, sites along the rights-of-way and the Jackson Graham Building. Upon request by the Design-Builder, and approved by the Authority's Representative, existing Authority Record Drawings may be obtained to incorporate the requirements of this Contract and may be submitted as Contract Shop Drawings. Process for utilizing the Authority Record Drawings shall be in accordance with the requirements of the CONTRACT RECORD DRAWINGS article of this Section.

1.07 CONTRACT RECORD DRAWINGS

A. General:

1. Before the scheduled date of the Final Acceptance of all Contract work, the Design-Builder shall submit approved as-built drawings, and electronic media for the completed work.

B. As-built Drawings:

1. As-built CONTRACT RECORD DRAWINGS shall include Installation Drawings, Shop Drawings, Working Drawings, kiosk data file drawings and revisions to all affected existing Authority Record Drawings.
2. Authority Record Drawings are as-built drawings provided to the Authority in previous communications contracts. The Design-Builder shall coordinate with the Authority to determine which existing Authority Record Drawings require revisions.
3. The Authority will furnish the Authority Record Drawings which require revisions from which the Design-Builder shall make reproductions for his use in preparing as-built drawings. Images shall be clear, sharp and readily legible.
4. Revisions to Authority Record Drawings shall match the base drawings in line weights, symbols, and lettering style and size. Drafting shall be performed with AutoCad software, and shall match original Information Drawings in line weights, symbols, and lettering style and size.
5. The Design-Builder shall submit three sets of prints of as-built drawings in a timely manner for review and approval.
6. Additions and corrections resulting from Authority review comments shall be incorporated by the Design-Builder. Three copies shall be submitted to the Authority not later than the applicable date specified in the Contract Schedule. Final As-Built Drawings shall also be submitted on electronic media (5 sets of CD-ROM's) using either AutoCAD(.DWG) or other Authority approved drawing file formats.
7. Completed as-built Contract Record Drawings shall bear the signature of an officer of the Design-Builder's organization, certifying compliance with as-built conditions using a rubber stamp, or electronic facsimile, as follows:

As-Built

Date _____

I certify that this drawing
accurately depicts the work
as constructed.

An Officer of the Company

Signature _____ Title _____

Design-Builder'S NAME

1.08 SPARE PARTS

This Contract includes the requirement for Communications spare parts. The Design-Builder shall assure that all spare parts required by this Contract are provided and delivered in accordance with the requirements of Division 1.

1.09 TRAINING

- A. The objective of the training program shall be to train WMATA maintenance and operating personnel to properly operate, diagnose, troubleshoot and maintain the communications equipment and/or systems provided by, or affected by, work in this Contract. Training shall be provided to cover the operations and maintenance of systems, equipment and components which have not previously been installed on the Metrorail System.
- B. The Design-Builder's training program shall be conducted by fully qualified instructors. The instructors shall have thoroughly mastered the specific specialized subject matter involved and shall have the ability to impart technical information to others in easily understood terms.

1.10 SAMPLES

- A. Samples For Review:
 - 1. Submitted to Authority's Representative for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
 - 2. After review, produce duplicates and distribute in accordance with Submittal Procedures article above and for record documents purposes.
- B. Samples For Information:
 - 1. Submitted for the Authority Representative's knowledge.
- C. Samples For Selection:
 - 1. Submitted to Authority's Representative for aesthetic, color, or finish selection.
 - 2. Submit samples of finishes from the full range of manufacturers' standard colors, textures, and patterns for Authority's Representative selection.
 - 3. After review, produce duplicates and distribute in accordance with Submittal Procedures article above and for record documents purposes.
- D. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- E. Include identification on each sample, with full Project information.
- F. Submit the number of samples specified in individual specification sections, one of which will be retained by Authority's Representative.
- G. Reviewed samples that may be used in the Work are indicated in individual specification sections.
- H. Samples will not be used for testing purposes unless specifically stated in the specification section.

1.11 DESIGN DATA

- A. Submitted for the Authority Representative's review.
- B. Submit for information for the purpose of assessing conformance with information given and the design concept expressed in the contract documents

1.12 TEST REPORTS

- A. Submitted for the Authority Representative's review.
- B. Submit test reports for information for the purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.13 CERTIFICATES

- A. When specified in individual specification sections, submit certification by the manufacturer, installation/application subcontractor, or the Design-Builder to Authority's Representative, in quantities specified for Product Data.
- B. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Authority's Representative.

1.14 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Authority's Representative for delivery to Authority in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- C. Refer to Section 16707 - Communications Systems Tests, Manufacturers' Field Services article.

1.15 MANUFACTURER'S FIELD REPORTS

- A. Submitted for the Authority Representative's review.
- B. Submit report within 30 days of observation to Authority's Representative for information.
- C. Submit for information for the purpose of assessing conformance with information given and the program criteria expressed in the contract documents.

PART 2- PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16707

COMMUNICATIONS SYSTEMS TESTS

PART 1 - GENERAL

1.01 SECTION DESCRIPTION AND BASIC REQUIREMENTS

- A. The Design-Builder shall provide and maintain the inspection and test plans required to cover the equipment, materials, and services specified herein.

1.02 RELATED SECTIONS NOT USED

1.03 REFERENCES

- A. American National Standards Institute (ANSI) Standard ANSI/ISO/ASQC Q9002-1994

1.04 DEFINITION OF TERMS

- A. Inspection and Test Plan: A document detailing how the Design-Builder will inspect and test Contract equipment, materials, workmanship, and services.
- B. Inspection: The physical act of verifying, by measurement and examination of the equipment, materials, workmanship, and services, that they conform to approved documents and established quality requirements

PART 2 - PRODUCT

NOT USED

PART 3 EXECUTION

3.01 TESTING MANAGEMENT

- A. This Section contains requirements which are unique to the communications equipment. The requirements herein shall be completed in addition to testing specified elsewhere in this specification.

3.02 INSPECTION AND TESTING

- A. The Design-Builder shall establish and implement a Unified Test Program that will ensure all communications and related systems, equipment, material and services, furnished during the performance of this Contract, meet the technical requirements and standards specified, as well as all performance criteria.
- B. As part of the Design-Builder's area of responsibility for the Unified Test Program, the Design-Builder will be required to:
 - 1. Develop a comprehensive Test Plan detailing methods and test procedures to be utilized to ensure compliance with all applicable specifications.

2. Develop detailed test procedures for each individual test within each category of testing, except Authority tests.
 3. Submit the Test Plan (including Authority System Validation Tests, Substantial Completion Acceptance, and Final Acceptance Programs) and all test procedures to the Authority's Representative for evaluation, review, and acceptance or rejection. Revise and resubmit until acceptance by the Authority's Representative is received.
 4. Furnish personnel, calibrated test equipment, tools, and miscellaneous supplies as necessary to perform all tests and retests, and to maintain all systems and equipment during the test period and until acceptance by the Authority.
 5. Coordinate Unified Test Program activities with the schedules and activities of other Design-Builders and with the Authority's Representative, to avoid conflicts with Authority operational requirements.
 6. Perform tests and inspections as detailed in all approved test procedures.
 7. Evaluate test procedure and inspection results and documentation. Prepare detailed test evaluation reports, summary reports and progress reports.
 8. Submit all raw test data, test results, evaluations, and summary reports for evaluation, review and acceptance or rejection by the Authority's Representative.
 9. Prepare and submit revised test procedures and test plans to correct procedural and technical errors or omissions discovered in those documents, after their initial Authority acceptance.
 10. Furnish corrective actions to effect Specification compliance, including: Remedy test program deficiencies, and system, equipment, material, workmanship, and documentation deficiencies promptly upon request by the Authority's Representative.
 11. Perform retesting and additional inspections until successful results are obtained, evaluated, and accepted by the Authority's Representative.
 12. Participate in Authority Pre-final Inspections, Substantial Completion (if any), and Final Acceptance activities. Clean the equipment and work site, secure the equipment, and remain responsible for prompt repair or replacement in the event of loss or damage until acceptance by the Authority is received. Furnish inventory services and demonstrate system or equipment operation in support of requests by the Authority. Provide support and access so that the Authority's Representatives, Technicians, Mechanics and Inspectors can inspect and test any portion of the work during normal work hours.
 13. Provide Unified Test Program reports on a monthly basis beginning within 30 days after the Authority's Representative's acceptance of the Test Plan, and continuing until the final completion of all contract work.
- C. The performance of each task requirement shall be subject to the Authority's Representative's acceptance of methods, procedures, and results, for Specification compliance, and as to scheduling for the benefit of the Authority.
- D. A Preliminary Test Plan shall be submitted to the Authority's Representative for review. Subsequently, the Final Test Plan shall be submitted to the Authority's Representative for review and acceptance or rejection. In the event of rejection or subsequent rejections, corrected re-submissions shall be delivered to the Authority's Representative within 15 days after the receipt of each rejection.
- E. Detailed test procedures shall be submitted to the Authority's Representative for review and acceptance or rejection. In the event of rejection or subsequent rejections, corrected re-submissions shall be delivered to the Authority's Representative within 15 days after receipt of each rejection. Approved test procedures shall be required prior to commencing any associated test.

- F. Each individual test procedure shall include, but not be limited to: An outline of test objectives, detailed step-by-step procedures with required results and allowable tolerances for each measurement or observation, diagrams illustrating all required test set-ups, manufacturer and model number of each unit and accessory item of required test equipment, and further details as may be required by the Authority's Representative to ensure that both Design-Builder and Authority field forces are presented with a totally comprehensive, understandable and accurate working procedure.
- G. The Design-Builder shall include complete and adequate safety procedures, warnings, and emergency instructions in Test Plans and test procedures, as appropriate. Test procedures shall also include complete examples of test Data Record Forms with required resultant values and allowable tolerances, in accordance with Specification requirements.
- H. The Authority reserves the right to perform additional non-destructive tests and inspections at any time during the course of the contract work. Results indicating deficiencies involving noncompliance with Specification requirements will be reported to the Design-Builder for corrective action.

3.03 DEFICIENCIES

- A. If the Authority's Representative determines from test data acquired from any category of test(s) that the system, equipment, materials, technical documentation, or services furnished do not conform to any Specification requirement(s), the Design-Builder shall recommend appropriate remedial action based on an analysis of test results within fifteen days after receipt of the Authority's Representative's notice of deficiency. When such recommendations relate to Authority's Representativeing deficiencies, the Design-Builder shall, upon receipt of the Authority's Representative's approval, make the necessary changes to all equipment and documentation of the type to be delivered or previously delivered (even if previously accepted) during the course of the Contract, at no additional cost to the Authority.
- B. When recommendations relate to other deficiencies such as quality control and installation workmanship, the Design-Builder shall correct all deficiencies at each location, at no additional cost to the Authority. Retesting after the changes have been completed (Factory Tests and Inspections, Installation Completion Tests and Inspections, and Technical Documentation Verifications) shall be required in whole or part, as determined by the Authority's Representative, at no additional cost to the Authority. If the timely correction of all deficiencies is not completed to effect Specification compliance, as evidenced by the Authority's Representative's acceptance of retest results, the Authority's Representative will initiate remedial actions to the benefit of the Authority. Such actions may include the exercise of warranty, correction of deficiency, delay of payments, disputes or default, and termination actions, in accordance with the General Provisions, or actions of benefit to the Authority, in accordance with any combination of these and other Specification provisions.

3.04 CATEGORIES OF TESTS

- A. Tests and inspections shall be required in each of seven categories, as listed below:
 - 1. Factory tests and inspections, including factory certifications and factory calibration certifications.
 - 2. Installation completion tests and inspections.
 - 3. System and integration tests.
 - 4. System validation tests and evaluations (Authority Conducted Program).
 - 5. Substantial Completion acceptance tests and inspections (if any) (Authority Conducted Program).
 - 6. Technical documentation verification inspections.

7. Final acceptance tests and inspections (Authority Conducted Program).
- B. Each test and inspection in each category shall be comprehensive, so that sufficient test result data and inspection result data is furnished to permit complete detailed examination and evaluation, as determined by the Authority's Representative.
- C. Additional specialized testing shall also be furnished, as defined in individual system specification Sections .
- D. Retesting, and the acceptance or rejection of test results, documentation, and evaluations, shall be within the discretion of the Authority's Representative.

3.05 FACTORY TESTS AND INSPECTIONS

- A. All equipment and materials, including custom developed Additional Equipment and any custom developed Test Equipment, furnished in accordance with these Specifications, shall be subject at all times and during all stages of manufacture and assembly, to inspection, test, and rejection by the Authority's Representative. The Authority's Representative may elect to accept factory or Design-Builder certifications in lieu of complete test result data for certain items when, 1) a WMATA accepted factory test has been previously conducted on one or more production samples or identical deliverable products, 2) the same brand and model of the product to be furnished has proven reliable in Authority revenue service for one year or more, or 3) to simplify test program administration when not adverse to achieving Test Program objectives.
- B. Before offering items for inspection or test, the Design-Builder shall furnish a complete set of applicable drawings for Authority use including, but not limited to, schematics, wiring diagrams, major assembly drawings, manufacturing drawings for custom developed equipment, and detailed specifications for the equipment and materials to be tested.
- C. The Design-Builder shall submit Factory Test and Inspection Plans and Procedures to the Authority's Representative for review. Tests required shall be performed at the point of manufacture and the point of assembly before shipment to the field. The Design-Builder shall furnish additional testing by an independent testing laboratory if the manufacturer's Factory Test Plan or Procedures are determined by the Authority's Representative to be inadequate to verify Specification compliance (a maximum of three major items may be designated by the Authority's Representative for independent laboratory testing at no additional cost to the Authority).
- D. After the Authority's Representativeing Development Review for each system has been submitted and approved by the Authority's Representative, Factory Tests and Inspections shall be scheduled for major items, custom prototypes, and other items of equipment and material designated for such testing by the Authority's Representative, to verify compliance with environmental criteria, quality assurance, specified performance, grade of components, reliability, and workmanship including manufacturing processes. The Design-Builder shall advise the Authority's Representative, in writing, when manufacturing of equipment begins and again two weeks prior to date of scheduled inspection or tests.
- E. A "Report of Factory Visit" for the purpose of confirmation and subsequent agreement of any decisions made on site shall be prepared by the Design-Builder and submitted to the Authority's Representative ten working days subsequent to each factory visit by the Design-Builder, Authority's Representative, or designated Authority Representative. Each report shall include the purpose of the visit, summary of tests performed and decisions made or required prior to factory certification and shipment.

- F. Two copies of test results certified by the manufacturer or an independent laboratory shall be furnished to the Authority's Representative for review and acceptance or rejection prior to shipment. Equipment shall not be shipped before the factory test results have been accepted by the Authority's Representative. Optionally, the Authority may elect to accept Design-Builder certified test and inspection results in lieu of manufacturer or independent laboratory certified test results.
- G. A 200 hour burn-in period (power on - attended or unattended) shall be required for all units of electrically operated and powered custom-made major items of equipment prior to installation, in accordance with instructions from the Authority's Representative. Each unit of custom made equipment shall be set up and powered on the Design-Builder's, SubDesign-Builder's, or supplier's premises. Reports of such activity shall be furnished to the Authority's Representative.

3.06 INSTALLATION COMPLETION TESTS AND INSPECTIONS

- A. Installation Completion Tests and Inspections shall be performed after installation to ensure that equipment and materials were not damaged in shipment and that they are properly installed and functioning in accordance with specified criteria, parameters and good commercial practice. Installation Completion Tests and Inspections shall consist of:
 - 1. Visual inspection with check-off lists to verify the following:
 - a. That full compliance with requirements detailed in the General Equipment and Material Standards and General Installation Standards sections of these Specifications has been met.
 - b. That only approved products have been used.
 - c. That Factory Tests and Inspections have been satisfactorily completed for major items, as required.
 - d. That inventory of major equipment and material items is available and accurate.
 - e. That equipment is installed in agreement with approved installation shop drawings.
 - f. That wire and cable terminations as to location, cable identification, routing, color code, and workmanship have been identified.
 - g. That Time Domain Reflectometry (TDR) measurements of all coaxial and outside plant cables have been made. Printed TDR records of each coaxial and outside plant cable shall be delivered to the Authority to illustrate the length of cable run (proven by demonstrating an open and a short condition before final termination), and the absence of any detectable faults on each coaxial cable and each outside plant cable pair after installation of the cable.
 - 2. Detailed testing shall be required to demonstrate that material and equipment installed meet the criteria and possess the characteristics and parameters contained in the Contract Specifications; including additional requirements and stated tolerances that are specified in Design-Builder Authority's Representative and product approval data submissions and in manufacturer's published specifications attributed to approved products.
- B. The testing of all items of equipment and material shall include electrical, mechanical, operational, and functional parameters. Such parameters include, but are not limited to: Levels of voltages, currents, power, distortion, noise, cross-talk, insulation resistance, continuity, attenuation (optical and electrical), physical strength, suitability of mounting method, paint and marking quality, graphics quality and style, location of operating controls and adjustments, and maintainability.

- C. These tests shall be performed after the installation of material and equipment and shall be in addition to any Factory Tests and Inspections previously performed. The Design-Builder shall perform all necessary alignments, adjustments, and maintenance prior to requesting the scheduling of Installation Completion Tests and Inspections.
- D. The Design-Builder shall advise the Authority's Representative, in writing, two weeks prior to the date(s) of scheduled tests and inspections. The Authority's Representative will witness these tests. Two certified copies of Installation Completion Test and Inspection data shall be submitted to the Authority's Representative within seven (7) days after test completion for review and acceptance or rejection.

3.07 SYSTEM AND INTEGRATION TESTS

- A. System and Integration Tests shall be on-site performance tests to verify that all operating parameters and functions perform as specified and that each system performs as specified in conjunction with each system or subsystem with which it interfaces. The Design-Builder shall demonstrate that all material and equipment elements of each installed system function together to meet the system criteria specified. Each system shall be powered a minimum of 48 hours prior to commencing system and integration tests. The Authority's Representative shall be notified, in writing, seven (7) days prior to equipment being powered. Failures shall be recorded by the Design-Builder and findings furnished to the Authority's Representative at the end of the 40 hours. The Design-Builder shall also include a description of corrective actions taken.
- B. The Design-Builder shall be responsible for meeting all System and Integration Test requirements including testing and documenting interface compatibility and integration with existing Authority-owned systems and equipment.
- C. Each and every interface shall be verified as to operation, function, level, and voltage. The Design-Builder shall test across the interface points; however, these tests shall only be made under the supervision of appropriate Authority personnel. When minor adjustment to, or reconfiguration of, existing equipment is required, the Design-Builder shall notify the Authority's Representative, in writing, of the required adjustment or reconfiguration. Authority personnel will make the adjustment or reconfiguration in the presence of the Design-Builder. The Design-Builder shall be responsible for the necessary adjustments or reconfigurations of Design-Builder-furnished equipment to ensure proper functioning, as specified.
- D. The successful completion of all specified Factory Tests and Inspections, and Installation Completion Tests and Inspections, including the correction of all outstanding discrepancies and subsequent retesting, is required as a prerequisite to System and Integration Tests.
- E. The tests will vary with each specific system. However, each test shall include all operating parameters and functions. Tests shall be conducted on a location-by-location basis with all failures and discrepancies noted. The Design-Builder shall not engage in further testing until the Authority's Representative has verified that the Design-Builder has taken necessary corrective action with respect to those failures and discrepancies. The Design-Builder shall retest after each successive failure and corrective action to verify Specification compliance.
- F. The Design-Builder shall advise the Authority's Representative, in writing, two weeks prior to the date(s) of scheduled tests. Prior to commencing the System and Integration Tests, the Design-Builder shall provide failures recorded and corrective action taken, at the conclusion of powering equipment a minimum of 40 hours. The Authority's Representative will witness these tests. Two certified copies of System and Integration Test data sheets shall be

submitted to the Authority's Representative within seven (7) days after test completion for review and acceptance or rejection.

3.08 MEASURING AND TEST EQUIPMENT

- A. The Design-Builder shall establish and implement measures for the selection, calibration, and control of measuring and test equipment (M&TE) used to determine conformance.
- B. M&TE of a range, accuracy, and sensitivity conforming with measurement tolerances specified within this contract shall be selected and used.
- C. Calibration procedures shall require M&TE identification and establish frequency of calibration, calibration method, acceptance criteria, records to be generated, and the action to be taken when results are unsatisfactory.
- D. M&TE shall be periodically calibrated using certified references traceable to the National Institute of Standards and Technology (NIST), to other nationally recognized standards when no such NIST standards exist, or to a documented standard acceptable to the Authority's Representative when none of the preceding standards exist.
- E. The calibration of M&TE shall be checked at prescribed intervals if testing or inspection will continue over an extended period.

3.09 INSPECTION AND TEST STATUS

- A. The Design-Builder shall establish and implement measures to identify and maintain the inspection and test status of systems, equipment or components until these are accepted by the Authority's Representative, to ensure that only purchased items that have passed the required inspection and test have been used.
- B. The means for status identification shall be such that the surface of the item is not damaged nor its use impaired. Status identification may also be via inspection records, test software, physical location, or other suitable means, which indicate the conformance or nonconformance of these items with regard to inspection and tests performed.

3.10 CONTROL OF NONCONFORMANCE

- A. The Design-Builder shall establish and implement measures to prevent the inadvertent use or installation of nonconforming items.
- B. Procedures shall provide for identification, segregation, documentation, evaluation, and disposition of nonconforming items, define the responsibility and authority for the disposition of nonconforming item.
- C. Nonconforming items shall be positively identified and the matter brought to the attention of Supplier's management representative, the Authority's Representative, and the appropriate OEM, subDesign-Builder or sub-supplier.
- D. The Design-Builder shall hold the nonconforming item from further work and, where possible, shall be physically segregated in an area clearly marked, until the responsible parties have provided for the disposition of the item.
- E. The disposition of a nonconforming item may be:
 - 1. Reworked (to meet original requirements)

2. Accepted as-is
 3. Repaired (to meet an alternative criteria)
 4. Re-graded (for alternative use)
 5. Rejected, returned to vendor, or scrapped
- F. The Design-Builder shall obtain written approval from the Authority's Representative prior to using a nonconforming item as-is or repairing it to be acceptable to a standard different from the original standard.
- G. Nonconforming items that have been repaired or reworked shall be re-inspected or retested by the party responsible for the original inspection or test in accordance with approved acceptance standards before being declared acceptable.
- H. The technical details of nonconformity that have been accepted as-is and of any repairs made shall be included in "as-built" documentation.
- I. Items for return to vendor shall be removed from the area of work and controls placed to prevent the reuse of the item or any part of it.
- J. Rejected or scrapped items shall be removed from the area of work and rendered unusable in a manner that prevents their inadvertent use.

3.11 CORRECTIVE ACTION

- A. The Design-Builder shall establish and implement measures to:
1. Investigate the cause(s) of noncompliance and nonconformance, and identify action(s) to prevent recurrence.
 2. Implement corrective action to minimize or eliminate noncompliance or nonconformance.
 3. Apply controls over the implementation of corrective action.
 4. Incorporate the preventive action into procedures.

END OF SECTION

SECTION 16710

COMMUNICATIONS GROUNDING

PART 1 - GENERAL

1.01 SECTION DESCRIPTION AND BASIC REQUIREMENTS

- A. This section describes hardware, and installation methods that the Contractor shall use to insure the installation of a competent grounding system that will avoid/minimize ground-loops, and Electromagnetic Interference (EMI) problems in the operation of the communications systems installed under this Contract. In addition to the methods detailed in this Section, the Design-Builder shall insure that his crews adhere to all generally accepted installation practices that are meant to minimize interference between communications systems

1.02 SECTION INCLUDES

- A. Equipment and Rack Grounding.
- B. Cable Shield Grounding.

1.03 REFERENCES

- C. NFPA 130 - Standard for Fixed Guideway Transit Systems

1.04 SUBMITTALS

- A. Submit under provisions of Section 16706.
- B. Shop Drawings: Indicate electrical system wiring diagram.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Ground Communication system and facilities, equipment and cables using a single-point grounding scheme. Each Communication Equipment Room will have a separate isolated ground bus bar designated as "communications ground."
- B. Unless otherwise specified, ground the shields of all single shielded communications cables, the shields of multi-conductor cables that have individual shielded pairs, and the inner shield of all double shielded communications cables and communications cables with separate shield and armor only at a single point and only to the "communications ground." These shields shall be electrically continuous throughout the cable length by bonding across all splices and terminations in equipment enclosures and junction boxes.
- C. Ground the outer shield of all double-shielded communications cables and the armor of all communications cables with separate shield and armor only at a single point in each cable

section. Locate the single point ground at the end of the cable section nearest to the associated Communications Equipment Room. Ground outer shield or armor cable sections originating at Communications Equipment Rooms to the "communications ground."

- D. Electrically isolate equipment racks and equipment cabinets from the building structure, adjacent equipment racks and equipment cabinets. Minimum resistance between adjacent equipment racks and equipment cabinets, and between equipment racks and equipment cabinets and the building structure, shall be 10 megohms. Individually wire each equipment rack and equipment cabinet to the communications ground, via the copper ground bus bar on the equipment rack and equipment cabinet, by a No. 6 AWG, stranded, insulated wire, Type XHHW or THHN.
- E. Wire each copper ground bus bar in the multi-section cable terminal housings of the Main Distribution Frame (MDF)/ MDF/Protector Cabinet and the systems distribution frames to the communications ground by a No. 6 AWG, stranded, insulated wire, Type XHHW or THHN.
- F. Electrically insulate all power conductors from equipment racks and equipment cabinets, with a separate power ground isolated from communications ground. Insulate Conduit containing power conductors running from ac distribution boxes to equipment racks, equipment cabinets, ac receptacle boxes on equipment racks and equipment cabinets from the equipment cabinet or equipment rack by means of short lengths of non-conducting conduit.

END OF SECTION

SECTION 16716

COMMUNICATIONS YARD ELECTRICAL POWER DISTRIBUTION SYSTEM

PART 1-GENERAL

1.01 PURPOSE

- A. The Yard Electrical Power Distribution System provides power distribution from a 3-phase, 4-wire, 120/208 VAC, primary power feed, to the Yard communication room disconnect switch. This system shall be modified as necessary to provide power to the various communications systems.

1.02 SYSTEM DESCRIPTION

- A. The Communications Power Distribution System described herein includes the following facilities:
1. 110/120 VAC Emergency Power (from existing UPS) for communications equipment in the Yard Communications Equipment Room(s), Yard Control Room and the Gatehouse.
 2. -48 VDC power for communications equipment in the Communications Equipment Room.
- B. The 120 VAC Emergency Power Distribution System described herein includes but is not limited to the following components:
1. In the Communications Equipment Room;
 - a. Power Distribution Panelboard
 - b. AC Power Receptacles
 - c. AC Power Disconnect Switches
 2. In the Yard Control Room
 - a. AC Power Disconnect Switch
 - b. AC Power Receptacles
 3. In the Gatehouse
 - a. Emergency AC Power Disconnect Switch
 - b. Emergency Power Distribution Panelboard
 - c. AC Power Receptacles
 4. Required conduits and fittings, junction boxes, feeder wires, and branch circuit wiring and cabling to apportion the 120 VAC power to the communications systems and facilities equipment.
- C. The -48 VDC Power Distribution System described herein includes but is not limited to the following components:
1. In the Communications Equipment Room;
 - a. -48 VDC Power Supply
 - b. -48 VDC Power Distribution System Status Panel.
- D. The -48 VDC Power Distribution System provides fail safe service by load-sharing several power supplies. Power supplies may be removed from the active -48 VDC Power Distribution System for repair, or added for increased capacity without disrupting communications services.
- E. The Status Panel provides voltage and current metering for the -48 VDC Power Distribution System. The Status Panel also distributes -48 VDC power to the Carrier Transmission (CTS),

and Fiber Optic (FOS) Systems equipment racks and, as needed, to any other communications equipment racks requiring a source of -48 VDC powers. The -48 Vdc shall be modified as necessary for additional equipment loads.

PART 2-PRODUCTS

2.01 MAJOR ITEMS TECHNICAL REQUIREMENTS

- A. The Major Items listed below shall conform to the operational and performance requirements of these Specifications. Incidental items, not specifically mentioned but required for complete and proper system operation, shall be furnished and installed by the Design-Builder.

2.02 POWER DISTRIBUTION PANEL BOARD

- A. Square D Co., Model No. NQOD424L100CU with Model No. MH23WP NEMA 12 enclosure (or approved equals).
- B. Type: NQOD, 3-phase, 4 wire, 120/208 Vac, main lugs only with isolated solid neutral bus and a ground bus.
- C. Capacity: 20 single-pole branch circuit breakers.
- D. Panel Amperage: Main Lugs, 100 Amps.
- E. Enclosure: NEMA Type 12 surface mounting and surface screw front cover with hinged door and flush lock.
- F. Circuit Breakers: 16 single-pole NEMA Standard AB-1.

2.03 FIRE AND INTRUSION POWER DISCONNECT SWITCH

- A. Square D Co., Model No. H221NA.
- B. Type: NEMA Standard KS1 (latest edition), type LD, and NEMA type 12, 2-pole, 3-wire, 240 Vac, single throw, fused with isolated solid neutral bus and a ground bus.
- C. Amperage Rating: 30 Amps.
- D. Fuse Rating: Appropriate for the Fire and Intrusion Alarm System power requirements.
- E. Surface Mount enclosure with knockouts.
- F. Color: OSHA red.

2.04 10 OUTLET AC POWER RECEPTACLES

- A. Wiremold Company Multioutlet System/Plugmold 2000, Series GB, Model No. 20GB506 (or approved equal).
- B. Prewired receptacles on 6-inch centers.
- C. 3-wire circuit, insulated ground conductor.

- D. Receptacles grounded to raceway.

2.05 6 OUTLET AC POWER RECEPTACLES

- A. Wiremold Company Multioutlet System/Plugmold 2000, Series GB, Model No. 20GB306 (or approved equal).
- B. Prewired receptacles on 6-inch centers.
- C. 3-wire circuit, insulated ground conductor.
- D. Receptacles grounded to raceway.

2.06 DUPLEX AC POWER RECEPTACLE

- A. Arrow Hart Division, Cooper Industries Model No. IG5362 with Model No. IG8248 wall plate (or approved equals).
- B. Rated for 20 Amps, 125 VAC.
- C. Isolated ground receptacle.
- D. Color: orange.

2.07 WIRE

- A. Triangle Pwc., Inc., Everene, Type RHW (or approved equal)
- B. Insulation Type: Cross linked Polyethylene in accordance with ICEA S-66-524.
- C. Conductors: 12 AWG or larger Class B stranded copper
- D. Voltage Rating: 600 volts.

2.08 GROUND CLAMP

- A. Wiremold Company Multioutlet System/Plugmold 2000, Model No. 2009 (or approved equal).
- B. Compatible with plugmold 2000
- C. For use on multi-outlet systems.
- D. Plated.

2.09 -48 VDC POWER SUPPLY

- A. Power Conversion Products model No. PS-19 shelf (or approved equal).
- B. Complete with PCP Model No. MOD-4812 rectifier modules (quantity of 2 per shelf).
- C. Input: 95-130VAC, 60 HZ (nominal), Power Factor: PF>90%.
- D. -48VDC, 24 AMP Load sharing output.

- E. Rectifier Output Failure indicator with Form "C" alarm contacts.
- F. High DC Voltage shutdown.
- G. 19-inch Rack mount complete with 23-inch rack mount adapters and hardware.

2.10 -48VDC POWER SYSTEM STATUS PANEL

- A. Power Conversion Products: Mini Load Center Model No. MDM-48-75 complete with 6 appropriately sized alarm breakers (or approved equals).
- B. Voltage and current metering (2% accuracy).
- C. High/Low DC Voltage Alarm Form-C Contacts.
- D. 6-position alarm breaker power distribution panel.
- E. 19-inch Rack Mount complete with 23-inch rack mount adapters and hardware.

2.11 CCTV EQUIPMENT CABINET POWER ISOLATION/STEP-DOWN TRANSFORMER

- A. Secondary: Able to supply 110/115 VAC, 1KVA (nominal).
- B. Wall/cabinet mount case style.
- C. Grounded Faraday electrostatic shield.
- D. UL-listed.

2.12 120 VAC POWER DISTRIBUTION TERMINAL STRIP

- A. Weidmuller Model SAKR terminal blocks with Model EK2 ground blocks and model SAKS1 Fuse block (or approved equals).
- B. 10 AMP fuse with indicator.
- C. Disconnect/test terminal blocks.
- D. Complete with test sockets, labeling, fuses, protective cover(s), and all required terminal block mounting hardware and accessories.

2.13 110 VAC POWER RECEPTACLE STRIP

- A. WABER, INC. Model No. UL24RA-6 (or approved equal).
- B. Six-110 VAC Receptacles.
- C. Illuminated on/off switch.
- D. UL-approved.

- E. Complete with all required installation and mounting hardware, wiring, and any required modification.

2.14 CCTV EQUIPMENT CABINET

- A. Metallic construction, NEMA-4X rated.
- B. Complete with Vapor Corrosion Inhibitor (VCI-Emitter), Cortec Corp. Model No. VCI-105 (or approved equal).
- C. Wall Mount.
- D. Complete with all required mounting and installation hardware.

2.15 FUSED POWER DISCONNECT SWITCH

- A. Square D Co., Model No. H321A, with Field Installable Solid Copper Neutral Assembly, Model No. H60SNC, and with Field Installable Copper Grounding Kit Model No. PKOGTC-1 (or approved equals).
- B. Type: NEMA Standard KS1 (latest edition), type LD, and NEMA type 12K, 3-pole, 4-wire, 240 VAC, single throw, fused with isolated solid neutral bus and a ground bus.
- C. Amperage Rating: 30 Amps.
- D. Fuse Rating: As appropriate for the connected system power requirements.
- E. Surface Mount enclosure with knockouts.

2.16 CCTV POWER ISOLATION TRANSFORMER

- A. Acme Model T-3-53043-S (or approved equal).
- B. Primary 120/240 VAC, single phase.
- C. Secondary 120/240 VAC, single phase.
- D. 3.0 KVA.
- E. Grounded Faraday Electrostatic shield.
- F. Floor/Wall mount.

2.17 POWER TRANSFORMER

- A. Acme Model T-2-53014-S (or approved equal).
- B. Primary: 240 VAC; single phase.
- C. Secondary: 120/240 VAC.
- D. 5 KVA.
- E. Grounded Faraday Electrostatic shield.

- F. Floor/Wall mount.

PART 3-INSTALLATION

3.01 INSTALLATION

- A. Installation shall conform to, but not be limited to, acceptable practices and standards specified to date by the National Electrical Code, AAR specifications and EIA standards.
- B. The Design-Builder shall furnish and install all junction boxes, terminals, connectors, fuses, circuit breakers, hardware, wiring and cabling, conduits and fittings, and make all connections and cross-connections required for complete operational installations.
- C. The Design-Builder shall provide branch circuit breaker designations and typical configurations for Power Distribution Panelboards. The Design-Builder shall calculate full load AC power requirements per branch circuit and shall configure each panelboard for an optimum phase load balance. The Design-Builder shall submit the calculations to the Authority's Representative for approval. The calculations shall indicate the full load AC power requirements for each item of equipment connected to each branch circuit.
- D. In the Communications Room, the Design-Builder shall install an AC power receptacle strip on each new communications equipment rack and console, and in each new equipment cabinet. The Design-Builder shall install the required mounting hardware to secure the AC power receptacle strips to the communications equipment racks cabinets and consoles. The Design-Builder shall install a ground clamp in each raceway of the AC power receptacle strips to ensure that the raceway base is grounded to the communications equipment rack, cabinet or console. The AC power receptacle strips shall be installed so that they do not create obstructions to mounted equipment within the communications equipment racks, cabinets and consoles, and so that all AC outlets are accessible.
 - 1. The Design-Builder shall install the appropriate branch circuit conductors (power phases and neutral) to provide 110/120 VAC communications power to each AC power receptacle strip on all communications equipment racks, cabinets, and consoles.
 - 2. The Design-Builder shall use appropriately sized rigid steel conduit.
- E. In the Gatehouse, the Design-Builder shall surface mount a completely assembled Emergency Power Distribution Panelboard and an Emergency Power Disconnect Switch in a location to be approved by the Authority's Representative.
 - 1. The Design-Builder shall make the following installations of power feeders (power phases, neutral and equipment ground) using appropriately sized rigid steel conduit where ever existing embedded conduit is not available:
 - a. From the Emergency Power Disconnect Switch to the Emergency Power Distribution Panelboard.
 - b. From the entry side of the Emergency Power disconnect Switch to the Secondary side of the Gatehouse Emergency Power Transformer in the Yard Operations Building AC Switchboard.

2. The Design-Builder shall provide and install the duplex receptacles, associated enclosures and cover plates within the Gatehouse and console as required. The Design-Builder shall install the required mounting brackets and hardware to secure the enclosures of the duplex receptacles to the Gatehouse structure and/or console.
 - a. The duplex receptacles shall be installed so that they do not create obstructions to the mounting equipment within the Gatehouse console, and so that all receptacles are accessible.
 - b. The Design-Builder shall install branch circuit conductors (power phases, neutral and equipment ground) using appropriately sized flexible metallic conduit from the Gatehouse Emergency Power Panelboard to the provided duplex receptacles within the Gatehouse Cabinetry.
- F. The Design-Builder shall install a 110/120 VAC Power Distribution Terminal Strip and a 110/120 VAC Power Receptacle Strip within new and existing the CCTV Equipment Cabinets located in ancillary buildings and structures. The Design-Builder shall install the required mounting hardware to secure the distribution and receptacle strips within the CCTV Equipment Cabinets.
1. The Design-Builder shall install a ground clamp in each raceway of the AC power receptacle strips to ensure that the raceway base is grounded to the CCTV Equipment Cabinet. The AC power receptacle strips shall be installed so that they do not create obstructions to mounted equipment within the CCTV Equipment Cabinets and so that all outlets are accessible.
 2. The Design-Builder shall install branch circuit conductors (power phases, neutral and equipment ground) from an appropriate emergency AC power source to the Power Isolation/Step-down Transformer using appropriately sized rigid steel and non-conducting conduit, and in accordance with the Contract Drawings and the following additional criteria:
 - a. If emergency power is not locally available, the Design-Builder shall make use of an appropriate Power Distribution Panelboard with a spare/unused breaker position nearest to the CCTV Equipment Cabinet.
 - b. The Design-Builder shall provide and install the proper size circuit breaker and appropriately label the circuit in the Power Distribution Panelboard.
 - c. Depending upon the physical dimensions of the CCTV Equipment Cabinet, the Design-Builder shall install a Power Isolation/Step-down Transformer within or adjacent to the CCTV Equipment Cabinet.

3.02 GROUNDING

- A. All conduit shall be electrically insulated from communications equipment racks, cabinets and consoles; power ground shall be separate and isolated from the communications ground. Conduit containing branch circuit conductors shall be insulated from the communications equipment racks, cabinets and consoles by means of short lengths of non-conducting conduits.

- B. Short lengths of flexible metallic conduit shall be provided in the communications equipment racks, cabinets and consoles between the non-conducting conduit and the AC power receptacles and strips. Each branch circuit shall contain a separate home-run neutral conductor.

END OF SECTION

SECTION 16720

COMMUNICATIONS YARD TELEPHONE SYSTEM SPECIFICATIONS

PART 1-GENERAL

1.01 PURPOSE

- A. The Yard Telephone System is part of the WMATA Telecommunications Network. Its purpose is to provide telephone service to WMATA personnel working within the Yard limits.
- B. Telephone instruments associated with the Yard Telephone System shall also be capable of accessing the Yard Public Address System.

1.02 SYSTEM DESCRIPTION

- A. The Yard Telephone System shall provide automatic Dual Tone Multiple Frequency (DTMF) tone telephone service in the Yard S & I shop and other yard facilities. All telephone instruments shall be wired to the existing S&I Shop Communications Room using dedicated CAT 5 cable and tie cables as required. All telephone instruments (with their own station number) shall be cross connected to the appropriate demark point.
- B. Digital feature telephone instruments shall be installed in most Yard administrative areas where telephone service is required. In some ancillary structures and shop areas, analog single-line ruggedized wall telephones shall be installed.
- C. Analog single line telephone instruments shall be installed in Emergency Trip Station (ETS) enclosures.
- D. The Yard Telephone System shall include an interface to the Yard Public Address System. Personnel within the yard shall be able to access and make voice communications over the Yard Public Address System, by dialing a restricted four (4) digit access code.
- E. Intercom calling capability will be available between telephone instruments located throughout the yard, via the existing Yard Telephone System. Intercom calls can be expedited by programming telephone extension numbers, which are frequently called, into the memory (auto-dial) feature of telephones equipped with this function.
- F. The Design-Builder shall upgrade the existing Yard Telephone System to provide service as required to all new, renovated, or relocated shop facilities.
- G. Verizon Telephone Company public pay stations shall be provided by others in selected locations within the Yard.

1.03 EMERGENCY TRIP STATION (ETS) TELEPHONE

Dustproof DTMF single-line analog telephone instruments shall be located in Emergency Trip Station (ETS).

1.04 SYSTEM PERFORMANCE REQUIREMENTS

The Design-Builder shall be responsible for the overall performance and testing of the complete Telephone System including ETS Telephones, and Yard Public Address System access. The following system performance requirements are designed to ensure that the Telephone System delivered meets

the specified performance requirements of the Washington Metropolitan Area Transit Authority.

1.05 SYSTEM PARAMETER AND REQUIRED PERFORMANCE

- A. Frequency response from end-to-end: 300 Hz to 3000 Hz, maximum 6 dB loss.
- B. Maximum Actual Measured Loss (AML) shall not exceed 8.5 dB at 1000 Hz when measured from the Communications Equipment Room to telephone instrument location - terminated into 900 ohms impedance.
- C. Noise objective of 20 dBrnC with 30 dBrnC maximum measured noise terminated into 900 ohm impedance.
- D. The DC loop resistance shall not exceed 1300 ohms being terminated into a short circuit.
- E. Loop DC current not less than 23 mA.
- F. Balance ratio not less than -50 dB.

1.06 MAJOR ITEM TECHNICAL REQUIREMENTS

The Major Items listed below shall conform to the operational and performance requirements of these Specifications. Incidental items, not specifically mentioned but required for complete and proper system operation, shall be furnished and installed by the Design-Builder.

PART 2 - PRODUCTS

2.01 TELEPHONE INSTRUMENTS

- A. The Design-Builder shall install telephone instruments appropriate to the existing PABX or Key System in each yard. The Authority Representative will identify the type of instrument to be installed at each location.
- B. Single Line and Digital Feature Telephones
 - 1. Analog-Cortelco 2500 BE Beige, DTMF, fully modular, desk or wall mountable (or approved equal).
 - 2. Digital Key System - Avaya model 4412D+ Display, desk or wall mountable (or approved equal).
 - 3. Digital PABX System - ROLM Model ROLMphone 240, desk or wall mountable (or approved equal).
- C. Digital Full feature Telephones
 - 1. Digital Key System - Avaya model 4424D+ Display, desk or wall mountable (or approved equal).
 - 2. Digital PABX System - ROLM Model ROLMphone 400, desk or wall mountable (or approved equal).

2.02 RUGGED TELEPHONE INSTRUMENTS

- A. Suitable for harsh environments.
- B. High-impact, anti-corrosive enclosure, resistant to chemicals and solvents.
- C. Sealed DTMF keypads.

- D. Sealed electronic ringer with loud ringer broadcast.
- E. With 15 foot extra strength cord.
- F. Noise canceling microphone.
- G. Connects to standard RJ11C modular jack.
- H. Mountable in weather proof enclosure.
- I. GAI-Tronics, Model 246 (or approved equal).

2.03 WEATHERPROOF ENCLOSURES

- A. Suitable for outdoor applications.
- B. High-impact, anti-corrosive enclosure, resistant to chemicals and solvents.
- C. Spring Door Return.
- D. Compatible with Rugged Telephone Instrument.

2.04 EMERGENCY TRIP STATION TELEPHONE INSTRUMENT

- A. Gai-Tronics Model K93112 (or approved equal).
- B. Analog Telephone Instrument with electronic ringer, DTMF keypad covered with protective seal.
- C. Face plate of heavy gauge steel, corrosion resistant, dustproof.
- D. Handset: Cradle of cast aluminum with nylon coating with heavy duty handset cord of appropriate length to fit into enclosure.

2.05 PROTECTOR BLOCKS

- A. Cook Electric W492-LCGX (or approved equal).
- B. With 400 VDC gas style arrestors.
- C. With required mounting hardware and appropriately sized enclosures.

2.06 TERMINAL BLOCKS

- A. 66-Type quick clip style with fanning strips.
- B. Connectorized when feasible.
- C. Siemens Company S66B series; Cook Electric C66M Series, (or approved equal).

2.07 OUTSIDE PLANT TIE CABLE

- A. Essex CASPIC-F+M 19-AWG (or approved equal).

- B. Filled shielded telephone cable with mechanical protection, sized as required.
- C. Conductors: Solid annealed copper conductors insulated with color coded polyolefin, standard telephone color code, twisted into pairs.
- D. Core covering: Non-hygroscopic dielectric tape.
- E. Shield: Inner polymer coated .2mm aluminum and outer polymer coated .15mm steel. Interfaces of shielding system flooded with waterproofing compound.
- F. Mechanical Protection: .15mm corrugated steel shield, flooded on both sides.
- G. Outer jacket: Black, low density, high molecular weight polyethylene.
- H. Shall meet REA Specification PE-39.

2.08 INSIDE PLANT CABLE

- A. Category 5e four pair cable.

2.09 ETS TELEPHONE CABLE

- A. Filled core, armored cable intended for direct burial applications in high risk area.
- B. Conductors solid annealed copper in 22 AWG.
- C. 3-pair with each conductor having an insulation consisting of an inner coating of natural, insulating-grade high density cellular polyethylene and a thin outer skin of color-coded high-density solid polyethylene.

2.10 DISTRIBUTION FRAME/CABLE TERMINAL HOUSING

- A. Terminal housing with easy cable access.
- B. Expandable.
- C. Fungus resistant plywood backboards.
- D. Removable doors.
- E. Distribution rings where required.
- F. Includes all necessary hardware for securing backboard and fastening sections together.
- G. Sized as required to accommodate all terminations and protectors for each location.

2.11 TELEPHONE JACK/FACEPLATE

- A. Modular wall plate system.
- B. Equipped with either a snap-in module (RJ 14) for two-line Analog feature telephones or with a snap-in module for a standard (RJ-11) single-line Analog telephone instrument.

- C. Shall mount flush to 2" x 4" junction box.
- D. Ivory Color.

2.12 PHONE- CALL BELL

A combination bell and solid state relay. An extension ringing device to attract attention to phone. Activate by ringing frequency (16-70 Hz). Benjamin Div./Thomas Ind. Part B ARR5060-120V (or approved equal).

2.13 REDUNDANT RINGING GENERATOR WITH AUTOMATIC TRANSFER ASSEMBLY

- A. Peco II Assembly, Model PEC 3877 (or approved equal).
- B. Mounting Frame Part No. 6064108S.
- C. Two 50 Watt ringing generator modules, Part No. 63134035S adjusted to produce a 105 VAC, 20 Hz signal.
- D. Monitor and automatic transfer circuitry to provide contact closure to the Technical Control Facility when a transfer occurs.
- E. Shall mount in standard 19-inch equipment rack.

PART 3-EXECUTIONS

3.01 GENERAL TELEPHONE INSTALLATION

The Design-Builder shall furnish and install the miscellaneous equipment, hardware, racks, jacks, terminals, protector blocks, enclosures, connecting blocks wiring, cabling conduit, fittings, wired connections and cross connections for a complete operational telephone system. This includes the telephone and cable installations in the various locations along the carrier transmission system.

3.02 TELEPHONE INSTRUMENT INSTALLATION

- A. Telephone instruments shall be installed in the new or renovated S & I shops.
- B. Outside plant telephone cable with over voltage protection shall be installed for the wiring of all telephone circuits outside of the Yard Operations Building.

3.03 RUGGED TELEPHONE INSTALLATION/MISCELLANEOUS AREAS

The Design-Builder shall furnish and install the appropriate conduit, fittings, and connectors to each rugged telephone instrument. The Design-Builder shall provide the appropriately sized hole in the rugged telephone instrument enclosure for connecting the conduit.

3.04 EMERGENCY TRIP STATION INSTALLATION

Emergency Trip Station enclosure within the yard. Emergency Trip Station telephone instruments shall be wired to Distribution Frame protector blocks in the Yard Operations Building Communications Equipment Room via Outside Plant Telephone Cable. All conductors, including spares, of Outside plant Cable installed for ETS Telephone Instruments shall be terminated to protector blocks and terminal blocks at the MDF within the Communications Room of the Yard Operations Building. The Design-Builder shall install protector blocks and terminal blocks in each Emergency Trip Station

enclosure to terminate the telephone line pair to be connected to the ETS Telephone Instrument. The Design-Builder shall furnish and install a plaque indicating the telephone number of the Yard Control Room Console inside each ETS enclosure.

3.05 TELEPHONE OUTLET INSTALLATION

The Design-Builder shall furnish and install telephone outlet boxes in all required yard buildings.

3.06 TELEPHONE JACK/FACEPLATE INSTALLATION

The Design-Builder shall furnish and install the required type of Telephone Outlet faceplate (modular wall plate with either a RJ-11 or with a RJ-14C snap-in module) at each telephone outlet. Telephone Jack Face plates shall be installed for any additional locations where telephone instruments are required.

3.07 TELEPHONE CABLE INSTALLATION

The Design-Builder shall install a CAT 5 inside plant cable between each telephone outlet and its associated Cable Terminal Housing or Distribution Frame (depending on location). The Design-Builder shall terminate all conductors, including spares, of each CAT 5 cable to terminal blocks within the Cable Terminal Housing or Distribution Frame.

3.08 SURFACE MOUNTED CONDUIT INSTALLATION

- A. The Design-Builder shall furnish and install the required appropriate type, size and color wire mold and surface mounted conduit and fittings, distribution/pull boxes and junction boxes to complete installation from the Distribution Frame or Cable Terminal Housing to the telephone outlet location as necessary in all yard buildings.
- B. In yard buildings, the Design-Builder shall furnish and install the appropriately sized conduit and fittings above the ceiling to connect the junction box to the outlet location. The Design-Builder shall be responsible for replacing any ceiling panels damaged during installation at no cost the Authority.

3.09 DISTRIBUTION FRAME/CABLE TERMINAL HOUSINGS

The Design-Builder shall install a Distribution Frame in the Yard Communications Equipment Room. A Cable Terminal Housing shall be installed in all other buildings. The Distribution Frame and Cable Terminal Housings shall contain the necessary protector blocks and terminal blocks to terminate and cross connect all telephone circuits. The Design-Builder shall terminate all cable pairs, including spares, at the Distribution Frame and Cable Terminal Housings. All conductors, including spares, of outside plant cables shall terminate to protector blocks and terminal blocks at the Distribution Frame and at each Cable Terminal Housing.

3.10 CIRCUIT IDENTIFICATION PROCEDURES

The Design-Builder shall identify each telephone circuit at both the Telephone Outlet location and at all points of termination. The circuit identification code shall be unique for each Telephone Outlet and indicate the location of the Telephone Outlet.

END OF SECTION

SECTION 16721

COMMUNICATIONS TELE/DATA CABLING SYSTEM

Part 1 GENERAL

1.01 SECTION DESCRIPTION AND BASIC REQUIREMENTS

- A. The Tele/Data Cabling System is part of the WMATA telecommunications network. Its purpose is to provide telephone and LAN/WAN service to WMATA personnel in selected locations within, and associated with, the Yard Buildings.
- B. All local telephone and data outlets shall be wired, using star topology, to the S&I Building Communications Room using dedicated cable pairs. The Design-Builder shall provide and test all required cable and terminations to the EIA/TIA specifications listed in this document. The length of each individual cable from the MDF to the information outlet shall not exceed 295-feet.
- C. The Design-Builder shall provide a dual 5-way Active Data Bridge shall be installed in the 19-inch CTS Rack in the Yard Communications Room.
- D. The Design-Builder shall install printed labels for all cables and cords, distribution frames, and outlet locations. No labels shall be written by hand. Machine labeling shall be used on all information outlets, patch panels, punch blocks, feed cables, etc.
- E. Provide AC outlets for equipment convenience and power.

1.02 SECTION INCLUDES

Placement of Cat-5e cable and terminations.

1.03 REFERENCES

- A. National Electrical Manufacturers Association (NEMA) Standard Publication 250-1997, Enclosures for Electrical Equipment (1000 Volts Maximum)
- B. National Electric Code
- C. ANSI/EIA/TIA-568-B Commercial Building Wiring Standard
- D. ANSI/EIA/TIA-568-B.2-1 Commercial Building telecommunications
- E. Cabling Standard Twisted pair Components Addendum1 -
- F. Transmission Performance Specifications for 4-Pair 100 Ohm Category 5e
- G. ANSI/EIA/TIA-568-B.2-6 Commercial Building telecommunications
- H. Cabling Standard Twisted pair Components Addendum 6 - Related Components Test Procedure.

1.04 SUBMITTALS

- A. Submit under provisions of Section 16706.
- B. Shop Drawings - Indicate electrical characteristics and connection requirements, including system-wiring diagram.
- C. Product Data - Provide showing electrical characteristics and connection requirements for each component.
- D. Manufacturer's Installation Instructions - Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Data outlets shall consist of a dual gang box with a modular 2 port face plate. One port shall be dedicated for voice and one port for LAN connectivity.
- F. The Design-Builder shall provide cable and a wall plate for Elevator Emergency phones.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.
- C. Installer: Service facilities within 50 Miles of Project.

1.06 SYSTEM PERFORMANCE REQUIREMENTS

- A. The following overall system performance objectives are applicable to WMATA's LAN System, and shall be maintained when performing the work in this Contract.
 - 1. All Cat 5e cable shall conform to EIA/TIA 568 B Commercial Building Wiring Standard and the EIA/TIA for unshielded twisted pair (UTP). The performance limits shall include: Insertion Loss, Near End Crosstalk (NEXT), Power Sum Near End Crosstalk (PSNEXT) Equal Level Far End Cross Talk (ELFEXT), Power Sum Equal Level Far End Cross Talk (PSELFEXT) Return Loss, Propagation Delay, and Delay Skew.
 - 2. All Plenum Category 5e Unshielded Twisted Pair (UTP) cables shall be composed of 24 AWG bare solid-copper conductors, insulated with FEP or other approved substituted material. Where required the cable shall be sheathed with a low smoke PVC or Flex Halar jacket to meet NEC requirements. Unless otherwise noted on the floor plans or within this document, all information outlets for 24-AWG copper cable shall be:
 - a. RJ45 type/8 position/8 conductor
 - b. Insulation displacement
 - c. Modular 568A Cat 5e rated
 - d. Universal application/multi vendor supportive accepting most phone and data plugs

PART 2 PRODUCTS

2.01 INSIDE PLANT CABLE CATEGORY 5e CABLE (UTP)

Provide 4-pair UTP cable that is Underwriter's Laboratories (UL) listed type, MPP, CMR or CMP.

Cables shall consist of one four pair category 5-e (Cat-5e), color blue, and one four pair category 5-e, color pink. The pink cable shall be assigned to the LAN network. The Blue shall be assigned to the phone system.

2.02 CATEGORY 5e CABLE TERMINATIONS

All Category 5e outlets shall utilize cross-over lead technology to address data circuits applications up to 100 MHz and meet or exceed the following electrical, mechanical and NEXT specifications listed below

- EIA/TIA Category 6- TSB40-A
- Data Rate: Fully supports 100Mbps TP-PMD at 328 ft (100m) over UTP per ANSI X3T9.5, and 155 MBPS ATM. Compatible with 16 MBPS IEEE 802.5 Token Ring applications. Compatible with 10 MBPS Institute of Electrical and Electronics Engineers Inc., (IEEE) 802.3, 10BASE- T applications.
- Insulation resistance: 500M Ohm minimum
- Dielectric withstand voltage 1,000 VAC RM5, 60 HZ .minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum to exposed conductive surface
- Contact resistance: 20 M Ohm maximum
- Current rating: 1.5 A at 68°F (20°C) per IEC Publication 512-3, Test 5b
- UL Listed
- ISO 9001 Certified Manufacturer
- CSA Certified
- Comply with FCC Part 68
- Plug Insertion Life: 750 insertions
- Contact Force: 3.5 oz (99.29) minimum using FCC-Approved modular plug
- Plug Retention Force: 30-lb. (133N) minimum between modular plug and jack
- Temperature Range: -40°F to 150°F (-40°C to 66°C)

2.03 TERMINAL BLOCKS

Siemons 66M series with Category 5e spacing mounted on 89-type brackets.

2.04 VOICE AND DATA OUTLETS

- A. All UTP Outlets shall be wired EIA/TIA 568A.
- B. The data outlet shall be dual gang with back boxes for flush mount applications.

2.05 DUAL 5 WAY ACTIVE DATA BRIDGE

- A. Manufacturer and Product - Tellabs Model No. 4445A (or approved equal).
- B. Ratings
 - 1. Dual five-way balance active data bridge
 - 2. Power Requirements: -48Vdc
 - 3. Transformer-coupled ports adjustable from -10 to +10 Design-Builder

2.06 DATA BRIDGE MOUNTING SHELF

- A. Manufacturer and Product - Tellabs type 10 Part Number 1011 (or approved equal).
- B. Ratings
 - 1. Wire wrap mounting shelves
 - 2. 19 in rack mount
 - 3. Accepts up to 11 standard Tellabs Type 10 modules

PART 3 EXECUTION

3.01 INSTALLATION

A. GENERAL

1. All cable plant installed by the Design-Builder shall be fully tested in accordance with the applicable certifying agency testing practices and procedures prior to acceptance.
2. The Design-Builder shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire, miscellaneous grounding and support hardware, etc. necessary to facilitate the installation of this project.
3. It shall be the responsibility of the Design-Builder to furnish any special installation equipment or tools necessary to properly complete the project. This may include, but is not limited to, tools for terminating cables, testing and splicing equipment for copper/fiber cables, communication devices, jack stands for cable reels, or cable wrenches.
4. The Design-Builder shall be responsible for printed labels for all cables and cords, distribution frames, and outlet locations, at the time of delivery. No labels will be written by hand. Machine labeling shall be used on all information outlets, patch panels, punch blocks, feed cables, etc.
5. The Design-Builder shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
6. The Design-Builder shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.
7. All Cables/fibers will be connected in numerical order in the MDF .

3.02 TELEPHONE CABLING INSTALLATION

- A. Telephone instruments locations shall have a dedicated Cat 5e cable from the telephone location to the Communications Room. No bridge cable taps shall be permitted.
- B. All cables will terminate in the communications room. The Design-Builder shall furnish and install telephone jacks, tele/data jacks and all miscellaneous equipment as required for a complete cable installation.
- C. Provide a separate cable (other than the Elevator Machine Room telephone) to the Elevator Controller that terminates at a surface mount type jack. The Elevator Contractor will be responsible for connection from this point to the elevator cab phone box via the traveling cable.

3.03 LAN CABLING INSTALLATION

- A. The 4-pair CAT 5e UTP cables shall be run using a star topology from the Communications Room to each information outlet. All cable routes to be approved by WMATA prior to installation of the cabling.
- B. The length of each individual run of copper cable from the MDF on each floor to the information outlet shall not exceed 295-ft. (90m.)
- C. Design-Builder shall observe the bending radius and pulling strength requirements of the 4-pair UTP cable during handling and installation.
- D. Each run of cable between the termination block interconnection unit and the information

outlet shall be continuous without any joints or splices.

- E. In suspended ceiling areas, the Design-Builder shall bundle station wiring with plastic cable ties at appropriate distances. The cable bundling shall be supported via "J" hooks attached to the existing building structure and framework no more than 60" apart. Bundles shall not exceed EIA/TIA maximum diameter specifications.
- F. If all interiors are not obstructed, the Design-Builder will conceal horizontal distribution wiring within the walls. If such obstructions exist, conduit shall be used.

3.04 AUTOMATIC ENERGY MANAGEMENT SYSTEM(AEMS) INSTALLATION

- A. Install a 5 way Active Data Bridge in the 19 inch CT5 Rack in the Control Tower Communications Room.
- B. WMATA will connect the output of the 5way bridge, via the MDF, to a 4W-E&M channel card. WMATA will connect one port to the existing substation RTU.
- C. The Installer will connect one port to the new 5&1 RTU. The connection from the data bridge to the RTU's shall be CAT -5e.
- D. WMATA will use an existing port on a 9 way bridge installed in the Communication Equipment Room of the Jackson Graham Building, or furnish and install a new 9 way bridge and connect one of these ports via the CDF, to 4W-E&M channel cards in the Jackson Graham Building CT5 Terminals: Digroup "B", Channel 24 of the associated passenger station(s).

3.05 CIRCUIT IDENTIFICATION

- A. The Design-Builder shall tag all telephone and data cables. The Design-Builder shall stencil all termination cabinets.
- B. The Design-Builder shall label all wall plates and jack terminations. Labeling shall provide for identification of all cable termination end points.

3.06 DEMONSTRATION

- A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Demonstrate Project equipment by a qualified person who is knowledgeable about the Project.
- C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at equipment location.
- E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- F. Demonstrate system operation.

- G. Conduct walking tour of Project and briefly describe function, operation, and maintenance of each component.
- H. Demonstrate testing procedure.

END OF SECTION

SECTION 16731

FIRE ALARM SYSTEM

PART 1 GENERAL

1.01 SECTION DESCRIPTION AND BASIC REQUIREMENTS

- A. The purpose of the Fire Alarm (FA) System is to provide alarm warnings to assist Washington Metropolitan Area Transit Authority (WMATA) employees in protecting the public, employees, and property. For this installation, the Yard Service and Inspection Buildings are the only areas requiring upgrades. The Fire Alarm (FA) System is monitored at the Guard House by the Guard. The Fire Alarm System described herein includes, but is not limited to, the following components
1. Microprocessor controlled unit
 2. FA Liquid Crystal Display (LCD) Annunciator Panel
 3. Addressable Fire Detection System
 4. Graphic Annunciator Panel
- B. The Common Control Unit located, in the Communications Equipment Room, shall be a programmable addressable system which contains all the logic and circuitry required to supervise and control the Fire Detectors. Fire Detectors and other addressable devices are connected to the Common Control Unit via a signaling line circuit and are programmed to annunciate by device or zone. The Common Control Unit contains trouble circuitry powered from a dedicated power source that electrically supervises all circuit wiring for a "Short" or an "Open." The Common Control Unit performs the following functions:
1. Provides alarm detection of each addressable device.
 2. Provides trouble detection of each addressable device.
 3. Provides audible and visual "trouble" and "alarm" indications at the FA LCD Annunciator panel.
 4. Provides common system controls to the FA LCD annunciator panel.
 5. Provide contact closures to indicate "trouble" conditions.
 6. Provide special interfacing between the FA System and the elevators.
 7. Provides electrical power for the signaling line circuits and notification appliance circuits as needed.
- C. The Microprocessor Common Control Unit is modular in construction to provide for ease of maintenance and expansion. The following types of modules are used in a typical FA System for this type of building:
1. Signaling Line Circuit Modules -Contain circuitry to recognize inputs and control outputs from addressable devices and to provide supervision of all devices on the circuit.
 2. Power Supply Modules -Provide primary and backup power, and supervision for the Fire Alarm System.
- D. The Common Control Unit shall be designed to operate with smart sensors" (sensors which transmit a digital data message to the Common Control Unit when triggered).
- E. LCD Annunciator Panel shall be located at the Guard House and in the building entranceway. The LCD Annunciator Panel shall contain a multi-line LCD display capable of displaying text messages. The LCD Annunciator Panel shall provide the following features:

1. Alarm, Supervisory, and Trouble conditions shall be indicated on the multi-line display and by a tone-alert.
 2. Each reported condition shall allow a push-button to silence the tone-alert, but retain the display text until the reported condition is returned to normal.
 3. System display shall indicate alarm status. identification of the device. type of alarm, number of alarms. supervisory conditions. and system troubles.
- F. All Fire Detectors shall transmits a programmable data message to the Common Control Unit when alarmed. All fire detector Alarms and Trouble Indications report directly to the Common Control Unit. which displays the alarms on the FA LCD Annunciator Panel. The Fire Detection System provides controls to and/or interfaces with the following systems and equipment:
1. Ventilation Fans
 2. Wet Fire Suppression System
 3. Elevators
 4. Manual Pull Stations
- G. Detector Usage
1. Combination Detectors (Rate-of-Rise and Fixed Temperature) shall be used to monitor room and area ambient temperature and temperature change to include elevator hoist ways when allowed by the NFPA 72.
 2. Fixed Temperature Detectors shall be used to monitor room and area temperature.
 3. Multi-sensor Photoelectric/Ionization/Heat Detectors shall be used to detect the presence of smoke.
 4. Duct Detectors shall be used to detect the presence of smoke in ventilation duct work.
 5. Multi-sensor detectors shall be used in AC switchboard rooms.
- H. The Wet Fire Suppression (Sprinkler) System is monitored by the Common Control Unit via addressable input modules and displayed on the FA LCD Annunciator Panel. Tamper switches detect any movement of the Fire Main manual shut-off valves and provide a "Trouble" condition in the Fire Zone associated with that Sprinkler System. Upon activation of the Sprinkler System. a flow valve detector provides a contact closure. thereby creating an "Alarm" condition in the addressable module associated with that Sprinkler System.
- I. Upon detection of smoke within an Elevator Machine Room. all elevators associated with the Elevator Machine Room shall immediately return to the designated floor, or alternate as appropriate. The elevator(s) shall remain at this-designated level and elevator cab controls (except for emergency controls) are rendered inoperative as long as smoke is detected within the associated Elevator Machine Room .
- J. Activation of a Manual Pull Station shall cause an Alarm signal in the associated Fire Zone and energize the notification appliance circuits for building evacuation.
- K. For annunciation purposes. Fire Zones are assigned in accordance with the following criteria:
1. No Fire Zone shall contain more than 10,000 square feet. The 10,000 square feet zone shall be contiguous.
 2. No Fire Zone shall contain more than four rooms plus a connecting passageway.
 3. No Fire Zone shall contain more than ten Detectors.
 4. The maximum distance between any two points of a Fire Zone shall not exceed 300 feet.

5. Each elevator machine room shall be assigned a separate fire zone.
- L. The FA System is to provide an immediate alarm indication on the Gate House and S&I annunciator panels upon the activation of any Fire Detector, flow valves and tamper switches. In addition, a summary alarm output must be provided and interfaced to the existing Yard FIA system for transmission to the Jackson Graham Building.
 - M. The audible alarm signal and an LED are activated upon receipt of a Detector Alarm. Depressing the "Alarm Acknowledge" pushbutton shall silence the audible signal. The LED light shall extinguish after the Fire Detector initiating the alarm has been attended, repaired or replaced. Depressing the "Alarm Acknowledge" pushbutton in response to an alarm in any zone shall not inhibit the audible alarm signal from being activated upon receipt of a detector alarm in subsequent zones.
 - N. A wiring fault (trouble condition) affecting circuit operation shall cause an audible and visual trouble indication at the FA LCD Annunciator Panel and shall cause a "Trouble" signal (contact closure) to be activated. A trouble condition shall not activate FA System zone alarms. The operation of a pushbutton to acknowledge a trouble alarm shall silence the audible trouble signal, but the associated LED indicator shall remain on until the fault is corrected. Correcting the fault shall extinguish the associated LED.
 - O. Activation of a Manual Pull Station shall cause an audible and visual indication at the FA LCD Annunciator Panels and shall also energize an audible/visual alarms. The audible and visual indications on the FA LCD Annunciator Panel shall be similar to any other detected Fire Alarm.
 - P. Signaling devices installed in pit areas are to be considered ancillary devices.

1.02 SECTION INCLUDES

- A. Fire Alarm common control panel
- B. Manual fire alarm stations
- C. Smoke and heat detectors
- D. Signaling devices
- E. Gatehouse Fire Alarm LCD Annunciator panel

1.03 REFERENCES

- A. NFPA 130 - Standard for fixed guide way transit system
- B. UL 1076 - Proprietary Burglar Alarm and Systems
- C. ANSI/ASME A17.1 - Safety Code for Elevators and Escalators
- D. NFPA 72 - National Fire Alarm Code

1.04 SYSTEM DESCRIPTION

- A. FA System - A state-of-the-art addressable, software-programmable FA System shall be designed, installed, tested, and documented. The addressable, software-programmable system shall be designed to report detected events using data messages to the LCD Annunciator Panel via the Common Control Unit. Fire Detectors are to be installed in the S&I building. The FA system shall be designed to be monitored by the Yard Gate Security Guard.
- B. Capacity
 - 1. The Common Control Unit shall be equipped to supervise the number of alarm points needed to meet Specification coverage requirements and to allow the addition of at least 25% additional sensors without the addition of modules or other modifications.
 - 2. The LCD Annunciator Panel shall be equipped to allow the supervision of at least 25% additional alarm points without panel hardware modifications.
 - 3. The quantity of devices is shown on the drawings.

1.05 SUBMITTALS

- A. Conformance to requirements of NFPA 130
- B. Shop Drawings: Provide LCD Annunciator layout and system wiring diagram showing each device and wiring connection required.
- C. Product Data: Provide electrical characteristics and connection requirements.
- D. Test Reports: Indicate satisfactory completion of required tests and inspections.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.
- B. Installer: Company specializing in installing the products specified in this section with minimum three years documented experience, and certified as fire alarm installer in the local jurisdiction where the equipment is being installed.

1.07 REGULATORY REQUIREMENTS

- A. Conformance to requirements of NFPA 70 and NFPA 101
- B. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

1.08 MAINTENANCE SERVICE

Furnish service and maintenance of fire alarm system until Final Completion.

1.09 EXTRA MATERIALS

- A. For each manual pull station so eqJipped provide a spare break-glass rod.
- B. Provide a spare key of each lock being installed.
- C. Provide one, or 20% (whichever is greater) additional (spare) detectors of each type of automatic smoke detector [without base].

PART 2 PRODUCTS

2.01 FIRE COMMON CONTROL PANEL

- A. Manufacturer and product - Edwards Systems Technology EST -3 (or approved equal)
- B. Control Panel - Modular Constructi9n with surface wall mounted enclosures.
- C. Capacity - Supports up to 125 intelligent Signature detectors and 125 intelligent Signature modules.
- D. Power supply - Adequate to serve control panel modules, remote detectors, remote LCD Annunciator, relays. and alarm signaling devices. Include battery-operated emergency power supply with capacity for operating system in standby mode for 12 hours followed by alarm mode for 10 minutes.
- E. System Supervision - Component or power supplies failure places system in trouble mode.
- F. Initiating Device Circuits - Supervised zone module with alarm and trouble indication; occurrence of single ground or open condition places circuit in trouble mode but does not disable that circuit from initiating an alarm. A supervised, microprocessor based, single Signature driver controller module is used to coordinate, process, and interpret information received from and sent to Signature devices. This is a Common Control Unit (CCU), local rail mounted module that provides an interface between the 3-CPU(1) module and Signature series devices.
- G. Indicating Appliance Circuits: Supervised signal module, sufficient for signal devices connected to system; occurrence of single ground or open condition places circuit in trouble mode but does not disable that circuit from signaling an alarm.

2.02 INITIATING DEVICES

- A. Manufacturer
 - 1. Edwards Systems Technology (or approved equal)
 - 2. Manual Station: EST SIGA-278. Surface mounted, non-coded type, dual action manual station. Provide manufacturer's standard back box. SIGA-278 station is a contemporary style manual station made from durable red colored Lexan. An alarm may be initiated by lifting the upper door marked "LIFT THEN PULL HANDLE", then pulling the alarm handle.
- B. Spot Heat Detector: Fixed temperature, 135 degrees F (57 degrees C.) EST Signature Series

Intelligent Heat Detectors. The detector shall gather analog information from their fixed temperature and/or rate-of-rise heat sensing elements and convert it into digital signals. The detector's on-board microprocessor shall measure and analyze these signals. It shall compare the information to historical readings and time patterns to make an alarm decision. Digital filters shall remove signal patterns that are not typical of fires.

- C. Spot Heat Detector: Combination rate-of-rise and fixed temperature, rated 135 degrees F (57 degrees C), and temperature rate of rise of 15 degrees F (8.3 degrees C). EST Signature Series Intelligent Heat Detectors. The detector shall gather analog information from their fixed temperature and/or rate-of-rise heat sensing elements and convert it into digital signals. The detector's on-board microprocessor shall measure and analyze these signals. It shall compare the information to historical readings and time patterns to make an alarm decision. Digital filters shall remove signal patterns that are not typical of fires. Ancillary normally open contacts, if needed, shall be provided by additional control modules.
- D. Ceiling Mounted Smoke Detector: NFPA 72E, photoelectric/ionization/heat type with adjustable sensitivity, plug-in base. EST Signature Series Intelligent Digital Multi sensor Detectors. Provide two-wire detector with common power supply and signal circuits.
- E. Ceiling Mounted Smoke Detector: NFPA 72E, photoelectric type with adjustable sensitivity, plug-in base. Signature Series Intelligent Digital Photoelectric Detector. Provide two-wire detector with common power supply and signal circuits.
- F. Duct Mounted Smoke Detector: NFPA 72E photoelectric type] with auxiliary SPDT relay contact. Signature Series Intelligent Digital Photoelectric Detector equipped with air sampling tubes.

2.03 SIGNALING/NOTIFICATION APPLIANCES

- A. Manufacturer - Edwards Systems Technology (or approved equal)
- B. Strobes
 - 1. Meets or exceeds Year 2004 UL requirements for standards UL 1638 and UL 1971.
 - 2. Complies with ADA Code of Federal Regulation, Chapter 28, Part 36, Final Rule.
 - 3. Mounts on standard 4-inch square electrical box.
 - 4. Two wire operation; Terminals accept #18 to #12AWG wire
- C. Combination Horn/Strobe
 - 1. NFPA 72G, surface type fire alarm horn
 - 2. Sound Rating: 96 dBA at 10 feet (3M)
 - 3. Provide integral strobe lamp and flasher in accordance with specifications for strobe unit.
- D. Pit Area Strobes
 - 1. Strobes mounted in pit areas shall be of weatherproof design and installation and compatible with other system devices.
 - 2. Use EST CS-405-7A (15 candela), EST CS-405-8A, or approved equal.
 - 3. Mount according to manufacturers instructions using weatherproof surface box, EST series 449 or approved equal.

2 .04 CONTROL RELAY MODULES

- A. Manufacturer - Edwards Systems Technology SIGA-CR (single gang box mount) or SIGA-MCR (UIO motherboard mount) (or approved equal.)
- B. Control modules shall be Signature compatible I/O modules with automatic device mapping and electronic addressing. Details about the module shall be permanently stored in its non-volatile memory and the module shall automatically update historic information. Modules shall be available in standard mount and plug-in (UIO) configurations.
- C. The intelligent input/output modules shall feature multiple user-set personality codes that define the module's behavior. Separate I/O and data loop connections shall be made to each module.
- D. The control relay module shall provide a Form C dry relay contact. The on-board microprocessor shall ensure the relay is in the proper ON/OFF state. Upon command from the loop controller, the relay shall activate the relay contact.
- E. SIGA-CR - Standard mount models shall mate to North American two-gang or one-gang electrical boxes.
- F. SIGA-MCR - Plug-in UIO modules mount shall mount to UIO motherboards. Motherboards shall accommodate individual risers for each on-board module, or shared risers in any combination with their UIO modules. All wiring connections shall be made to terminal blocks on the motherboard.
- G. Characteristics
 - 1. Operating Current -100micro amps
 - 2. Operating Voltage -15.2 to 19.95 VDC (19 VDC nominal)
 - 3. Relay Rating -Form C
 - a. 24VDC -2 amps -pilot duty
 - b. 120VAC- 0.5 amps
 - c. 220VAC -0.5 amps
 - 4. Operating temperature -32 deg F to 120 deg F
 - 5. Humidity -0 to 93% non-condensing
 - 6. LED Operation
 - a. On-board Green LED -flashes when polled
 - b. On-board Red LED -flashes when in alarm/active

2 .05 SOLID-STATE FAN RELAYS (NORMALLY-OPEN CONTACTS)

- A. Manufacturer - Teledyne Part No. SSR1200480D25 (or approved equal).
- B. Contact Configuration: Normally open.
- C. Output current rating: 25-amps.

2 .06 FAN RELAYS (NORMALLY-CLOSED CONTACTS)

- A. Manufacturer - Teledyne Part No. S2840B5SSR (or approved equal)
- B. Contact Configuration - Normally closed

C. Output current rating - 25-amps.
2 .07 ICD ANNUNCIATOR

- A. Manufacturer - Edwards Systems Technology 3-LCD (or approved equal.)
- B. The FA annunciator shall provide both display and keypad functions to indicate system status and arming/disarming the system. The unit shall support additional display functions such as fire/security annunciation.
- C. The unit shall feature a backlit 8 lines of 21 characters LCD readout.
- D. It will be powered from 24VDC provided by the fire alarm panel. It shall draw 95mA or less.
- E. It shall communicate with the fire alarm panel using RS-485 protocol.
- F. The keypad shall provide both tactile and audible user feedback to facilitate entry of information.
- G. User entries shall be menu driven, and capable of executing system commands. A context sensitive help system shall be available to the user at any time.
- H. All keypad/display addressing shall be electronic, jumpers or DIP switches shall not be considered as equivalent to electronic addressing. All data within the unit shall be stored in non-volatile memory to prevent data loss.
- I. The unit shall be constructed of a thermoplastic housing with integral (removable) cover, and be suitable for mounting directly on a finished wall or standard 4" square or 2-gang electrical boxes. All wiring terminations shall be to an integral terminal strip.
- J. Install in Gatehouse on ceiling using a custom manufactured bracket, field fit. Install in S&I Building using manufacturer's standard wall mount.

2 .08 FA DISTRIBUTION FRAME/CABINET

Manufacturer - Sun West Engineering Model No. PBI-036030207 (or approved equal)

2 .09 TERMINALS

- A. Manufacturer - Weidmuller, Model No. SAKR (or approved equal)
- B. Disconnect feature - Knife switch design, remains attached to terminal block body.
- C. Complete with test sockets, labeling, and all required terminal block mounting hardware and accessories.

2.10 INTRA-BUILDING CONDUIT WIRING

- A. Manufacturer -Not specified

- B. Non-power limited cable for fire protective signaling circuits.
- C. Characteristics
 - 1. Solid copper conductors in the following configurations:
 - a. 1 pair 18AWG
 - b. 2 pair 18AWG
 - c. 1 pair 16AWG
 - d. 2 pair 16AWG
 - e. 1 pair 18AWG -shielded
 - f. 2 pair 18AWG -individually shielded
 - g. 3 pair 18AWG -individually shielded
 - h. 1 pair 16AWG -shielded
 - 2. Red jacket
 - 3. In accordance with NEC Article 760
 - 4. UL listed, subject 1424
 - 5. Type NPLF
- D. Number of conductors shall be based on equipment requirements shown in drawings

2.11 INTER-BUILDING CABLE

- A. Manufacturer -Not specified
- B. REA PE-39 or ISMA 60-6 with aluminum or copper shield. 4 or 6 pair #16 shielded.

2.12 PROTECTOR BLOCKS

- A. Manufacturer: Coming (Seicor) W492-LCGX (or approved equal)
- B. Ratings
 - 1. Unit Type - Two-pair
 - 2. Protection Type - Gas Tube Arrester
 - 3. Nominal Voltage Rating - 400 Volts
 - 4. Mounting - Mounting/Grounding bar

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Mounting location
 - 1. In office areas install manual station with operating handles 4 feet 6 inches [1.4 M] above floor. Install audible and visual signal devices 7feet 6 inches [2.3 M] above floor.
 - 2. In open shop area, and as shown on drawings, mount signaling devices on roof trusses below 30-feet above finished floor. Initiating devices will be mounted as noted above.
 - 3. In shop pits mount signaling devices on walls to maximize their visibility.
- C. Use 18 AWG minimum size conductors for fire alarm detection and signal circuit conductors.

Install wiring in conduit.

- D. Mount end-of-line device box with last device or separate box adjacent to last device in circuit.
- E. Make conduit and wiring connections to sprinkler flow switches, sprinkler valve tamper switches, duct smoke detectors, and fan shutdown relays.
- F. Install conductors and appropriate zone wiring to interconnect the FA System Common Control Unit.
- G. Provide and install all required wiring, junction boxes, terminal strips, control relays, and cabling from the Elevator Machine Room and other controlled devices to the FA Common Control Unit.
- H. Interface the control relay contacts to the elevator control equipment. Install within the Elevator Machine Room conduit, wires and cables, junction boxes, terminal strips, and any other mechanical and/or electronic equipment necessary to affect the interface described herein.

3 .02 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 16707.
- B. Test in accordance with NFPA 72H and local fire department requirements.

3 .03 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section 16707.
- B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.

3 .04 FIRE ALARM WIRE AND CABLE COLOR CODE

- A. Provide fire alarm circuit conductors with insulation color coded as follows, or using color tape at each conductor termination and in each junction box.
- B. Power Branch Circuit Conductors: Black, Red, White.
- C. Initiating Device Circuit: Black, Red.
- D. Detector Power Supply: Violet, Brown.
- E. Signal Device Circuit: Blue (positive +)' White (negative -).

3 .05 ADJUSTING

Adjust operating Products and equipment to ensure smooth and unhindered operation.

3 .06 ELEVATOR INTERACTION AND COORDINATION

- A. Install elevator circuits in accordance with ANSI/ASME A 17.1, Safety Code for Elevators and

Escalators and NFPA 72, National Fire Alarm Code. Elevator hoistways and machinery spaces are sprinklered. Elevator power must be removed prior to the application of water. Power removal will be accomplished with a fusible shunt trip switch as described in the Electrical specifications.

- B. Elevator shutdown shall be monitored by the Fire Alarm system for integrity.
- C. Elevator power shutdown is to occur prior to the sprinkler activation. Shutdown shall be accomplished by the activation of heat detectors located in the hoistway and machine room. Heat detectors are required to be located within two feet of each sprinkler head. Heat detectors will be set to 135 F, and sprinkler heads will be set to 165 F. See also Sprinkler specifications.
- D. The heat detectors shall activate a Control Relay, which in turn will supply power to the shunt trip coil and cause the disconnecting means to open the circuit.
- E. A Volt Monitor Relay is required to monitor for presence of the shunt trip voltage. This relay shall be placed in parallel to the shunt trip coil so that it receives the same voltage. Then the contacts from this relay shall be monitored for integrity by the fire alarm system. If at any time the voltage is not present to the relay, a trouble signal would be sent to the fire alarm system and annunciate an alarm.
- F. Upon system activation, the elevator is sent to the shop floor where the doors stay open. If the fire gets to the point where it is detected by the heat detector(s), power is removed before it gets hot enough to release water through the sprinkler heads. In the event the smoke detector outside the elevator on the Shop Floor level is activated the alternate elevator park location shall be the Basement level.
- G. The Control Relay shall be monitored for integrity by the fire alarm system to make sure that the wiring remains intact and must be located within three feet of the shunt trip device.

3 .07 DEMONSTRATION

- A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Demonstrate Project equipment by a qualified person who is knowledgeable about the Project.
- C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at equipment location.
- E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- F. Demonstrate system operation.
- G. Conduct walking tour of Project and briefly describe function, operation, and maintenance of each component.

END OF SECTION

THIS PAGE NOT USED

SECTION 16791

COMPREHENSIVE RADIO COMMUNICATIONS SYSTEM

PART 1 GENERAL

1.01 SECTION DESCRIPTION AND BASIC REQUIREMENTS

- A. This Section describes the basic components of the WMATA Comprehensive Radio Communications System (CRCS) used at the Yard Service and Inspection (S&I) facility. This section installs a bi-directional amplifier and associated cables, and antennas, to provide improved service inside the S&I building.
- B. The purpose of the WMATA Metrorail Subsystem is to provide two-way voice communications between control consoles, provided by others, located within the WMATA Rail Operations Control Center (RAIL OCC), and portable, vehicular and rail car radios, utilized throughout the WMATA Rail Rapid Transit System and the Washington Metropolitan Area. The work in this contract is to extend that coverage into the S&I building.
- C. The WMATA CRCS is a shared, digital, trunked, simulcast radio system operating in the UHF (490 MHz) portion of the frequency band. The WMATA CRS is a jointly shared radio system used by Metrorail, Metrobus, Metro Transit Police Department (MTPD), and various maintenance disciplines.
- D. Vehicular and portable radios shall not be provided under this contract.
- E. Unlike line section head-end amplifiers, the shop unit will NOT have an alarm subsystem.

1.02 SECTION INCLUDES

NOT USED

1.03 REFERENCES

- A. National Electric Code (NEC)
- B. Federal Communication Commission (FCC)

1.04 SUBMITTALS

- A. Design-Builder shall size all equipments and materials included in contract and provide information in the Final Design Submittal.
- B. System Final Design
- C. Shop Drawings - Indicate electrical characteristics and connection requirements, including complete and detailed system wiring diagram.

- D. Product Data - Provide showing electrical characteristics and connection requirements for each component.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- F. Radio coverage performance field demonstration results.
- G. As-built drawings
- H. Operations and Maintenance Manuals.

1 .05 QUALIFICATIONS

- A. Manufacturer - Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- B. Supplier - Authorized distributor of specified manufacturer with minimum three years documented experience.
- C. Installer - Authorized installer of specified manufacturer with service facilities within 50 miles of Project and with minimum five years documented experience.
- D. Radio coverage for requirements at all WMATA facilities within the project area, using portable radio units at hip level, shall be as follows (whichever is better radio coverage)
 - 1. Delivered Audio Quality (DAQ) equal to 4.0.
 - 2. Equivalent to 98% availability or 99.0% of the shop floor 99.0% of the time.

1 .06 MAINTENANCE SERVICE

Furnish service and maintenance of the S&I CRS until Final Completion.

PART 2 PRODUCTS

2 .01 EXTERNAL ANTENNA

- A. Manufacturer - Decibel Products Model DB436-E (or approved equal)
- B. Description – Roof -mounted, UHF yagi antenna complete with mounting hardware.
- C. Electrical Data
 - 1. Frequency Range: 488-512
 - 2. VSWR: 1.5 to 1 or less
 - 3. Nominal Impedance - 50-ohms
 - 4. Forward Gain - 10dBd
 - 5. Polarization - Vertical
 - 6. Maximum Power Input - 250-watts
 - 7. Vertical Beamwidth (half-power) - 44deg

8. Horizontal beamwidth (half-power) - 60deg
9. Front-to-Back Ratio - 16dB
10. Lightning Protection - Direct ground
11. Standard Termination - Type

D. Mechanical Data

1. Support Boom - 1"OD with 0.083 wall
2. Elements - Aluminum
3. Mounting Brackets - Galvanized Steel
4. Maximum Exposed Area (flat plane equivalent) - 0.45-sq. ft.
5. Lateral Thrust at 100 mph - 18 lbf
6. Wind Rating, without ice - 125 mph
7. Wind Rating, with 0.5" radial ice - 90 mph
8. Dimensions - 14.5" by 35"
9. Net weight - 7 lbs
10. Mounting Clamps - Stainless steel V-bolts
11. Minimum Power - 100-watts.
12. Frequency Range - 406-512 MHz
13. Minimum Vertical Beamwidth - 75-degrees

2.02 INTERNAL ANTENNA

A. Manufacturer - Decibel Products ASP-7A or approved equal

B. Description - Quarterwave ground plane antenna, unity gain.

C. Electrical Data

1. Power handling - 100 watts maximum
2. Frequency Range - 108 to 512 MHz
3. VSWR - less than 1.5 to 1
4. Impedance - 50 ohms nominal
5. Lightning protection - Built-in gap type arrester
6. Termination - SO-239 (accepts PL-259 connector)

D. Mechanical Data

1. Length - 26 inches at lowest frequency
2. Weight - 0.75 lbs
3. Radiating Element - Chrome-plated brass
4. Radials - Stainless steel
5. Mounting - U-bolt supplied for 1-1/4" maximum OD tubing

2.03 FLEXIBLE FOAM-DIELECTRIC Y2-INCH COAXIAL CABLE

A. Manufacturer and Product - Andrew Corporation; Superflexible HEL/AX Model No. FSJ4RN-50B (or approved equal).

B. Ratings - Impedance: 50 ohms with a non-halogenated, flame-retardant and smoke-resistant jacket.

2 .04 CRS DUAL-BAND UHF BI-DIRECTIONAL LINE AMPLIFIER

- A. Manufacturer and Product - KAVAL Telecom, Inc. Bi-Directional Amplifier BDA 1300-XCC4-B (or approved equal)

- B. Description
 - 1. Line amplifier for extending multi-channel UHF radio systems coverage throughout tunnel areas and other confined spaces
 - 2. Housed in NEMA-style enclosed cabinet
 - 3. Linear Amplification - equipment shall be capable of passing analog and digital trunked system protocols in the UHF bands
 - 4. Equipped with microprocessor control module that allows installers and technicians the ability to set and check all system parameters of the amplifier at the time of installation or during a regular or emergency service call. The module maintains non-volatile memory of all system parameters allowing quick module replacement without system realignment. The microprocessor control also has the following:
 - a. Password protection
 - b. Self diagnosis and continuous monitoring
 - c. Battery backup and management control
 - d. Thermal management control
 - e. Over current/under current fault monitoring
 - f. Automatic (AGC) and digital (DGC) gain controls
 - g. RS-232 interface
 - 5. Gain control that allows up to 14 dB adjustments in 1 dB increments
 - 6. Nominal maximum gain of 38 dB and a pass band ripple of +/- 2.5 design-Builder
 - 7. 3rd Order Intercept Point of 45 dBm and Noise Figure less than 9 design-Builder
 - 8. Capable of a maximum RF input of + 10 dBm
 - 9. All subsystem components shall be modular for quick replacement.
 - 10. Input/output impedance of 50 Ohms
 - 11. Operating temperature of -30 to +50 C
 - 12. N-female input and output connectors
 - 13. Cabinet shall be NEMA style with approximate dimensions of 23H X 24W X 7D inches.

2 .05 CO-AXIAL CABLE

- A. Manufacturer and Product - Timesmicrowave LMR500-UF (or approved equal)

- B. Description
 - 1. Provide coaxial cable of a flexibility and bendability cable design. The flexible outer conductor shall enable tight bend radius.
 - 2. RF Shielding shall be 50 dB greater than typical single shielded coax (40 dB). The multi-ply bonded foil outer conductor is rated conservatively at > 90 dB (i.e. >180 dB between two adjacent cables).
 - 3. Weatherability - Cables shall be designed for outdoor exposure and have a life expectancy in excess of 10 years.

- C. Electrical and mechanical characteristics:

CHARACTERISTIC	VALUE
Size-Nominal	1/2'

Impedance	50 ohms
Cutoff Frequency	12 GHz
Propagation Speed	0.85 C
Peak Power Rating	16kW
DC Resistance, inner conductor	0.86 ohms/1000 feet
DC Resistance, outer conductor	1.65 ohms/1000 feet
DC Breakdown	2,500 volts
Jacket Spark	8,000 volts RMS
Capacitance	23.9 pF/ft
Inductance	0.06 mH/ft
Outer Conductor	Aluminum tape - 0.376" Overall braid, tinned copper
Inner Conductor	Stranded BC
Diameter over Jacket	0.500 inches
Diameter over Copper Outer Conductor	0.405 inches
Diameter Inner Conductor	0.142 inches
Minimum Bending Radius	5 inches
Bending Moment	1.25 lb-ft
Cable weight.	0.1 lb/ft
Tensile Strength	260 lb
Flat Plate Crush Strength	35 lb/in
Attenuation	2.6 max dB/100 feet at 450 MHz

2.06 CO-AXIAL CABLE CONNECTORS

- A. Appropriate for each type and size cable
- B. Type "N" connectors and/or PL-259 as appropriate
- C. Covered with shrink sleeving or other approved waterproof covering

2.07 CABLE GROUNDS

- A. Provide cable grounds at the base of the antenna and at the outside cable entrance into the cabinet.
- B. Ground shall be Andrew Company SureGround Grounding Kit or approved equal.
- C. Description: Provide a one-piece grounding assembly with weatherproofing molded into the grounding strap providing a minimum of 200 mm of surface contact area.
- D. Universal ground lug that can be fitted to a one- or two- hole earthing attachment point.
- E. Waterproof to IEC529, IP68.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Metrorail Radio Subsystem
 - 1. The Design-Builder shall install the CRS amplifiers, the antennas, and all related equipment and material as shown on the Information Drawings, in a location approved by the Authority Representative .
 - 2. The Design-Builder shall install the required cabling, conduit and fittings, connectors, AC receptacles, junction boxes, and hardware and make the necessary connections and cross-connections to provide 120-Vac, 60-Hz power .
 - 3. The Design-Builder shall install the required co-axial cable, and appropriate size and RF type connectors, to interconnect the equipment.
 - 4. The Design-Builder shall label each end of every cable run to display cable use, cable number designation, and end terminal destinations.
- B. Internal Antenna
 - 1. Mount antenna to building ceiling joist, pointing down, near center of S&I shop floor.
 - 2. Install and connect cables to BDA.
- C. Bidirectional Amplifier
 - 1. Install on mezzanine level, near stairwell. locate so door can be opened.
 - 2. Install power and coax cables.
- D. External Antenna
 - 1. Mount antenna on building antenna mount.
 - 2. Install lightning protection.
 - 3. Install and connect cables to BDA.
 - 4. Aim antenna to obtain best signal from WMATA donor site.

3 .02 ADJUSTING

Adjust operating Products and equipment to ensure smooth and unhindered operation.

3 .03 DEMONSTRATION

- A. Demonstrate operation and maintenance of Products to WMATA personnel two weeks prior to date of Substantial Completion.
- B. Demonstrate Project equipment by a qualified person who is knowledgeable about the Project.
- C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with WMATA personnel in detail to explain all aspects of operation and maintenance.
- D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at equipment location.
- E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- F. Demonstrate system operation.
- G. Conduct walking tour of Project and briefly describe function, operation, and maintenance of each component.

END OF SECTION

SECTION 16823

YARD PUBLIC ADDRESS SYSTEM SPECIFICATIONS

PART 1-GENERAL

1.01 PURPOSE

The Public Address System shall enable announcements to be made throughout the Yard buildings. The announcements shall originate from telephones within the buildings.

1.02 SYSTEM DESCRIPTION

- A. The Public Address System shall provide for announcements to be made in the Yard building. Announcements shall originate from telephone instruments within the TCR/Tower and other yard buildings.
- B. The Public Address System shall consist of loudspeakers, including enclosures and baffles, and paging horns installed in selected rooms and locations within each Yard building. A Telephone Access Paging System, power amplifiers, distribution panels and jack field panels shall be provided in the Communications Equipment Room.
- C. The loudspeakers of the Public Address System shall be grouped into individual zones throughout the yard buildings. The Public Address System shall be configured to permit announcements to be made to the speakers in an individual zone, or simultaneously to a combination of any and all zones (ALL PAGE) by dialing the appropriate zone code(s).
- D. The Telephone Access Paging System shall accept an audio input from the Yard Telephone System and provide the appropriate dialed zone decoding and audio routing of the announcements to the desired zone amplifiers, which provide audio amplification for announcements to each zone circuit. The audio inputs and outputs of the Telephone Access Paging System shall be connected to a distribution panel.
- E. Jack field panels shall provide audio test points for the Public Address System. Each Public Address Loudspeaker circuit shall be wired through a jack field panel to a loudspeaker distribution panel. In addition, the loudspeaker distribution panels shall provide single point ground connections for the Public Address System cabling.

1.03 OPERATING DESCRIPTION

The Public Address System shall provide the communications and control link from the telephone system to the speakers throughout the Yard buildings. The Public address System shall enable announcements to be made from the telephone sets to the Public Address System speakers within the yard buildings by dialing the appropriate code to address the selected zone(s).

1.04 SYSTEM PERFORMANCE REQUIREMENTS

- A. The Design-Builder shall be responsible for the overall performance of the Public address System. The following overall system performance requirements are designed to ensure that the Public address System, delivered under these Specifications, meet the performance requirements of the Washington Metropolitan Area Transit Authority.
- B. Total System Performance
 - 1. Frequency Response: ± 5 dB over the range 200Hz to 8KHz
 - 2. Noise Level: 60 dB less than rated output
 - 3. Loudspeaker System Sound Pressure Level:
 - a. At least 100dB (ref. 0.0002 dynes/cm²) measured from 1 meter from front, on axis, of loudspeaker for areas with ceiling heights greater than or equal to 25 feet.
 - b. At least 70 dB (ref. 0.0002 dynes/cm²) measured 1 meter from front, on axis, of loudspeaker for areas with ceiling heights less than 25 ft.
 - 4. System Harmonic Distortion: less than 5% over the range 250Hz to 5.5KHz

PART 2-PRODUCTS

2.01 MAJOR ITEM TECHNICAL REQUIREMENTS

The Major Items listed below shall conform to the operational and performance requirements of these Specifications. Incidental items, not specifically mentioned but required for complete and proper system operation, shall be furnished and installed by the Design-Builder.

2.02 TELEPHONE ACCESS PAGING SYSTEM

- A. The Design-Builder shall furnish and install a Telephone Access Paging System which shall include decoding circuitry to provide selection of at least four individual zones, and all zones during an "ALL PAGE".
- B. The telephone interface shall work in conjunction with the existing WMATA telephone system. A dedicated telephone extension number provided by WMATA shall provide access to the paging system.
- C. The telephone shall be Valcom Model V-9973 and page zone access by a Valcom V-2006 (or approved equal).
- D. The Design-Builder shall be responsible for determining, providing and installing the required Telephone System and Public Address System hardware and software to interface these systems together. The Design-Builder shall ensure that the Telephone System, Telephone Access Paging System, and the Public Address System are compatible and function properly together.

2.03 POWER AMPLIFIER

- A. The Design-Builder shall furnish and install power amplifiers in the Communications Equipment Room. Each Power Amplifier shall be equipped with enough Power Modules to drive its assigned loudspeaker zone at specified performance with at least a 20% power reserve.
- B. ALTEC LANSING model 2280B (or approved equal), with the following characteristics
 1. Power Output: Capable of at least 375 watts continuous rms (50-10,000 Hz) @ 70.7 volts.
 2. Total Harmonic Distortion: Less than 1% (50- 10,000 Hz) @ 70.7 volts.
 3. Frequency Response: Plus or Minus 1dB (30 - 15,000 Hz).
 4. Input impedance: 600 ohm and 10K ohm balanced.
 5. Complete with input/output modules needed to provide specified audio performance in each loudspeaker zone.

2.04 LOUDSPEAKERS

- A. The Design-Builder shall furnish and install loudspeakers in selected rooms and areas of the Yard buildings, as required. The Design-Builder shall submit to the Authority Representative for approval a proposed loudspeaker layout, including transformer taps to be used and the power level distributed between loudspeakers. The Design-Builder shall furnish any alternate audio transformers/pads needed to adjust any individual loudspeaker/horn that cannot be adjusted to a acceptable sound level using the specified transformer.
- B. Atlas/Soundolier Model UHT70C-U51 (or approved equal) with the following characteristics:
 1. Loudspeakers shall be 8-inch diameter, 8 Ohm, with a frequency response of ± 2 dB over 30Hz to 19,000 Hz and a power rating of 7 watts. The loudspeakers shall be a high efficiency, low distortion, per-manent magnet type with a moisture resistant seamless cone. The loud-speakers shall be suitable for either recessed or surface mounting (EIA standard mounting hole spacing on the loudspeaker basket). The loudspeakers shall have mounting holes for a speaker transformer on the rear of the basket.
 2. Each loudspeaker shall have a 70.7 volt matching transformer providing selectable power levels of $\frac{1}{2}$, 1, 2, and 5 watts to the loudspeaker.

2.05 PAGING HORNS

- A. The Design-Builder shall furnish and install paging horns in all assigned areas, as required. The Design-Builder shall submit to the Authority Representative for approval a proposed paging

horn layout, including transformer taps to be used and the power level distributed between paging horns.

- B. GAI-tronics Model 13315-003 Driver with GAI-tronics Model 13306-001 Horn (or approved equal) with the following characteristics:
1. The paging horns shall be of a weatherproof design consisting of a water-sealed all-metal construction and gray baked epoxy finish suitable for use both at indoor and outdoor locations.
 2. The paging horns shall contain built-in 70.7-volt line transformers with selectable audio power levels of 3.7, 7.5, 15, and 30 watts.
 3. Each paging horn shall include a mounting assembly which shall permit precise installation positioning in the vertical and horizontal planes.
 4. A protective cover with a built in strain relief for the connecting cable.
 5. The paging horns shall be complete with all necessary accessories.

2.06 LOUDSPEAKER ENCLOSURES AND BAFFLES

The Design-Builder shall furnish and install a loudspeaker enclosure with baffle for each loudspeaker. Two types of loudspeaker enclosures shall be provided: one type for installation of loudspeakers in areas with a suspended ceiling, and the other for surface mount installation of loudspeakers.

2.07 RECESSED LOUDSPEAKER ENCLOSURES

Atlas/Soundolier Model No. T195-8 (or approved equal) with the following characteristics:

- A. recessed type loudspeaker enclosure made of heavy gauge steel construction with a rust preventative coating. The interior shall be undercoated with patched jute lining to prevent mechanical and acoustical resonances. In addition, the enclosure shall have slotted receptacles to accept the torsion springs of the associated baffle.
- B. The enclosure shall be sized for the installation of an 8 inch loudspeaker and shall have a depth of 5 inches.
- C. A Mounting ring shall be provided for each enclosure to extend the enclosure through the suspended acoustical ceiling.
- D. The baffle for this loudspeaker enclosure shall be round with a diameter of 12 inches to accommodate the 8 inch loudspeaker, have welded studs on the rear for the mounting of the loudspeaker, have two torsion spring devices and shall be finished in baked white enamel.
- E. The enclosure and the baffle shall be appropriate for the loudspeaker selected.

2.08 SURFACE MOUNT LOUDSPEAKER ENCLOSURES

Atlas/Soundolier Model No. 410-8 (or approved equal) with the following characteristics:

- A. The enclosure and baffle for a surface mount loudspeaker installation shall be one complete assembly. This assembly shall be round, unidirectional, and a surface mount type.
- B. The assembly shall be manufactured of aluminum and shall have a satin finish coated by a clear acrylic baked finish.
- C. The interior of the assembly shall be undercoated with a patched jute lining to prevent acoustical and mechanical resonances.
- D. The assembly shall be sized for the installation of an 8-inch loudspeaker and shall have a depth of approximately 4-1/2 inches.
- E. The loudspeaker grille of the assembly shall be of one piece construction and have the required mounting holes for securing the loudspeaker to the grille.
- F. The loudspeaker enclosure and baffle assembly shall be appropriate for the loudspeaker selected.

2.09 WALL-MOUNT LOUDSPEAKER

The Design-Builder shall furnish and install one wall-mount loudspeaker in the Train Control Building. The loudspeaker shall have a 70.7 volt matching transformer providing selectable power taps of 1, 2, 4 and 7.5 watts. The loudspeaker shall be surface mounted in a 4" square box. Wiring to speaker

shall be enclosed in 1/2" conduits. ATLAS/SOUNDOLIER Model SVT-77U (or approved equal).

2.10 JACK FIELD PANEL

- A. The Design-Builder shall furnish and install jack field panels in the Communications Equipment Room of the TCR/Tower/Operations Building. The number of jack field panels furnished shall be sufficient to accommodate the connections for all of the Public Address System loudspeaker circuits.
- B. ADC Telecommunications Model PJ30A panel with PJ899 strip (or approved equal) each jack field panel frame shall have 2 rows and accommodate 52 normal-through telephone jacks. The jack field panel frame shall be made of black plastic with steel mounting brackets reinforcing strips. In addition, the jack field panel frame shall contain two marking designation strips with a clear plastic cover mounted at the top and bottom of the front side for identification of the jacks.
- C. The jack field panel shall contain 52 ADC Telecommunications Model PJ339W (or approved equal) telephone jacks. Each shall be tip-ring-sleeve type with normal-through for the tip and ring. Each telephone jack shall have gold cross bar contacts and wire-wrap tails.
- D. The Design-Builder shall furnish and install patch cord holders, complete with patch cords, in the Communications Equipment Room for each jack field panel provided. The patch cord holder shall be mounted to a blank panel on the equipment rack containing the Public Address System equipment.
- E. The Design-Builder shall furnish and install six patch cords for each Jackfield panel provided. The patch cords provided with each shall be six feet in length, two conductor (tip and ring) with shielding and have the ADC Telecommunications Model PJ047B (or approved equal) mating plugs to interface to the Jackfield jacks. Two of the six patch cords provided with each panel shall have the two conductors on one end terminated with wire spade lugs, with the shields connected only at the mating plug.

2.11 LOUDSPEAKER DISTRIBUTION PANEL

The Design-Builder shall furnish and install loudspeaker distribution panels in the Communications Equipment Room. Each distribution panel shall be fabricated from the following:

- A. Standard 19-inch aluminum rack mount panel: 0.125 inch thick with smooth mill finish, and slotted holes positioned at EIA standard spacing.
- B. Loudspeaker distribution panel terminal barrier strip. Curtis Industries, Inc., #2015 15 terminals (or approved equal).
- C. Loudspeaker distribution panel jumper stock. Curtis Industries, Inc., #267-A42-5 Plated Brass (or approved equal).

2.12 SPEAKER/HORN WIRE

Belden No. 88760, single pair, plenum, overall Beldfoil Shield, 18 AWG, Standard Conductors (or approved equal).

PART 3-EXECUTION

3.01 GENERAL PUBLIC ADDRESS SYSTEM INSTALLATION

The Design-Builder shall install a complete Operational Public Address System, as described herein, in the S & I shop. The Design-Builder shall furnish and install all equipment racks, loudspeaker channel supports, jack fields, distribution panels, protector blocks complete with accessories, conduit, wire mold, and fittings, junction boxes, installation hardware, and make all connections and cross connections for complete installations.

3.02 COMMUNICATIONS EQUIPMENT ROOMS

- A. The Design-Builder shall install the completely assembled Telephone Access Paging System, power amplifiers, and the distribution panels and jack field panels in a standard 19-inch open equipment rack in the Communications Equipment Room.

- B. The Design-Builder shall furnish and install the necessary intrarack wiring between the pieces of equipment, the necessary connectors, and make all necessary connections and cross-connections. The intrarack wiring shall be shielded, stranded, 20 AWG, twisted pair cable. The shields of the cable shall only be grounded at the distribution panels.
- C. The Design-Builder shall furnish and install the required cables, connectors and plugs, and make the necessary connections to provide 120 VAC, 60 Hz power from the AC power receptacle strip to the Public Address System equipment.
- D. The Design-Builder shall furnish and install all required hardware to interface the Public Address System to the Telephone System. The Design-Builder shall make all connections and cross connections between the telephone system and the Telephone Access Paging System.
- E. The Design-Builder shall furnish and install the required terminals and make the required connections to connect the Telephone Access Paging System to the power amplifiers for each zone.
- F. The Design-Builder shall furnish and install the required cabling and hardware to connect the ac power receptacle strip in racks to the 120 Vac, 60 Hz UPs Power Distribution Panel Located in the Communications Room.
- G. The Design-Builder shall furnish and install all conduits, wire mold, sleeves and fittings for loudspeaker conductors.

3.03 LOUDSPEAKER/PAGING HORN INSTALLATION GENERAL

- A. The Design-Builder shall install the loudspeakers, with the appropriate type enclosures and baffles, and the paging horns in the selected rooms and areas as shown on the Information Drawings.
- B. The installation of the paging horns and loudspeakers, with their associated enclosures and baffles, shall not interfere with existing air ducts, air duct diffusers, lighting fixtures, plumbing, fire detectors, and fire sprinkler system equipment.

3.04 SUSPENDED CEILING LOUDSPEAKER INSTILLATION

- A. At the suspended ceiling loudspeaker locations, the Design-Builder shall remove and be responsible for the condition of the suspended ceiling panels required to accomplish the installations.
- B. The Design-Builder shall furnish and install two channel supports for each loudspeaker installation. The channel furnished supports shall be appropriate to support the loudspeakers selected.
- C. The Design-Builder shall mount the round recessed enclosure with mounting ring to the channel supports. The Design-Builder shall cut a hole in the suspended ceiling section which shall contain the speaker. The hole shall be centered, as conditions permit.
- D. The Design-Builder shall install the channel supports with the round recessed enclosure and mounting ring on top of the suspended ceiling section that shall contain the loudspeaker. The Design-Builder shall attach the loudspeaker with matching transformer to the round recessed baffle and attach the baffle to the enclosure with the mounting ring.
- E. Upon completion of the installations, the Design-Builder shall replace the undamaged removed panels. The Design-Builder shall furnish and install, at no additional cost to the Authority, new suspended ceiling panels for any existing panels damaged during the installation. The new suspended ceiling panels shall be identical in manufacture and type to the existing suspended ceiling panels that are damaged.

3.05 SURFACE MOUNT LOUDSPEAKER INSTALLATION

- A. For the surface mount loudspeaker installations, the Design-Builder shall be responsible for maintaining the original condition of the plaster building ceiling. Upon completion of the installations, the Design-Builder shall, at no additional cost to the Authority, replace, repair, or reconstruct any portion of the plaster building ceiling that was damaged during the installation. The replaced, repaired, or reconstructed portions of the plaster building ceiling

shall be identical in appearance to the original adjacent undamaged areas of the plaster building ceiling.

- B. The Design-Builder shall attach the round enclosure to the plaster ceiling. The method of installation shall be determined by the Design-Builder and approved by the Authority Representative. The Design-Builder shall install the loudspeaker with matching transformer to the grille of the enclosure and install the grille to the enclosure.

3.06 PAGING HORN INSTALLATION

The paging horns with built in transformer shall be wall mounted at heights approved by the Authority Representative. The Design-Builder shall provide the mounting hardware for installation at each paging horn location.

3.07 LOUDSPEAKER AND PAGING HORN CABLING

- A. All conduits, sleeves and fittings shall be provided by the Design-Builder from the Communications Equipment Room of the building to Public Address speaker/horn outlets at selected locations within the rooms and areas of the Yard S & I shop. These conduits will be either imbedded in the or surface mounted to the structures (walls, ceilings, floors, etc.) of the buildings. Cables routed shall terminate on enclosed protector blocks and terminal strips within the S & I shop.
- B. In the areas where there is acoustical suspended ceilings, the conduit shall be provided on the structural ceiling above the acoustical suspended ceiling.
- C. In the areas where there is either plaster or metal deck ceilings, the conduit and speaker outlets shall be flush mounted in, or surface mounted on the ceiling and walls.
- D. The Design-Builder shall furnish and install the appropriate type and size conduit and fittings to connect each type of loudspeaker enclosure and paging horn to junction boxes for the passage of the cabling to the loudspeakers and paging horns.
- E. The Design-Builder shall provide the required passageways and conduit sleeves in the building structures for the installation of the conduit between the loudspeaker enclosures and paging horns. Flexible metallic conduit shall be provided for the loudspeaker enclosures that are installed in acoustical suspended ceiling. Rigid steel conduit shall be provided for the loudspeaker enclosures that are attached directly to the metal deck building ceiling, and for the paging horns.
- F. The Design-Builder shall furnish and install the required single pair, 18 AWG, stranded, shielded cables and make the necessary connections to interconnect the loudspeakers and paging horns in the circuit configurations shown on the Information Drawings. The Design-Builder shall furnish and install the required single pair cables to connect the loudspeaker/paging horn circuits to the jack fields in the Communications Equipment Room.
- G. The Design-Builder shall furnish and install the single pair 18 AWG, stranded, shielded cables and make the necessary connections to extend the loudspeaker/paging horn circuit cables terminated on the jack field panels to the distribution panels in the 19-inch equipment rack.
- H. The Design-Builder shall furnish and install the required terminals in the distribution panels to terminate all conductors and shields of the individual loudspeaker/paging horn circuit cables.
- I. The Design-Builder shall make the necessary cross-connections on the distribution panels to connect the appropriate announcement zone output to the loudspeaker/paging horn circuits.

END OF SECTION

SECTION 16831

YARD CONSOLES

PART 1-GENERAL

1.01 PURPOSE

- A. This Specification Section is included for informational purposes only to cover the possibility that the Design-Builder requires interface information as part of the final design. No specific console modifications are included as part of the Scope of Work, Section 16700, except for the possible integration of the CCTV System additions at the Shady Grove Yard Control Room.

1.02 YARD COMMUNICATIONS CONSOLE

- A. The Yard Communications Console shall be a self-contained, table top console housing, a Talkback Control panel, a CCTV Pan, Tilt and Zoom panel, a cable terminating facility and AC power receptacles.
- B. The console shall be of steel construction equipped for mounting standard 19-inch console panels. The console shall be designed for attachment to a conference table top.
- C. The Design-Builder shall mount the (9") CCTV Monitor on the conference table top.

1.03 GATEHOUSE CONSOLE

- A. The Gatehouse Console shall be a self-contained console housing a Talkback Station Panel (with remote amplifier), an Intrusion alarm Subsystem Annunciator Panel, a Fire Alarm Subsystem Annunciator Panel, a 9-inch Television Monitor Assembly, a CCTV Control Panel, a coax Video Receiver Panel, a PT&Z Star-Distribution Panel, a Gatehouse Intercom Panel, wire and cable terminating facilities and AC power receptacles.
- B. The console shall be of steel construction equipped for mounting standard 19-inch console panels. The consoles shall be designed for attachment to the walls and floor of the Gatehouse.

PART 2-PRODUCTS

2.01 MAJOR ITEM TECHNICAL REQUIREMENTS

- A. The Design-Builder shall design, fabricate, furnish, install, and test or furnish and deliver to the Authority, as detailed herein, the following major items in the quantities indicated below. All other materials, equipment and services not specifically listed but otherwise specified or required for full and complete consoles and the Gatehouse intercom network shall be furnished by the Design-Builder. The provisioning of samples, prototypes, cable splicing allowances and wastage of material during installation efforts shall be the Design-Builder's responsibility at no additional cost to the Authority.

2.02 YARD COMMUNICATIONS CONSOLE

- A. The Design-Builder shall design, fabricate, furnish and install a Yard Communications Console in the Yard Control Room of the Yard Operation Building in the Yard. Included with the Yard Communications Console shall be a cable terminating facility provided inside the console.

- B. The Design-Builder shall furnish and install a conference table for the mounting of the Yard Communications Console and 9" TV monitor.

2.03 CONSOLE

- A. The Yard Communications Console shall be a self-contained, single bay table top cabinet. The cabinet shall be constructed of 16 gauge steel and shall provide for the mounting of 19-inch wide equipment panels in the front section of the cabinet.
- B. Refer to Information Drawings for the cabinet dimensions and profile. The cabinet shall be constructed so that equipment panels can be installed or removed without disassembly.
- C. The cabinet frame shall be reinforced to provide rigidity required to maintain alignment. Accurately machined surfaces shall be provided to assure proper positioning. Steel shall be accurately rolled and have a smooth finish. Joints shall be formed to a tight fit with abutting edges flush and securely welded. Joints shall be welded their full length and dressed flush on exposed surfaces. Spot welding shall be used when practicable in preference to screws or rivet fasteners. Holes for screws or bolts shall be drilled and countersunk. All bolts, nuts, washers and screws shall be cadmium plated. The finish work shall be strong and rigid and neat in appearance. Surfaces shall be smooth and free from warps and buckles. Front panel openings shall be recessed and tapped in accordance with EIA Standard RS-310C.
- D. The cabinet shall have the required appropriately sized and shaped top panel, side panels and back panel to fully enclose the cabinet. The back panel shall be perforated to provide ventilation for the equipment that will be mounted on the console. The finish on the cabinet frame, top panel, side panels and back panel shall be Hammer stone Gray.
- E. Appropriate protected passageways shall be provided at the rear portion of the bottom panel (if provided) for the installation of cables to the various equipment within the console and for the installation of the power conductors to the ac duplex receptacles. In addition, an appropriate protected passageway shall be provided at the bottom rear portion of the right side panel for the installation of the cables to the MRS radio base station microphone and telephones that will be installed on the conference table adjacent to the Yard Communications Console.

2.04 CONSOLE PANELS AND EQUIPMENT

- A. The Design-Builder shall furnish and install the following equipment panels and equipment in the Yard Communications Consoles in the space indicated on the Information Drawings:
 - 1. Talkback Control Panel as specified and provided in the Yard Talkback System section.
 - 2. Yard Telephone instruments as specified and provided in the Yard Telephone System section (not part of console).
 - 3. Three AC duplex receptacles as specified and provided in the Electrical Power Distribution Systems section.
 - 4. Mobile radio base station microphone and cabling interface with the mobile radio base station in the TCR/Tower/Operations Building." (not part of console).
 - 5. CCTV control panel with the PT&Z panels as specified and provided in the Yard CCTV System Section.

2.05 CABLE TERMINATING FACILITY

- A. The Design-Builder shall furnish and install the required terminals inside the Yard Communications Console to terminate all conductors (including spares) of the cables associated with the Yard Public Address panel, and the Talkback Control Panel from the Communications Equipment Room. In addition, the Design-Builder shall furnish and install a line Terminal Block inside the Yard Communications Console to terminate all conductors

(including spares) of the cable(s) associated with Yard Telephone and CCTV control system from the Communications Equipment Room.

- B. All terminals shall be Weidmuller Terminations, Inc., Type SAKR (Test screw sockets) Test/Disconnect Terminals with necessary accessories or approved equal. The Line terminal Blocks shall be a 4 x 26 matrix, with wire wrap terminals on both sides. The Line Terminal Blocks shall be Northern Telecom Model No. 132-2624 (or approved equal).
- C. The Design-Builder shall furnish and install the required mounting brackets and hardware to install the terminals and Line Terminal Block of the Cable Terminating Facility to the cabinet frame. The Design-Builder shall configure the Cable Terminating Facility so that the terminals and Line Terminal Block are accessible upon the removal of the back or front panel.

2.06 CONFERENCE TABLE

- A. The Design-Builder shall furnish and install a 30-inch by 60-inch oak conference table in the Yard Control Room of the Yard Operation Building for the mounting of the Yard Communications Console, MRS base station microphone and telephones.

2.07 GATEHOUSE CONSOLE

- A. The Design-Builder shall design, fabricate, furnish and install a Gatehouse Console in the Gatehouse of the yard. Included with the Gatehouse Console shall be a wire and cable terminating facility provided at the Gatehouse.

2.08 CONSOLE

- A. The Gatehouse Console shall be a self-contained, double bay floor mounted cabinet. The cabinet shall be constructed of 16 gauge steel and shall provide for the mounting of 19-inch wide equipment panels in the front section of the cabinet (both bays).
- B. Each cabinet bay shall be comprised of a Turret Frame and a vertical Instrument Frame. The Turret Frame shall consist of a 20-degree sloped front that provides 21-inches of sloped panel space. The vertical Instrument Frame shall provide 12 1/4-inches of vertical panel space in the front section. The cabinet bays shall be constructed so that equipment panels can be installed or removed without disassembly.
- C. The cabinet frames shall be reinforced to provide rigidity required to maintain alignment. Accurately machined surfaces shall be provided to assure proper positioning. Steel shall be accurately rolled and have a smooth finish. Joints shall be formed to a tight fit with abutting edges flush and securely welded. Joints shall be welded their full length and dressed flush on exposed surfaces. Spot welding shall be used when practicable interference to screws or rivet fasteners. Holes for screws or bolts, shall be drilled and countersunk. All bolts, nuts, washers and screws shall be cadmium plated. The finish work shall be strong and rigid and neat in appearance. Surfaces shall be smooth and free from warps and buckles. Front panel openings shall be recessed and tapped in accordance with EIA Standard RS-310C.
- D. The cabinet bays shall have the appropriately sized and shaped top panels, side panels, and back panels to fully enclose the assembled cabinet (two bays). In addition, the Design-Builder shall furnish and install the appropriately sized and shaped louvered panels in the side section of the Instrument Frame of each cabinet bay as shown on Information Drawings. The finish of the cabinet frames, top panels, side panels, back panels, and side louvered panels shall be ANSI-61 Gray.
- E. Appropriate protected passageways shall be provided in the back panels and the bottom panels (if provided) for the installation of cables/wires to the various equipment within the console. In addition, appropriate protected passageways shall be provided for the installation

of power conductors (in conduit) to the AC duplex receptacles with the console in locations determined by the Design-Builder.

2.09 CONSOLE PANELS AND EQUIPMENT

- A. The Design-Builder shall furnish and install the following equipment panels and equipment in the Gatehouse Console in the space indicated on Information Drawings:
 - 1. Talkback Station Panel with associated amplifier as specified and provided in the Yard Talkback system section.
 - 2. Fire and Intrusion Alarm Subsystem Annunciator Panel as specified and provided in the Yard Fire and Intrusion Alarm System section.
 - 3. One 9-inch television monitor assembly as specified and provided in the Yard Closed Circuit Television System section.
 - 4. Yard CCTV Control Panel as specified and provided in the Yard Closed Circuit Television System section.
 - 5. Required AC duplex receptacles and receptacle strips as specified and provided in the Electrical Power Distribution Systems section.
 - 6. A PT&Z Star-Distribution Panel as specified and provided in the Yard Closed Circuit Television System Section.

2.10 WIRE AND CABLE TERMINATING FACILITY

- A. The Design-Builder shall furnish and install a wire and cable terminating facility in the Gatehouse to terminate all wires and cables (except video cables) that enter and exit the Gatehouse.
- B. The Design-Builder shall furnish and install a Protector Cabinet to contain a portion of the components of the wire and cable terminating facility. The Protector Cabinet shall be a NEMA 4 type enclosure. The Protector Cabinet shall be appropriately sized and shaped to contain the required components of the wire and cable terminating facility plus 10% expansion.
- C. The Design-Builder shall furnish and install the required protector blocks in the Protector Cabinet to terminate all wires and cables (including spares) that exit and enter the Gatehouse. Coax video cables associated with the Yard Closed Circuit Television System are not to be terminated on protector blocks, but installed directly to the appropriate equipment. The protector blocks shall be Cook Electric W492-LCGX Protector Blocks with 400 Vdc gas arrestors or approved equal.
- D. The Design-Builder shall furnish and install the required terminals in the Gatehouse console to extend the terminated wires and cables at the protector blocks in the Protector Cabinet to the Gatehouse Console. The Design-Builder shall furnish and install a Line Terminal Block in the Gatehouse Console for the Yard Telephone Panel. All terminals shall be Weidmuller Terminations, Inc., Type SAKR (test screw sockets) Test/Disconnect Terminals with necessary accessories or approved equal. The Line Terminal Blocks shall be a 4 x 26 matrix, with wire wrap terminals on both sides. The Line Terminal Blocks shall be Cook Electric 130-3784 (or approved equal).
- E. The Design-Builder shall furnish and install the required mounting brackets and hardware to install the terminals and the Line Terminals Block to the console frames. The Design-Builder shall configure the terminals and the Line Terminal Block so that they are accessible from the bottom front portion of the console by removing the front panels.

2.11 GATEHOUSE DATA FILES

- A. The Design-Builder shall design, draw, publish and deliver to the Authority twelve sets of Gatehouse Data Files.

- B. Each Gatehouse Data File shall consist of six or more 11" x 17" drawings. The drawings shall be as follows:
1. Telephones - a cross reference of telephone numbers and telephone locations within the yard and yard buildings.
 2. Fire Zones - a cross reference of the designated fire zones, building and room numbers and descriptions for all areas within the yard.
 3. Intrusion Zones - a cross reference of the designated intrusion zones, building and room numbers (as required) and descriptions for all areas of the yard.
 4. Public Address - a diagram showing room description, and location of Public Address speakers and horns within the yard and yard buildings.
 5. Talkback System - a cross reference of talkback stations by station number and location for all talkback stations within the yard.
 6. CCTV - a cross reference of TV monitor assignments and arrangements, CCTV camera designations, locations and areas of coverage for all cameras and monitors within the yard.
- C. The Authority's Representative shall furnish the Design-Builder with format and symbols for the Gatehouse Data files.
- D. Each drawing shall be sealed in a protective plastic laminate. Each Gatehouse data file shall be in looseleaf booklet form. The covers shall be 11" x 17". The cover material shall be a minimum of 60 pound punched paper with holes reinforced with plastic, cloth or metal. Covers shall be sealed in a protective plastic laminate.
- E. A draft copy of each Gatehouse data file shall be submitted to the Authority's Representative for approval prior to reproduction and assembly.
- F. The Design-Builder shall furnish a complete set of mylar reproducible drawings for each Gatehouse Data File, and electronic copies (in AutoCAD release 2000 format) on diskette.

PART 3-EXECUTION

3.01 INSTALLATION

- A. The Design-Builder shall install a complete operational Yard Communication Panel for Yard Control Console and Gatehouse Console, as described herein, in the Yard.
- B. Installation shall conform, but not limited, to accepted practices specified by the National Electrical Code, the Association of American Railroads and the Electronic Industries Association.
- C. The Design-Builder shall furnish and install all terminals, hardware, wiring and cabling, conduits and fittings, and make all connections and cross connections required for a complete operational installation.

3.02 YARD COMMUNICATIONS CONSOLE

- A. The Design-Builder shall install the conference table in the Yard control Room of the Service and Inspection Shop Building in the vicinity where the existing conduit/cable duct from the Communications Equipment Room enters the room (at floor level). Exact location shall be approved by the Authority's Representative.
- B. The Design-Builder shall install the fully assembled Yard Communications Console securely to the conference table top in the Yard control Room. Contract Drawing provide mounting details. The exact mounting location of the console on the table top shall be approved by the Authority's Representative.

- C. The Design-Builder shall install the Talkback Control Panel in the Yard Communications Console in accordance with Information Drawings.
- D. The Design-Builder shall install the CCTV Pan Tilt and Zoom Control panel in the Yard Communication console in accordance with Information Drawings.
- E. The Design-Builder shall furnish and install the required cabling and wire harnesses, connectors, and make the necessary connections and cross-connections to connect the Talkback Control Panel, the Yard Telephone Panel to the cable terminating facility in the Yard Communications Console.
- F. The Design-Builder shall install the ac duplex receptacles inside the Yard Communications Console in locations approved by the Authority's Representative. The Design-Builder shall provide the required conduit and fittings, power conductors, receptacle enclosures, and make the necessary connections to connect the ac duplex receptacles to the Communications Equipment Room Power Distribution Panelboard, as specified in the electrical Power Distribution Systems section. The Design-Builder shall furnish and install the required ac power receptacles, wires and cables, conduit, and make the necessary connections and cross-connections to provide 120 Vac, 60 Hz primary power to the various equipment in the Yard Communications Console from the ac duplex receptacles.
- G. The Design-Builder shall furnish and install an appropriately sized enclosed cable duct system between the Yard Communications Console and the existing conduit/cable duct entrances at floor level in the Yard Control Room for the passage of cables to the console. The provided cable duct system shall enter the console at the rear section of the bottom of the console.
- H. The Design-Builder shall make the necessary connections to terminate the various communications systems multiconductor cables from the Communications Equipment Room to the cable terminating facility.

3.03 GATEHOUSE CONSOLE

- A. The Design-Builder shall install the fully assembled Gatehouse Console in the Gatehouse as shown on Information Drawings. The Gatehouse Console shall be secured to the floor and the walls of the Gatehouse.
- B. The Design-Builder shall install the Talkback Station panel, the Intrusion Alarm Subsystem Annunciator Panel, the Fire Alarm Subsystem Annunciator Panel, the Yard CCTV Control Panel, the dual 9-inch Television Monitor assembly, and the Pan, Tilt and Zoom panel in the Gatehouse Console in accordance with Information Drawings.
- C. The Design-Builder shall install the amplifier associated and the Talkback Station panel in the Gatehouse Console. The exact mounting locations of the amplifiers shall be approved by the Authority's Representative.
- D. The Design-Builder shall install the required terminals and the Line Terminal Block of the wire and cable terminating facility inside the Gatehouse Console. The locations of the terminals and Line Terminal Block shall be approved by the Authority's Representative. The Design-Builder shall furnish and install the required cable harnesses, connectors, and make the necessary connections between the various equipment in the Gatehouse Console and to connect the panels and console equipment as required to the terminals and Line Terminal Block of the wire and cable terminating facility.

- E. The Design-Builder shall install the Protector Cabinet on an interior wall of the Gatehouse. The Design-Builder shall furnish and install the appropriately sized cable passageway in the Gatehouse structure to connect the Gatehouse Console to the Protector Cabinet.
- F. The Design-Builder shall install the required protector blocks of the wire and cable terminating facility in the Protector Cabinet.
- G. The Design-Builder shall make the necessary connections to terminate the various communications systems cables (except the coax video cables) to the Gatehouse on the protector blocks of the wire and cable terminating facilities. The Design-Builder shall furnish and install the required wiring, and make all necessary connections and cross-connections between the protector blocks and the terminals of the wire and cable terminating facilities. The Design-Builder shall furnish and install the required ground wires, connectors, and make the necessary connections to ground the protector blocks.
- H. Gatehouse Power Distribution shall consist of the required conduits and fittings, junctions boxes, branch circuit wires, and the appropriate type AC receptacles to apportion the primary power to the communications systems and facilities equipment within the Gatehouse as shown on Information Drawings. A power distribution Panelboard is provided by others in the Gatehouse for the connection of the required branch circuits.
- I. The Yard Communications Console grounding bar shall be connected to the Communications ground in the Communications Equipment Room. Console equipment shall be isolated from building and power grounds.

END OF SECTION

THIS PAGE NOT USED

SECTION 16840

YARD TALKBACK SYSTEM SPECIFICATIONS

PART 1-GENERAL

1.01 PURPOSE

This specification is included for information purposes only. No modifications or additions are included in the Scope of Work (Section 16700) for this project. The purpose of the Yard Talkback System is to:

- A. Provide voice paging from the Yard Communications Console located in the Yard Control Room, to personnel located track side (via nearby loudspeaker/talkback stations) or to the Gatehouse Building console;
- B. Provide the ability for track side personnel or Gatehouse personnel to verbally answer a page or signal the Yard Communications console that they want to talk to the Yard dispatcher;
- C. Broadcast an emergency tone, originating from the Communications Console, to the loudspeaker/talkback stations located track side;
- D. Broadcast an "All Call" verbal message, originating from the Communications Console, to all of the loudspeaker/talkback stations located track side.

1.02 YARD TALKBACK SYSTEM DESCRIPTION

- A. The Yard Talkback System (also known as the Talkback System) will provide paging and talkback service between the Yard Communications Console located in the Gatehouse, the talkback stations located along the tracks throughout the yard area.
- B. The Yard Talkback System includes a master control panel in the Yard Communications Console from which the Yard Dispatcher can call the talkback stations located in the vicinity of track switching points throughout the Yard. This panel gives the dispatcher the ability to select a specific Yard talkback station, to select all talkback stations simultaneously, to broadcast an emergency tone and/or identify and listen to an incoming call from a Yard talkback station.
- C. The Yard talkback stations provide trackside personnel with the ability to hear a voice page over loudspeakers (they only have to be in the vicinity of the station, not directly in front of it); the ability to verbally respond by talking toward the loudspeaker(s); or to signal the Yard Communications Console, by pushing a button, when they want to talk to the dispatcher.

1.03 OPERATING DESCRIPTION

- A. The following is a functional description of the operation of the Yard Talkback System from the Talkback Control Panel in the Yard Communications Console:
 - 1. Depress the pushbutton associated with the desired talkback station.
 - 2. Switch the "TALK/LISTEN" switch to the talk position.
 - 3. Speak into the loudspeaker on the panel.
 - 4. Personnel in the vicinity of a called talkback station respond by speaking in the direction of the loudspeakers mounted at the top of the selected Yard Talkback Standard.
 - 5. A conversation between a Talkback Control panel and a talkback station is controlled

by the "TALK/LISTEN" switch on the Talkback Control Panel.

- B. The attendant at the Talkback Control panel in the Yard Communications Console may "Page" all talkback stations by:
 - 1. Depressing the "ALL CALL" pushbutton.
 - 2. Switching the "TALK/LISTEN" switch to the TALK position.
 - 3. Speaking into the loudspeaker on the panel.
 - 4. The attendant at the Talkback Control Panel may transmit a warning signal by depressing the "EMERGENCY CALL" pushbutton. The warning signal shall be broadcast by the loudspeakers of all talkback stations.
- C. The attendant at the Yard Communications Console, upon conclusion of a conversation over the Yard Talkback System, depresses the "RESET" pushbutton. This returns the Yard Talkback System to its quiescent state.

1.04 YARD TALKBACK STATION

- A. The operation of the Yard Talkback System from a Talkback Standard located along the track is accomplished by:
 - 1. Pushing the "CALL" pushbutton mounted on the talkback standard.
 - 2. Listening for the Communications Console response.
 - 3. Speaking into the loudspeaker mounted at the top of the talkback standard.
- B. The operation of a "CALL" pushbutton on a talkback standard will:
 - 1. Light the pushbutton lamp on the Yard Control Room Control Panel associated with that particular talkback station.
 - 2. Activate a chime in the Yard Control Room.
- C. The attendant at the Control Panel then:
 - 1. Depresses the illuminated talkback station pushbutton.
 - 2. Switches the talk/listen switch to the talk position.
 - 3. Speaks into the loudspeaker on the panel.

1.05 GATEHOUSE TALKBACK CONSOLE PANEL

- A. The operation of the Yard Talkback System from the Gatehouse console is accomplished by:
 - 1. Depressing the "PUSH-TO-CALL" pushbutton.
 - 2. Listening for the Yard Communications Console voice response.
 - 3. Speaking into the loudspeaker on the console panel.

1.06 SYSTEM PERFORMANCE REQUIREMENTS

- A. The following performance requirements are the minimum acceptable parameters for the Yard Talkback System to operate properly. The Design-Builder shall engineer the Talkback System and select equipment that will meet or exceed these requirements. The Design-Builder shall, upon completion of the system, deliver a system conforming to the operational intent of these requirements and the talkback needs of the Washington Metropolitan Area Transit Authority (WMATA).

1.07 TALK OUT SPECIFICATIONS

- A. For the system configured in a talk out configuration (the talkback station speakers are used as loudspeakers), the following parameters shall apply when a 300-3000 Hz audio signal test source is used at the Yard Communications Console Talkback panel (in the Gatehouse) in lieu

of, but at the same input voltage level as the panel speaker/microphone:

- B. Standard talk out speaker power >103 dB at 4 feet (as measured by a test microphone connected to an appropriate power meter).
- C. Talk out distortion (as measured by a test microphone connected to an appropriate distortion meter): <1.5% total harmonic distortion (330-3000 Hz).
- D. Talk out speaker(s) total audio dispersion: two speakers (90 degree dispersion each) mounted back to back (published specification).
- E. Talk out system frequency response: ± 1.5 dB or better between 300-3000 Hz (as measured and charted by use of a test microphone connected to an appropriate power meter or equivalent).

1.08 TALKBACK SPECIFICATIONS

- A. For the system configured so that the talkback station speakers are configured as microphones, the following parameters should apply as measured at the Yard Communications Console Talkback panel speaker leads.
- B. Talkback system frequency response: ± 1.5 dB or better between 300-3000 Hz for all speaker/microphone inputs.
- C. Standard mounted talkback speaker/ microphone(s) sensitivity (for a 1000 Hz audio source of 70 dB, ref. 0.0002 microbars [moderately louder than normal conversation], 10 feet directly in front of the speaker standard) shall produce at the Yard Communications Console Talkback speaker:
 - 1. Full Talkback System panel audio output, when the panel volume control is adjusted to its maximum.
 - 2. and <1.5% harmonic distortion in item a.
 - 3. where both a. and b. are measured under conditions of non-train movement and normal environmental noise, i.e., 20-45 dB, ref. 2000 microbars.

1.09 SPECIAL ENVIRONMENTAL CONSIDERATIONS

- A. All equipment shall be fully operational without damage or functional degradation under any combination of the following:
 - 1. Ambient temperature -30°C to +60°C.
 - 2. Relative humidity 0 percent to 95 percent.
 - 3. All standards and standard mounted components shall be considered outdoor equipment and shall be capable of withstanding the effects of:
 - a. rain, salt, dust, oil, and other pollutants.
 - b. winds up to and including 90 MPH with rime icing.
 - c. vigorous and normal use.
 - d. train related vibrations.

PART 2-PRODUCTS

2.01 MAJOR ITEM TECHNICAL REQUIREMENTS

- A. The items listed in this section of these Specifications shall be considered the major, but not necessarily the only items that the system is comprised of. Items not stated, but that are necessary for testing and proper system operation shall be provided by the Design-Builder.

- B. The following is a list of the major items required to accomplish the talkback functions:
1. Master Yard Talkback Panel with loudspeaker located in the Yard Communications Console in the Rail Yard Control Room.
 2. Gatehouse Talkback Panel with loudspeaker.
 3. Weatherproof Speaker Talkback Stations.
 4. Distribution Frame in the Communications Equipment Room of the Yard TCR/Tower/Operations Building.
 5. Talkback Control Unit with multi tone generator in the Communication Equipment Room.
 6. Cable Termination Frame in the Gatehouse.
 7. Cable Termination Blocks for the Yard Control Console and Gatehouse Panels.
 8. Gatehouse Amplifier and Control unit.

2.02 YARD COMMUNICATIONS CONSOLE TALKBACK PANEL

- A. The Console Talkback Panel shall be 19 inches wide and shall be constructed for the Yard Communications Console located in the Yard Control Room. All necessary enclosures and peripheral pieces necessary for this purpose shall be provided by the Design-Builder.
- B. A chime shall be provided and installed to alert the console operator to an incoming call from one of the talkback stations or from the Gatehouse.
- C. All interfaces as described in these Specifications shall be provided by the Design-Builder.
- D. Primary features that the Console Talkback Panel shall have are:
1. Multi-position split screen illuminated pushbutton switches. Each talkback station will have its respective button.
 2. A loudspeaker to be used:
 - a. for listening to the field stations or Gatehouse panel calls;
 - b. to serve as the microphone for paging or conversation purposes.
- E. A spring loaded toggle switch labeled "TALK/LISTEN", normally in the LISTEN position.
- F. An illuminating pushbutton labeled "ALL CALL", that can permit a simultaneous page to go out over all field stations and the Gatehouse panel.
- G. An illuminating pushbutton labeled "EMERGENCY CALL" that connects the control panel to all the field stations and the Gatehouse panel. This switch activates a distinctive tone signal from the multi-tone generator as an emergency alert signal. The switch shall be protected from accidental activation by a flip type cover.
1. A volume control for changing the loudspeaker output level.
 2. An illuminating momentary pushbutton switch labeled "RESET", used to return the system to its quiescent state.
 3. A separate single stroke chime to indicate an incoming call.
- H. The top portion of the illuminating pushbutton switches shall light when the switch is depressed for calling or answering a talkback station. The bottom portion of the switches shall illuminate when a call is made from a talkback station or the Gatehouse panel. The pushbutton switches shall contain legends listing the Talkback Station Number on the lower portion of the switch, in accordance with the Information Drawings. It shall extinguish when the call is answered.
- I. The Yard Communication Talkback Panel shall be GAI-Tronics Model No. L91043, (or

approved equal).

2.03 TALKBACK CONTROL UNIT

- A. The Design-Builder shall provide a Talkback Control Unit to be located in the Communications Equipment Room of the TCR/Tower/Operations Building. The Talkback Control Unit shall include the following:
1. Control function circuitry for the Yard Talkback System.
 2. Terminal blocks for wire and cable terminations.
 3. Circuitry to distribute primary power to the talkback stations.
 4. Amplifier.
 5. Multi tone generator with the required circuitry to generate at minimum three types of tones - steady siren, slow wailing, and fast wailing.
 6. DC Power Supply with 120 VAC, 60 Hz input, and appropriate DC output compatible with the talkback system supplied. The DC power used shall not exceed 60 Vdc.
- B. The circuitry, terminal blocks, amplifier and power supply shall be protected by a metal enclosure to protect the equipment from moisture, dust, inadvertent contact with other objects or persons, and other problems of an accidental nature. The AC and DC power leads shall be protected by fuses or circuit breakers.
- C. The metal enclosure shall be at minimum a NEMA TYPE 1 (36" H x 30" w x 6" D) enclosure and be made of 14-gauge steel with a gray lacquer finish. The steel cover panel for the metal enclosure shall be a 12-gauge white enamel finished steel cover panel. Enclosures and panels exceeding these characteristics will be considered.
- D. The Talkback Control unit shall be GAI-Tronic Alarm Merge/Isolate Cabinet Model No. L91044, (or approved equal).

2.04 TALKBACK STANDARDS - RAIL YARD

- A. The Design-Builder shall construct Talkback Standards, for the yard talkback stations. Each Talkback Standard shall consist of:
1. Concrete base.
 2. Metal stanchion.
 3. Amplifier.
 4. Weatherproof enclosure.
 5. Weatherproof enclosure cover.
 6. "CALL" pushbutton.
 7. Two weatherproof speaker horns.
 8. Circuitry to provide switching the speaker horns from output to input devices.
 9. The concrete base shall be sized and shaped as shown on Information Drawings. Four anchor bolts shall be imbedded in the concrete base for mounting the metal stanchion. A one and one half inch elbow PVC sleeve shall be embedded in the center of the concrete base for passage of the cable to the stanchion. Each metal stanchion shall consist of:
 10. 1/2-inch aluminum pipe.
 11. 1-1/4 -inch aluminum pipe.
 12. 1-1/2-inch diameter aluminum pipe.
 13. 1/4 - inch thick aluminum plate base.
- B. The 1-1/2 inch diameter aluminum pipe shall be attached to the aluminum plate base with four 3/8-inch thick aluminum plate gussets. Adjustment gussets shall be perpendicular to each other. The 1-1/2-inch diameter aluminum pipe with the 3/8-inch thick aluminum plate base

shall be attached to the concrete base with four 1/2-inch diameter anchor bolts. The 1-1/2 inch diameter aluminum pipe shall extend from the aluminum plate base to the bottom of the weatherproof amplifier enclosure. The 3/8-inch thick aluminum plate base shall have sized mounting holes for installation on the concrete base. Information Drawings provide details on the metal stanchions.

- C. A weatherproof enclosure shall be secured to the aluminum pipe at the height shown on the Information Drawings. The 1-inch diameter aluminum pipe shall extend from the top of the weatherproof enclosure to the top of the stanchion. The weatherproof enclosure shall be at minimum a NEMA Type 4 enclosure. The weatherproof enclosure shall house the following:
1. Barrier-type terminal strip for terminating the direct burial cable from the Communications Equipment Room.
 2. Speaker horn switching circuitry.
 3. "CALL" pushbutton.
 4. Amplifier.
- D. The amplifier shall fit in the metal enclosure and have the following characteristics:
1. Input Power - 24 Vdc nominal Current @25 Vdc 1.0 A max
 2. Speaker Amplifier: Output: Push-pull, Class B, 12 watts min, @24Vdc Amplifier
 3. Sensitivity: 0.5 Volts: at rated output
 4. Frequency Response: 250-4000 Hz \pm 1.5 Db
 5. Distortion: 1% max total harmonic distortion @1,000 Hz, 12 watts
 6. Regulation: Full to no load -1 dB max rise
 7. Input Impedance: 50,000 ohms nominal
 8. Temperature Range: -30°C to +70°C
- E. A weatherproof momentary normally open contact pushbutton switch sealed against oil and water. The pushbutton shall be connected to the barrier-type terminal strip of the enclosure with 18 AWG, single conductor wires. The label "CALL" shall be printed below the pushbutton on each enclosure cover, the lettering shall be Helvetica Medium, black and shall be 1-inch in height. The label will be weatherproof and element resistant, and shall be inseparable from the weatherproof enclosure.
- F. A control relay or equivalent circuitry for the talk/listen function shall be wired in each enclosure of each stanchion. This will switch the output to input of the amplifier.
- G. The Design-Builder shall also provide the following, as required for the installation:
1. Conduit.
 2. Hub plates.
 3. Gaskets.
 4. Reducers.
 5. Conduit Tees.
 6. Other accessories for passage of burial cable and speaker wires from inside the aluminum pipe to the weatherproof enclosure.
- H. Two weatherproof speaker horns shall be furnished with each Talkback Standard. The weatherproof speaker horns shall be secured to the top of the stanchion by:
1. 1 1/4 inch conduit tee.
 2. 1/2--inch diameter aluminum pipe.
 3. Required mounting accessories.
- I. There shall be 3/8-inch diameter access holes provided in the 1 1/2-inch diameter aluminum pipe for passage of the speaker wire from inside the aluminum pipe of the stanchion to the horns. Information Drawings show installation details for mounting the horns to the metal stanchion.

The weatherproof GAI-tronics Model 13320-002 (or approved equal) speaker horns shall have the following characteristics:

1. Aluminum horn with gray epoxy finish for corrosion resistance.
 2. Locking swivel mount to allow precise positioning
 3. Compact integral 8 ohm 30 watt driver
 4. Low Frequency Cut-off 250 Hz
 5. Dispersion Angle: 90°
 6. Sound Pressure level: 116 dB @12 W, 119 dB @30 W
 7. Frequency Range: at least 450 - 6000Hz
 8. Air Column Length: 1.4 ft
 9. Dimensions (Approx.): 10.3" Diameter by 9" long.
- J. Each horn shall be connected to the barrier-type terminal strip of the weatherproof enclosure. A 2-conductor, twisted, 14 AWG, shielded outdoor cable shall be used.
- K. All mounting hardware and supporting of Equipment in enclosures shall be stainlesssteel.

2.05 CONSOLE TALKBACK PANEL GATEHOUSE

- A. The Design-Builder shall provide a Talkback Station 19" rack mountable 3.5" high panel in the Gatehouse Console. The Panel shall consist of:
1. Talkback loudspeaker.
 2. "PUSH-TO-CALL" pushbutton switch.
 3. Volume control for the loudspeaker output.
- B. The "PUSH-TO-CALL" pushbutton switch shall signal the Talkback Control Panel in the Yard Control Room Console.
- C. The Design-Builder shall install a Station Amplifier. The Station amplifier shall be housed in an amplifier enclosure independent of the Talkback Station Panel.
- D. A control relay or other circuitry for the talk/listen function shall be installed in the amplifier enclosure. This will switch the Panel loudspeaker from output to input of the amplifier.
- E. The Talkback Station Panel shall be GAI-Tronics Corporation, Model L91046, or approved equal.

2.06 DISTRIBUTION FRAME

- A. The Yard Talkback Distribution Frame shall contain the required protector blocks and terminals to terminate all Yard Talkback System cables including spares entering and leaving the Communications Equipment Room in the Service and Inspection Shop Building. Cables external to the Service and Inspection Shop Building shall be terminated on the protector blocks.
- B. The Distribution Frame shall consist of:
1. Terminal housing with top and bottom assemblies. Hinged and sections.
 2. Fungus resistant plywood backboards.
 3. Lift-out doors.
 4. Distribution rings.
- C. The frame shall be Cook Electric, Model C-202, or approved equal.
- D. The terminal blocks shall HAVE Test Socket Screws, with accessories, and be Weidmuller, Model SAKC-4, (or approved equal). The protector blocks shall be complete with 400 Vdc gas

arrestors and ground bar assemblies. The protector blocks shall be Cook Electric, Model W492-LCGX, (or approved equal).

- E. Information Drawings provide details of the layout with a wiring block diagram of the Talkback Distribution Frame.

2.07 CABLE TERMINATION FRAME GATEHOUSE

- A. The Gatehouse Termination Frame shall contain the required protector blocks and terminals to terminate all Yard System cables including spares entering and leaving the Gatehouse Room.
- B. The Frame shall consist of:
 1. Terminal housing with top and bottom assemblies.
 2. Hinged end sections.
 3. Fungus resistant plywood backboards.
 4. Lift-out doors.
 5. Distribution rings.
- C. The Frame shall be Cook Electric, same as previous page.
- D. The terminal blocks shall HAVE Test Socket Screws, with accessories, and be Weidmuller, Model SAKC-4, or approved equal. The protector blocks shall be complete with 400 Vdc gas arrestors and ground bar assemblies. The protector blocks shall be Cook Electric, Model W492-LCGX, or approved equal .
- E. Information Drawings provide details of the layout with a wiring block diagram of the Gatehouse Frame.

2.08 AUDIO CABLE

- A. Independent Cable Corporation type "Filled Direct Earth Burial Communications Cable" (or approved equal)
- B. Insulation Rating: 300 Volts
- C. 3-Pair, 16-AWG solid copper conductors
- D. Inner Jacket: Polyethylene
- E. Outer Jacket: Black Polyethylene
- F. Shield: Copper Tape
- G. Overall Steel Armor
- H. Shall meet IMSA Spec. 60-6

2.09 POWER CABLE

- A. Clifford Cable Corporation type "Direct Earth Burial Signal Communications Cable"(or approved equal)
- B. Insulation Rating: 600 Volts

- C. 2-Pair, 14-AWG solid copper conductors
- D. Inner Jacket: Polyethylene
- E. Outer Jacket: Black Polyethylene
- F. Shield: Copper Tape
- G. Overall Steel Armor
- H. Shall meet IMSA Spec. 20-6

PART 3-INSTALLATION

3.01 GENERAL

- A. The Design-Builder shall install in the Rail Yard a complete operational Talkback System, as described in these Specifications.
- B. The Design-Builder shall furnish and install all terminals, hardware, wiring, cabling, conduits, fittings, connections and cross-connections required for a complete operational system. This includes the proper grounding of all equipment. The Design-Builder shall provide wiring to supply the dc power to all dc operated equipment and the 110/120 Vac, 60 Hz power to all AC operated units in these Specifications.

3.02 COMMUNICATIONS EQUIPMENT ROOM

- A. The Design-Builder shall install on a wall in the Communications Equipment Room:
 - 1. Distribution Frame.
 - 2. Talkback Control Unit.
 - 3. Multi tone Generator.
- B. The locations for the equipment shall be approved by the Authority's Representative.
- C. The Design-Builder shall connect the Talkback Control Unit to the terminals on the Talkback Distribution Frame and the multi tone generator.
- D. The Design-Builder shall wire between the various terminals and protector blocks on the Talkback Distribution Frame. Ground bars, grounding and ground wiring shall be provided by the Design-Builder.
- E. The Design-Builder shall make the connections to provide 120 Vac, 60 Hz power to the Talkback Control Unit from the Communications Equipment Room Power Distribution Panel board.
- F. The Design-Builder shall make the connections to provide dc power to each of the yard Talkback Stations. This power shall feed through the Talkback Distribution Frame in the Communications Equipment Room, via the 4 conductor power cables.

3.03 YARD TALKBACK CONSOLE - YARD CONTROL ROOM

- A. The Design-Builder shall install the Talkback Control Panel in the Yard Talkback Console as

shown on Information Drawings. The Design-Builder shall install the single stroke chime in the interior of the Yard Communications Console.

- B. The Design-Builder shall wire the chime to the Cable Termination Block in the Yard Communications Console.
- C. The Design-Builder shall install a 25-pair (22 AWG) cable and a 12-pair (22 AWG) cable from the Cable Termination Block in the Talkback console to the Talkback Distribution Frame in the Communication Equipment Room.

3.04 GATEHOUSE BUILDING CABLE TERMINATION FRAME

- A. The Design-Builder shall place a Cable Termination Frame in the Gatehouse as outlined in these Specifications. The Design-Builder shall install a 3-pair, 16-AWG Audio Cable between the Gatehouse Cable Terminating Frame protector blocks and the protector blocks on the Distribution Frame in the Communication Equipment Room of the Yard Operations Building. The Design-Builder shall terminate all wires including spares. Protector block grounding at both ends shall be implemented by the Design-Builder as approved by the Authority's Representative. The Design-Builder shall wire 110/120 Vac, 60 Hz power to the Gatehouse Remote Talkback Amplifier from the duplex AC power receptacles or the AC Power Panel of the Gatehouse.

3.05 YARD TALKBACK STANDARDS OPEN RAIL TRACK AREA

- A. The Design-Builder shall install the completely assembled Talkback Standards along the tracks within the yard limits. The Talkback Standards shall be installed in the vicinity of the yard track switching points. Information Drawings show proposed locations and installation details of the Talkback Standards.
- B. The exact location of each Talkback Standard shall be approved by the Authority's Representative. The Design-Builder shall make a field survey with the Authority's Representative to determine the locations of the Talkback Standards and obtain T/C & Communications conduit locations in vicinity of Talkback Standards locations throughout yard.
- C. The Design-Builder shall install Power and Audio Cables between each Talkback Station and the Main Distribution Frame in the Yard Operations Building. The Design-Builder shall terminate all wires including spares on protector blocks. All remaining cross-connections and dc wiring shall be performed by the Design-Builder

3.06 GATEHOUSE CONSOLE

- A. The Design-Builder shall install the Talkback Station Panel amplifier with enclosure in the Gatehouse Console. This is shown on the Information Drawings and outlined in these Specifications.
- B. The Design-Builder shall perform all the wiring between the amplifier, the Talkback Station Panel, the Cable Termination Block, and the Talkback Cable Termination Frame in the Gatehouse Building. Final 110/120 Vac wiring shall be completed as outlined in these Specifications.

END OF SECTION



SECTION 16853

YARD CLOSED CIRCUIT TELEVISION SYSTEM

PART 1 - GENERAL

1.01 PURPOSE

This Section specifies certain basic requirements for the design and fabrication of Yard Closed Circuit Television System modifications and expansions. The Closed Circuit Television (CCTV) System consists of two independent CCTV Systems. The Gatehouse(Yard Security) CCTV System provides the Gatehouse attendants with surveillance of major parking bays and the yard perimeter. The Yard Control CCTV System shall provides the Yard Control Room attendants with surveillance of interlocking switching track areas. This specification is intended to specifically address Yard Control CCTV requirements at Shady Grove Yard. The Yard Control System at Shady Grove Yard shall be totally independent of the Gatehouse (Yard Security) CCTV System.

1.02 SYSTEM DESCRIPTION

- A. The Yard Control CCTV System described herein includes, but is not limited to, the following components:
1. CCTV Cameras.
 2. Pan and Tilt Units.
 3. PT&Z Control Panels.
 4. CCTV Monitors
 5. CCTV Patch Panel.
 6. PT&Z Terminal Panel.
 7. CCTV Camera Power Distribution Panel(s).
 8. Fiber Optic Video Transmitter Cards.
 9. Fiber Optic Video Receiver Cards.
 10. Fiber Optic Video Card Cage.
- B. The Gatehouse CCTV System has recently replaced by a new Yard Security CCTV System. Selected As-Built drawings of this system are available for review if required.
- C. Each CCTV camera equipped with a pan and tilt unit shall also be equipped with a zoom lens.
- D. CCTV monitors located in the Yard Control Room shall be used to monitor the video output from each CCTV camera in the Yard-Control CCTV System. CCTV monitors shall be located



in the Yard Communications Console or other designated area located within the Yard Control Room.

- E. The CCTV Patch Panel(s) and test/patch cords shall provide access to the CCTV circuits for the purpose of testing and maintenance.
- F. Fiber Optic Video Links shall provide a means of transmitting CCTV Camera Video and PT&Z signals over a fiber optic facility.
- G. Fiber Optic Video Links shall be used for all inter-building conduit paths between a camera and its control point.

1.03 OPERATING DESCRIPTION

- A. The Yard Control CCTV System shall provide the Control Tower attendant with fields of view covering at least 90 percent of the yard interlocking switching track areas, exclusive of the areas in the direct view of the Yard Control Tower.
- B. The Control Tower attendant shall be provided the ability to view multiple interlockings simultaneously with either individual monitors and or split screen arrangements. The attendant must have the ability to select any individual camera for full screen viewing and PT&Z control. The ability to establish pre-sets for each PT&Z camera and to program manual or sequential displays for all cameras shall be included.
- C. Determination of size and location of color monitors and control functions shall be based on the best ergonomic design compatible with final console arrangements and the Control Tower attendants mode of operation. Final selections are subject to approval by the Authority Representative.
- D. Digital recording of the Yard Control CCTV cameras is not included in the scope of this project.

PART 2 - PRODUCTS

2.01 SYSTEMS PERFORMANCE REQUIREMENTS

The Design-Builder shall be responsible for the performance of the Closed Circuit Television Systems. The following system performance requirements are designed to ensure that the Closed Circuit Television Systems delivered under these Specifications meet the performance requirements of the Washington Metropolitan Area Transit Authority.

A. OVERALL PERFORMANCE REQUIREMENTS FOR CCTV SYSTEMS

- 1. Minimum Scene Illumination
 - a. Each CCTV camera shall provide a usable video output with IR filter and AGC on with a faceplate illumination of 0.04 footcandles (or less).
 - b. A faceplate illumination of 0.2 foot-candles (or less) with IR filter and AGC off shall cause a full video output from the CCTV camera
- 2. Resolution

- a. The center limiting vertical resolution, as determined by viewing on any CCTV monitor, as produced by a signal originating from each associated CCTV camera and passing through the installed cable and distribution equipment for each CCTV system, shall not be less than 350 lines in the center when all system equipment is operated to any combination of values within those specified. The horizontal resolution measured under these conditions shall not be less than 550 TV lines in the center of the picture when viewing on any CCTV monitor.
3. Video Signal Level
 - a. Video signal levels shall conform to level requirements of EIA Standard RS-170 when measured at the input of the installed CCTV monitors.
 4. Scanning Lines
 - a. 525 lines per frame, interlaced 2:1 Standard RS-170 with no discernible interlace jitter or pairing on the monitor.
 5. Frame Frequency
 - a. 30 frames per second.
 6. Aspect Ratio
 - a. Height to width ratio of 3 to 4.
 7. Environmental Standards
 - a. All equipment mounted outdoors shall be fully operational without damage or functional degradation under any combination of the following environmental/working conditions:
 - 1) Ambient temperature -40 degrees C to +55 degrees C.
 - 2) Relative humidity 0 percent to 100 percent.
 - 3) Operation to +60 degrees C shall be fully satisfactory with less than 100 lines reduction in camera horizontal resolution.
 - 4) Rain, salt, dust, oil, and other pollutants.
 - 5) Winds up to and including 90 MPH with rime icing.
 - 6) Vigorous and normal use.
 - 7) Train related vibrations.
 - b. Noise
 - 1) Operation of any aspect of the system, including the pan & tilt unit or zoom lens function controls, shall not produce any discernible noise on the CCTV monitor. The signal-to-noise ratio under all

transit system operating conditions shall be degraded by no more than 3 dB.

8. Coverage Requirements

- a. The Yard-Control CCTV System equipment shall include television cameras whose combined fields of view shall provide primary coverage for at least 90 percent of the interlocking switching track areas, exclusive of the areas in the direct view of the Yard Control Room.

2.02 FIBER OPTIC VIDEO LINK

- A. The Fiber Optic Video Link is used to transmit CCTV video and PT&Z control signals over long distances through areas of high EMI. The use of fiber optics also eliminates ground loops and eliminates the need for equalization amplifiers needed on long runs of copper cable.
- B. The Fiber Optic Video Link typically consists of a Fiber Optic Transmitter, a Fiber Optic Facility, and a Fiber Optic Receiver.
- C. The transmitter module shall convert a standard NTSC baseband video signal and PT&Z control signals to an optical signal for transmission over a fiber optic facility. The transmitter modules shall have a stand-alone mounting topology.
- D. From the opposite end of the fiber optic facility, the receiver module shall convert the transmitter's optical signal into a standard NTSC baseband video and PT&Z control signals.
- E. The Fiber Optic Link shall have sufficient optical budget to overcome facility and termination losses incurred to transmit and receive signals a minimum distance of 3 kilometers.
- F. The Design-Builder shall be responsible for optical connector compatibility between fiber optic facilities and fiber optic video links.

2.03 MAJOR ITEM TECHNICAL REQUIREMENTS

The Major Items listed below shall conform to the operational and performance requirements of these Specifications. Incidental items, not specifically mentioned, but required for complete and proper system operation shall be furnished and installed by the Design-Builder.

- A. CCTV CAMERAS (PT&Z)
 1. Philips Model LTC 0928/25-F G3 Envirodome 18X Day/Night Integrated PTZ CCD Camera w/Fiber Module and 4.1 -73.8 mm Lens (or approved equal).
 2. The PTZ cameras shall be capable of providing a color or black and white video output. During the day, or whenever lighting levels are adequate, these cameras shall produce a color signal. At night, or whenever lighting levels become too low for usable color video, these cameras shall automatically switch to the monochrome mode and remove the IR filter for improved performance. The capability to manually switch between modes shall be provided.

3. The PTZ cameras shall be capable of providing 360 degrees of continuous pan coverage at 120 degrees per second.
4. The PTZ cameras shall be provided with programmable pre-position features to automatically pan/tilt/zoom to the appropriate view in response to commands, and to sequence to predetermined viewing areas for video tours when so programmed.

B. CCTV MONITORS

1. SVGA High Brightness LCD Monitor 15 to 20 inch. Stealth Model SV1500-PM-HB (or approved equal). Actual screen size shall be largest practical within range given dependant on mounting arrangement (i.e. console, ceiling, wall, or desktop) to be determined by Design-Builder. Model number given is for technical characteristics exclusive of screen size.

C. FIBER OPTIC LINK

1. Accommodates standard NTSC video signal and PT&Z control signals.
2. Video Input/Output signal 1V p-p.
3. 15 MHz Video Bandwidth.
4. Video Input/Output impedance 75 ohms unbalanced.
5. Operating environment -20 deg C to +65 deg C, 0 to 95% relative humidity (non condensing).
6. 110 Vac operation.
7. Shall include required hardware for mounting in CCTV equipment cabinets or in 19-inch equipment rack (Yard Operations/Maintenance Building, Communications Equipment Room and Shop Facility Building Communications Equipment Room.)

D. VIDEO SWITCHER/CONTROL SYSTEM

1. Philips - Allegiant Microprocessor-Based Video Switcher/Control System Model No.LTC 8300/xx sized to support camera quantity (or approved equal).
2. Must include all necessary software and peripherals to provide the Yard Control Tower Attendant maximum viewing flexibility and selective PT&Z control of all cameras.

E. PARAPET MOUNT ADAPTERS

1. Philips LTC 9230/00 (or approved equal)

F. COAXIAL VIDEO CABLE (75 OHM)

1. RG59 type coaxial cable
2. 75-ohm impedance.

G. 2-CONDUCTOR SHIELDED POWER CABLES

1. BELDEN 1032A TSP #18 (or approved equal)

H. VIDEO TEST/PATCH PANEL

1. Trompeter Model #JS-24L (or approved equal).
2. Accommodates 12 patch jacks (listed below).
3. 19-inch rack mount.
4. Height: 2 rack units (3.5 inches).
5. With stainless steel identification strip with card and plastic window for identification of each connector on panel.

I. VIDEO PATCH JACKS

1. Trompeter Model #J14WT-75 (or approved equal).
2. Normal thru signal path.
3. Patching terminates unused side in 75 ohms.
4. BNC rear connectors (75 ohm).
5. WECO patch connectors (75 ohm).

J. TEST/PATCH CORDS (PATCH PLUG TO PATCH PLUG)

1. Trompeter Electronics, Inc., Model No. PCW-24-75 (or approved equal).
2. Length : 2 feet.
3. Connectors: 75 ohm WECO patch plugs.
4. RG59 type coaxial cable.

K. TEST/PATCH CORDS (PATCH PLUG TO BNC)

1. Trompeter Electronics, Inc. Model No. UPCWX-60-75 (or approved equal).
2. Length 5 feet.
3. Connectors: 75 ohm WECO to 75 ohm BNC.
4. RG59 type coaxial cable.

L. CCTV CAMERA POWER DISTRIBUTION PANEL

1. Alarmsaf Model TV244-300 Multi - Camera Power Supply.120 VAC/24/VAC (or approved equal).

M. FIBER OPTIC CABLE

1. Siecor 002K51-31141-24 (2) Fiber Loose-tube, 62.5 Micron (or approved equal)
2. Environmental: -40oC to +70oC.

PART 3 EXECUTION

3.01 GENERAL CLOSED CIRCUIT TELEVISION SYSTEM INSTALLATION

- A. The Design-Builder shall furnish power supplies and install all terminals, hardware, wiring and cabling, connectors and adapters, conduits and fittings, and make all the necessary connections and cross-connections required for complete operational installation. The onus shall be on the Design-Builder to verify product compatibility and system performance of all equipment, including equipment specified under the Major Items sections of this Contract.

3.02 GROUNDING

The Design-Builder shall design a grounding scheme for the Closed Circuit Television System that shall comply with the following requirements:

- A. All CCTV equipment installed in Communications Equipment Rooms shall be connected to Communications ground.
- B. Shields of all copper coaxial cables shall be grounded only to the communications ground in a Communications Equipment Room or the Gatehouse.
- C. The grounds of CCTV equipment installed in CCTV equipment cabinets shall be electrically isolated from power/building ground.
- D. All CCTV cameras shall be isolated from ground through structures and wiring, except for a single ground path via the shield of the video coaxial cable to the communications ground from a Communications Equipment Room and, except for a single ground path, via the shield of the video coaxial to the Fiber Optic video transmitter, or to the ground from an insulated CCTV equipment cabinet.
- E. All installed video connectors and adapters shall be covered with shrink sleeving to electrically isolate the connectors from power/building ground.

3.03 CAMERA EQUIPMENT

- A. The Design-Builder shall install the CCTV cameras in enclosures with the appropriate type mounting brackets. The Design-Builder shall optimize the camera coverage identified in these Specifications by identifying conduit stub-outs with appropriate conduit extensions necessary to provide the optimum coverage. The Design-Builder shall submit the optimum design layout of the cameras and lens types as part of the Engineering Definition Review. The Engineering Definition Review shall be used to assist the Authority's Representative in determining the adequacy of the design and, in conjunction with a field survey, determining the exact location

of each CCTV camera. The bottom of installed CCTV cameras shall, ideally, be two feet or greater above the finished parapet, and may extend beyond the inside edge of the parapet as specified or approved by the Authority's Representative. CCTV camera conduit routing shall be approved by the Authority's Representative.

3.04 CCTV SYSTEM CABLING

A. VIDEO CABLE

1. The Design-Builder shall install coaxial cable for all video connections.

B. VIDEO CONNECTORS

1. The Design-Builder shall install the required video connectors and adapters and connect the video cables to the CCTV equipment. Video connectors shall be crimp type with weatherproof gaskets. Shrink Sleeving (with two layers of electrical tape for splices) shall be installed on video connectors and adapters that are exposed to the environment, including splices. All splices shall be TDR tested and approved by the Authority's Representative.

C. MULTICONDUCTOR PT&Z CONTROL CABLE


1. The Design-Builder shall install and connect a shielded multiconductor cable to the following CCTV system components:
 - a. From Pan and Tilt units and Zoom lens controls on cameras equipped with PT&Z, to PT&Z fiber optic interface.
 - b. From the fiber optic interface to PT&Z control receivers (Gatehouse CCTV System).
 - c. From the fiber optic interface to PT&Z Control Panels (Yard-Control CCTV System).

D. POWER CABLES

1. The Design-Builder shall install and connect shielded twisted pair primary power cables from CCTV Camera Power Distribution Panels (in Communications Equipment Rooms) and from ac power terminal strips (in ancillary buildings with CCTV equipment cabinets) to the appropriate CCTV Cameras and heaters in Pan and Tilt Units.

E. FIBER OPTIC CABLE

1. The Design-Builder shall install fiber optic cable between fiber optic video transmitters and receivers to establish the required fiber optic video links as shown on the Contract Drawings. Each fiber optic cable run shall be continuous and without splices.
2. Installation in conduit:
 - a. The Design-Builder shall use communications conduit reserved for CCTV.
 - b. If the CCTV conduit is filled, the Design-Builder shall use the least filled communications conduit.

- 
3. At each end of a fiber run, the Design-Builder shall coil 10 feet of slack fiber cable before termination and store neatly in the appropriate CCTV equipment rack/cabinet.
 4. The slack fiber coils and any bends in the fiber incurred during installation shall have a bending radius greater than or equal to the manufacturer's specified minimum cable bending radius.

F. COMMUNICATIONS EQUIPMENT ROOM CCTV INSTALLATION

1. The Design-Builder shall install the CCTV equipment located in the Communications Equipment Rooms on 19-inch equipment racks.

G. FIBER OPTIC CONNECTORS

1. The Design-Builder shall install the required fiber optic connectors and adapters and connect the fiber optic cables to the fiber optic video link equipment.
2. All connectors shall have a ceramic or stainless steel ferrule and incorporate a strain relief technique/mechanism.
3. Repeatable connector losses shall be less than 0.7dB using either chemical bonding or mechanical crimp to achieve fiber captivation.

END OF SECTION



THIS PAGE NOT USED

SECTION 16900

YARD TRAIN CONTROL SYSTEM (AVAILABLE STANDARD SPECIFICATIONS)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section lists the WMATA 16900 Standard Specifications Sections that are considered relevant to the Yard Signal Control and Interlocking Systems work. Unedited versions of these documents will be provided upon request.

B. BASIC YARD SIGNAL DEFINITIONS, CHARACTERISTICS and BACKGROUND INFORMATION:

Section 16900	Basic Definitions, Characteristics and Background Information
Section 16905	Transit Vehicle Characteristics
Section 16912	ATC Submittal Requirements
Section 16914	ATC - Environmental Requirements
Section 16915	Basic ATC Equipment Requirements
Section 16916	Basic ATC Circuit Requirements
Section 16917	Basic Interlocking Requirements
Section 16921	ATC Power Distribution Systems
Section 16922	ATC - Lightning/Surge Protection and Grounding Systems
Section 16923	ATC Maintenance Telephone System
Section 16931	ATC Maintenance and Test Facilities
Section 16932	Spare ATC Equipment and Selectable Items
Section 16941	Basic ATC Electrical and Electronic Component Requirements
Section 16942	Printed Circuit Cards
Section 16943	Vital Relays
Section 16944	Non-Vital Relays and Timers
Section 16945	Plugboards and Cabinets for Relays and PC Cards
Section 16946	Transformers
Section 16947	Ground Detectors
Section 16948	Plug Connectors
Section 16949	ATC Wire and Cable
Section 16951	ATC - Transfer and Bypass Equipment
Section 16952	ATC - DC Power Supplies
Section 16963	Power Frequency Track Circuit Layouts
Section 16964	Track Switch Operating Layouts
Section 16965	Signal Layouts
Section 16968	Track Bonding Layouts
Section 16969	Snowmelter Layouts
Section 16971	Racks and Cable Trays
Section 16972	Junction Boxes
Section 16973	Conduit
Section 16974	Locks and Keys
Section 16975	Foundations
Section 16977	Tagging and Marking
Section 16978	Miscellaneous Components and Materials
Section 16979	Surface Trench
Section 16980	ATC Tests, Inspections and Quality Assurance
Section 16991	ATC Drawings and Tracings
Section 16992	ATC Instruction Manuals

**PART 2 PRODUCTS
NOT USED**

**PART 3 EXECUTION
NOT USED**

END OF SECTION

SECTION 16905

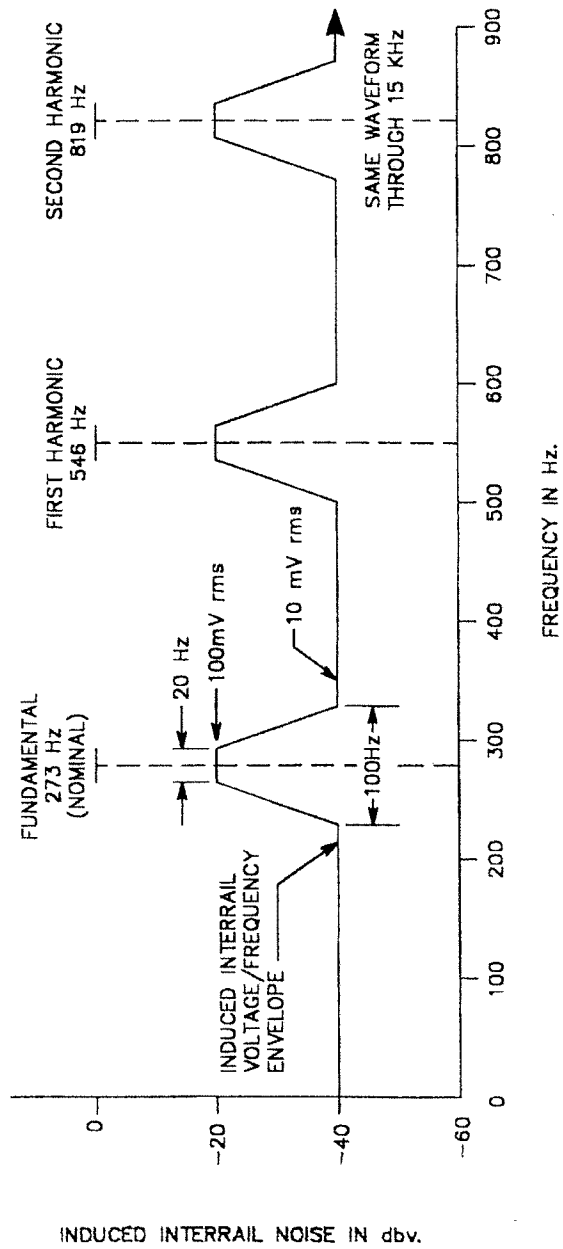
TRANSIT VEHICLE CHARACTERISTICS

PART 1 - GENERAL

1.01 ELECTRICAL EQUIPMENT CHARACTERISTICS

The characteristics of the chopper-controlled BREDA vehicle electrical equipment are as follows:

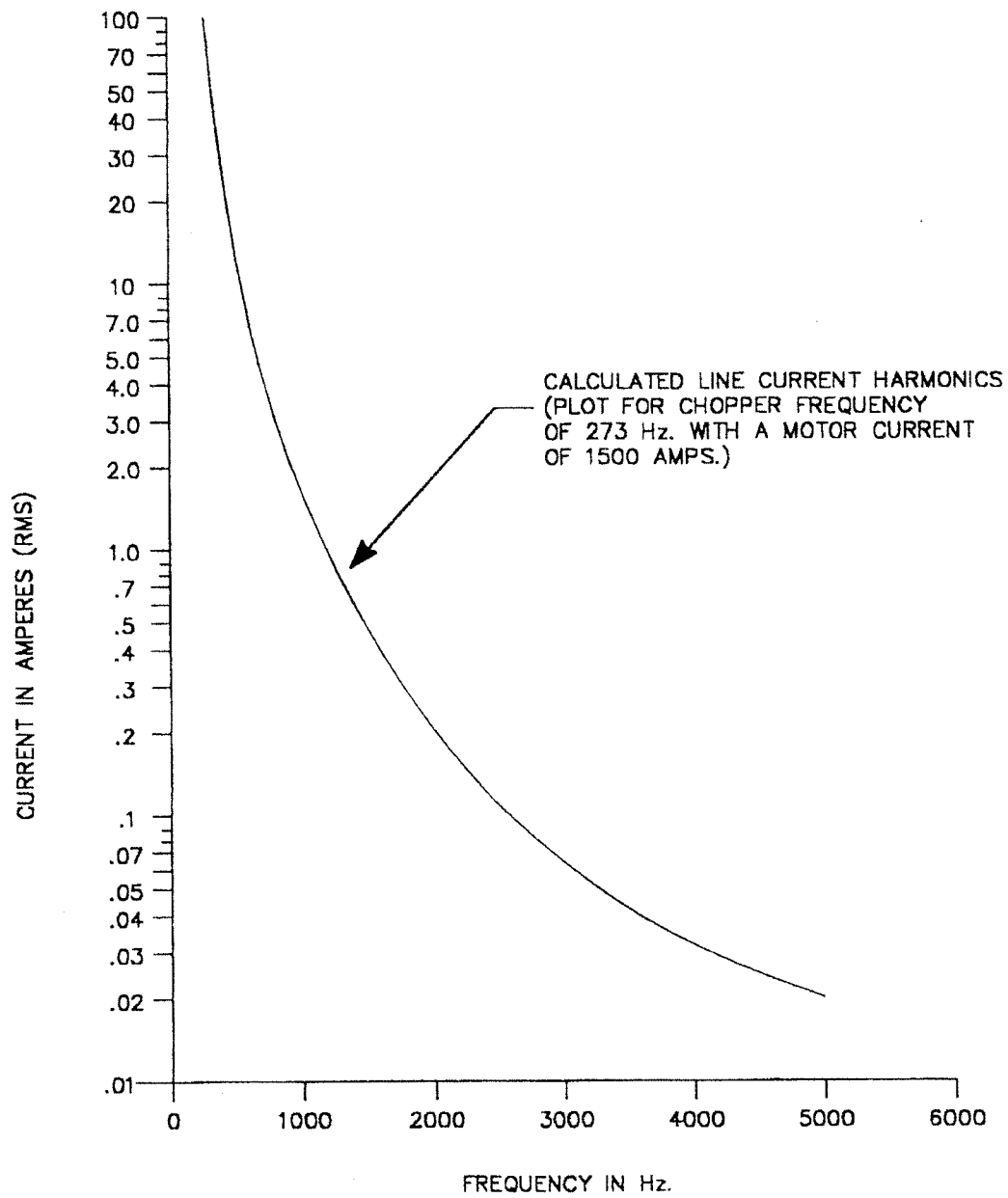
- A. The normal operating frequency of the propulsion and braking chopper will be 273.0 Hz, with a tolerance of +/-6 Hz on the 15th harmonic, which is 4095 Hz.
- B. The normal range of frequency drift of the propulsion and braking chopper, will be +/-0.01 percent.
- C. The level of inductive interference produced by the propulsion chopper and all auxiliary choppers will be not greater than that shown in Graph 1, Level of Induced Interference which represents the magnitude of open-circuit rail-to-rail potential vs. the train control frequency spectrum. The open circuit rail-to-rail potential presented in Graph 1 is the worst-case rail-to-rail potential that would be measurable at any point beneath the vehicle with no train control equipment connected to the rails. The values given are a composite from all emitting sources on the married pair.
- D. The level of conductive interference produced by the propulsion chopper and all auxiliary choppers will be not greater than that shown in Graph 2, Level of Conductive Interference which represents the magnitude of the AC component of the return current from a single car (4 motors) vs. the train control frequency spectrum. The AC current component shown in Graph 2 is the worst-case composite of the interference produced by all of the electrical subsystems of a single married pair. The train control frequency spectrum is 50 Hz to 15,000 Hz.



LEVEL OF INDUCED INTERFERENCE

(AS MEASURED WITH A SD345 SPECTRUM ANALYZER, DISPLAYING RESOLUTION BANDWIDTH OF 5Hz OR LESS, USING A LINEAR AVERAGING MODE WITH 16 OR MORE SAMPLES AVERAGED)

GRAPH 1



LEVEL OF CONDUCTIVE INTERFERENCE

GRAPH 2

**PART 2 - PRODUCTS
NOT USED**

**PART 3 - EXECUTION
NOT USED**

END OF SECTION

SECTION 16911

SCOPE OF WORK

YARD SIGNAL CONTROL AND INTERLOCKING SYSTEM

PART 1: GENERAL

1.01 DESCRIPTION: The Washington Metropolitan Area Transit Authority (WMATA) is embarking on a Metro Matters Shops Program where the primary objective is to expand and improve current operations at both the Brentwood Yard and Shady Grove Yard. Work to be accomplished under this project is diverse and includes various tasks such as the installation of new turnouts and shop lead tracks, track realignment, installation of new wayside signaling equipment and train control room signaling equipment, yard control machine revisions and building of civil infrastructure to support signaling. This Section describes the general scope, functional design, and other requirements for the Yard Signal Control and Interlocking (YSCI) system work to be accomplished in Brentwood Yard and Shady Grove Yard.

1.02 GENERAL FEATURES BRENTWOOD YARD AND SHADY GROVE YARD

- A. The new yard signaling system control and indication logic shall either be relay or microprocessor based and meet the design requirements provided under this Contract. The Design-Builder shall use Entrance-Exit type philosophy for routing train movements throughout the turnouts. The yard signaling system logic shall be designed using traditional vital and non-vital signaling philosophy consistent with the existing in-service signaling system at Brentwood Yard and Shady Grove Yard.
- B. A Yard Control Machine located in the Yard Tower shall be used to control routing throughout the yard by utilization of pushbuttons and switches located on the Yard Control Machine.
- C. Single rail power frequency track circuits shall be provided to ensure train detection throughout the yard turnouts and shop lead tracks.
- D. Trailable switch machines layouts with external switch circuit controllers shall be installed on all new turnouts.
- E. Switch rail heaters and crib heaters shall be installed on all new power operated yard switch machine turnouts. Control of the heaters shall be from the Yard Control Machine.
- F. Transit style wayside signals shall be installed at the limits of all interlockings to provide the train operator with a proceed or stop aspect.
- G. Interconnecting signal cables between the wayside equipment and Yard train control room shall be routed through new ductbanks, surface trench and conduit systems designed, furnished and installed by the Design-Builder under this contract. Where existing ductbank and conduit systems can accommodate the additional cabling without exceeding fill limitations, they may be used subject to Authority approval.

1.03 SCOPE OF WORK

- A. The work to be performed for the YSCI system under this Contract shall comply with the requirements of the Program Criteria and the Specifications. The Design-Builder may propose alternatives to the existing facilities, the criteria and the specifications within the parameters established for the project. It shall be the Design-Builder's responsibility to

provide conclusive evidence that acceptance of an alternative is in the best interests of the Authority. Project Specific Drawings developed to identify signal work, WMATA Typical Layout Drawings and selected Yard As-Built Drawings to demonstrate the existing circuit and equipment configurations are provided as Information or Reference Drawings to enable the Design-Builder to understand the expected installation methods and functional requirements. The Design-Builder's design shall be based on the existing conditions within the respective yards. Complete sets of Yard As-Built Drawings will be furnished by the Authority upon request by the Design-Builder. The Design-Builder shall be responsible to incorporate any changes marked on the TCR Room Book of Plans that have not been incorporated in the permanent drawings.

- B. Brentwood Yard: The Design-Builder shall furnish the design, manufacture, documentation, delivery, storage, installation, demonstration, testing, interface requirements, placing into service and as-built drawings for the new YSCI system in the Brentwood Yard. This work shall include, but not limited to the following components:
1. Train Control Room Enlargement:
 - a. Install interior building walls to provide additional space as required to accommodate the additional Yard Signal Control and Interlocking equipment. Remove the existing wall providing alternate support or relocation of any equipment attached to or mounted on the wall. The train control equipment shall be protected from physical damage and dust during all construction and demolition work.
 2. Trailable switch machine layouts
 - a. Provide new SW 93 switch layout to relocated Maintenance-of-Way Track 10.
 - b. Provide new SW 103 switch layout to new Shop Track 9C.
 - c. Provide new SW 105 switch layout to new Shop Track 9A.
 - d. Provide new SW 205 switch layout to relocated Shop Track 9.
 - e. Provide new SW 207 switch layout to new Shop Track 9A.
 - f. Provide new SW 209 switch layout to new Shop Track 9B.
 3. Snowmelter cases:
 - a. Provide new Snowmelter Control Case for new Switch 93.
 - b. Provide new Snowmelter Control Case for new Switches 103 and 105.
 - c. Provide new Snowmelter Control Case for new Switch 205.
 - d. Provide new Snowmelter Control Case for new Switches 207 and 209.
 4. Snowmelter rods and crib heaters
 - a. Provide new Snowmelter rods and crib heaters for new Switches 93, 103, 105, 205, 207 and 209.

5. Single rail power frequency track circuits
 - a. Provide new and reconfigured track circuits for the new interlockings and lead tracks.
6. Wayside signals:
 - a. Provide new signal layouts to replace existing Signals 92 and 102 if required to be relocated by new trackwork.
 - b. Provide new signal layouts for new Signals 96, 104, 106, 108, 204, 206, 208 and 210.
7. Yard Signal Control Logic:
 - a. Provide vital and non-vital equipment and circuits to implement changes and additions to accommodate the program track changes. Non-vital circuit requirements may be satisfied with the use of microprocessors or non-vital relay logic.
8. Yard Control Panel Replacement:
 - a. Replace three existing panels of the Yard Control Machine with new panels equipped with new switches, pushbuttons, indicator lamps and other panel control and indication components for the existing and new tracks. The required replacement panels may be engraved phenolic panels or mosaic tile compositions and shall be wired to plug connectors to expedite panel replacement.
9. Signal bonding:
 - a. Provide signal bonding as required for new and modified turnouts.
 - b. Provide signal bonding around any existing insulated joints which are not required in the new track circuit configurations.
10. Power bonding:
 - a. Provide power bonding as required for new and modified turnouts.
 - b. Provide power bonding on shop and yard tracks to connect new tracks to existing negative return system.
 - c. Provide power bonding around any existing insulated joints which are not required in the new track circuit and negative return rail configurations.
11. Cabling:
 - a. Provide new cabling between the Train Control Room and the wayside equipment.
 - b. Provide all necessary temporary and permanent wiring within the Train Control Room.



- c. Provide all necessary cabling between the Train Control Room and the Yard Control Room.
 - 12. Ductbank, Conduit and Surface Trench:
 - a. Provide new ductbank, conduit and surface trench to expand or supplement the existing facilities to accommodate the new cabling requirements.
 - b. Relocate, modify or replace existing conduits and surface trenches which interfere with new road and driveway construction.
 - 13. Revisions and additions to the existing power distribution system:
 - a. Provide new power distribution equipment as necessary to accommodate the additional electrical loads for the new signal equipment.
 - 14. Event recording:
 - a. Provide a new Event Recorder for monitoring the signal control and interlocking system functions of the entire yard.
 - 15. Power supplies, associated subsystems, equipment, materials, cables, hardware, and appurtenances, to provide a complete operating signal system as described.
- C. Shady Grove Yard: The Design-Builder shall furnish the design, manufacture, documentation, delivery, storage, installation, demonstration, testing, interface requirements, placing into service and as-built drawings for the new YSCI system in the Shady Grove Yard. This work shall include, but is not limited the following components:
- 1. Trailable switch machine layouts
 - a. Provide new SW 161 switch layout to relocated shop Track 6.
 - b. Provide new SW 167 switch layout to new shop Track 7.
 - c. Provide new SW 165 switch layout to new shop Track 8.
 - d. Provide new SW 163 switch layout to new shop Track 10.
 - e. Provide new SW 147 switch layout to relocated shop Track 6.
 - f. Provide new SW 149 switch layout to new shop Track 7.
 - g. Provide new SW 173 switch layout to new shop Track 8.
 - h. Provide new SW 169 switch layout to new shop Track 9.
 - i. Provide new SW 171 switch layout to new shop Track 10.
 - j. Provide new SW 95 switch layout to new M/W 7 Track.
 - 2. Snowmelter cases



- a. Provide new Snowmelter Control Case for new Switch 161 and 165.
 - b. Provide new Snowmelter Control Case for new Switch 163 and 167.
 - c. Provide new Snowmelter Control Case for new Switch 147.
 - d. Provide new Snowmelter Control Case for new Switches 149 and 169.
 - e. Provide new Snowmelter Control Case for new Switch 173.
 - f. Provide new Snowmelter Control Case for new Switch 171.
 - g. Provide new Snowmelter Control Case for new Switch 95.
3. Snowmelter rods and crib heaters
- a. Provide new Snowmelter rods and crib heaters for new Switches 95, 147, 149, 161, 163, 165, 167, 169, 171, and 173.
4. Single rail power frequency track circuits
- a. Provide new and reconfigured track circuits for the new interlockings and lead tracks.
5. Wayside signals
- a. Provide new signal layouts to replace existing Signals 92, 94, 96, and 100 if required to be relocated by new trackwork.
 - b. Provide new signal layouts for new Signals 162, 164, 166, 168, 170, 172, 174 and 176.
6. Yard Signal Control Logic
- a. Provide vital and non-vital equipment and circuits to implement changes and additions to accommodate the program track changes. Non-vital circuit requirements may be satisfied with the use of microprocessors or non-vital relay logic.
7. Yard Control Panel Replacement:
- a. Replace three existing panels of the Yard Control Machine with new panels equipped with new switches, pushbuttons, indicator lamps and other panel control and indication components for the existing and new tracks. The replacement panels shall be wired to plug connectors to expedite panel replacement. The required replacement panels may be engraved phenolic panels or mosaic tile composition however, if mosaic tile type panel is provided, all panels on the machine must be replaced.
8. Signal bonding:
- a. Provide signal bonding as required for new and modified turnouts.

- b. Provide signal bonding around any existing insulated joints which are not required in the new track circuit configurations.
 - c. Provide signal bonding and new track circuit connections to accommodate the car shop blow pit extensions.
9. Power bonding:
- a. Provide power bonding as required for new and modified turnouts.
 - b. Provide power bonding on shop and yard tracks to connect new tracks to existing negative return system.
 - c. Provide power bonding around any existing insulated joints which are not required in the new track circuit and negative return rail configurations.
 - d. Modify existing negative return bonding to accommodate the car shop blow pit extensions.
10. Wire and Cabling:
- a. Provide new cabling between the Train Control Room and the wayside equipment.
 - b. Provide all necessary temporary and permanent wiring within the Train Control Room.
 - c. Provide all necessary cabling between the Train Control Room and the Yard Control Room.
11. Ductbank, Conduit and Surface Trench:
- a. Provide manholes, ductbanks, conduit and surface trench as determined necessary to replace the existing facilities that interfere with the construction of the new shop building.
 - b. Relocate, modify or replace existing conduits and surface trenches which interfere with new road and driveway construction.
 - c. Provide new ductbank, conduit and surface trench to expand or supplement the existing facilities to accommodate the new cabling requirements.
12. Revisions and additions to the existing power distribution system:
- a. Provide new power distribution equipment as necessary to accommodate the additional electrical loads for the new signal equipment.
13. Event recording:
- a. Update the existing Event Recording System to incorporate the new equipment.

14. Power supplies, associated subsystems, equipment, materials, cables, hardware, and appurtenances, to provide a complete operating signal system as described.

D. The Design-Builder shall furnish the management, labor, data, design, relay logic, testing services, training, manuals, parts, materials, tools, equipment, appurtenance, and incidentals necessary to complete the work in accordance with the Contract requirements.

E. The Design-Builder shall be responsible for the design, installation, test and final acceptance of all interfaces between the existing Yard Signal Control and new YSCI system.

F. Products and Materials: The Design-Builder shall furnish, unless otherwise specified in the Contract, all material, implements, machinery, equipment, tools, supplies, transportation, and temporary utilities necessary for the prosecution and completion of the work.

G. Design: The Design-Builder's design shall include, but not be limited to the following:

1. System Design: Provide as required, signal circuits, operational descriptions and all other system type designs that depict system operational requirements.

2. Product Design: Provide detail design, circuits, drawings, test results and documentation of necessary components, and subsystems in conformance with all requirements specified in the specifications.

3. Circuit Design: Provide the circuitry, detail design, testing, circuit check and drawings in conformance with all requirements specified in these Specifications. The Design-Builder shall design the new YSCI circuits in accordance with the existing WMATA circuit design standards for Brentwood Yard and Shady Grove Yard.

4. Installation Design: Provide complete electrical and mechanical design drawings for installation of the required signal equipment in conformance with all requirements detailed in the specifications.

5. Interface Design. It shall be the responsibility of the Design-Builder to determine that all new signaling system interfaces and control logic circuitry are compatible with current conditions. The Design-Builder shall request the as-built drawings from WMATA prior to the start of design. Any discrepancies encountered between the as-built drawings and as-built conditions shall be noted by the Design-Builder and immediately brought to the attention of WMATA.

6. The Signal Control and Interlocking System equipment manufacturer shall be the Designer of Record and shall be directly responsible to the principle design-build firm.

H. Testing:

1. Factory Acceptance Testing: It shall be the responsibility of the Design-Builder to perform factory acceptance testing of signaling equipment and components not previously approved for installation on the WMATA Metrorail System. The design-Builder shall develop a Factory Acceptance Testing procedure and submit for approval.



2. Field Testing: The Design-Builder shall obtain approval for the test plan and procedures as set forth in these specifications prior to starting field testing. The Design-Builder shall perform all tests necessary to ensure that the Signal system performs according to the specifications.
- I. System Support:
 1. The Design-Builder shall furnish the signal system with the support materials and services such as manuals, spare parts, initial provisioning and equipage, and training as specified in the specifications.
 2. The Design-Builder shall also provide testing and maintenance support after the yard has been certified for train operations as specified.
 - J. Damage During Construction: The Design-Builder shall be responsible for the repair and/or replacement in kind of any cabling and equipment damaged during the construction.
 - K. Insulated Joints: It shall be the responsibility of the Design-Builder to confirm that the new trackwork design for insulated and non-insulated rail joints meets the functional requirements for the new signaling system. This work shall also include verification that the existing insulated and non-insulated rail joints are installed in the correct locations to support and integrate with the new and existing signaling system.

1.04 STAGING:

Staging of interim and new YSCI systems shall be incorporated in a comprehensive Staging Plan for the Brentwood Yard and Shady Grove Yard that minimizes impacts to the existing Yard operations during construction. The Staging plan shall be fully coordinated with others performing work in the same area and include all necessary manpower and equipment requirements to meet the needs of the temporary and final Yard signal control. The Design-Builder's work shall consist of, but not limited to, the following:

- A. Design, install and test interim or temporary YSCI circuits.
- B. Design, install and test interim or temporary interface YSCI circuits.
- C. Furnish, install and test interim or temporary YSCI equipment.
- D. Furnish, install and test temporary signal and power bonding.
- E. Furnish, install and test temporary YSCI cables.
- F. Maintain, up-to-date circuit plans that reflect all interim or temporary changes.
- G. Provide operations descriptions for all interim operating situations.

1.05 YARD TRAIN CONTROL ROOM

- A. The Design-Builder shall provide adequate space in both the Brentwood Yard and Shady Grove Yard Train Control Rooms for the installation of new signaling equipment. This work shall include expanding the Brentwood Yard Train Control Room by relocating existing walls.

1.06 CONDUITS AND DUCTBANKS

- A. It shall be the responsibility of the Design-Builder to furnish and install the necessary civil infrastructure to support the installation of all signaling cabling and equipment. Part of the Design-Builder's work shall be to modify, relocate or replace an existing ductbank at Shady Grove to allow the construction of the new shop building.

1.07 YARD CONTROL MACHINE – SHADY GROVE AND BRENTWOOD

- A. The Design-Builder shall replace the existing yard control panels where applicable to incorporate all new controls, indications and hardware to accommodate the new yard turnouts and tracks. The replacement panels shall be equipped with new pushbuttons, switches, lamps and other devices as well as plug connection cables. These modifications shall be accomplished in a manner that will ensure seamless integration between the existing yard control machine and existing yard control panels to remain.

1.08 INTERFACE REQUIREMENTS

- A. The Design-Builder shall be responsible for all coordination, integration and interfaces between signaling systems furnished, existing equipment and equipment furnished by others. This shall include all design, labor, materials, tools, equipment and supplies necessary to provide interfaces that are functionally seamless. It will be the design-builders responsibility to coordinate and schedule sub-contractor work activities to avoid conflicts.

1.09 WARRANTY OF CONSTRUCTION

- A. The warranty period for all goods, supplies, systems and equipment except spare parts shall be two (2) years after final acceptance of the work. Final Acceptance is as defined in The General Provisions.

1.10 SUBMITTALS

- A. The Design-Builder shall submit performance data and final design and installation drawings to the designated Authority Representative for approval of all equipment which the Design-Builder proposes to use under this Contract. The Engineer's approval will be for the purpose of minimizing changes and delays in the field and shall in no way relieve the Design-Builder of full responsibility for providing complete, safe, reliable, and coordinated operating systems and subsystems for yard signal control and interlocking systems which are compatible with the existing Metrorail ATC system in every respect.
- B. It shall be the responsibility of the Design-Builder to ensure that competent personnel are assigned and retained for the task of preparing the required submittals and all other documentation necessary to comply with the Specifications. Submitted documents shall be complete. Submitted circuit and equipment drawings shall have been thoroughly checked for completeness and accuracy and shall bear the initials or signature of a fully qualified checker in witness thereof before being submitted to the designated Authority Representative for approval.
- C. The Design-Builder shall submit all required schedules, inspection procedures, inspection reports, progress reports, test procedures, test reports and other specified documentation to the designated Authority Representative as described in Section 01330 with respect to the scheduled progression of the work.
- D. When submitting drawings, manuals and other documentation to the designated Authority Representative for the initial approval of some product, subsystem, or layout, the Design-

Builder shall submit all drawings, manuals and other documentation germane to the subject, at one time. The submittal shall also include all applicable catalog cuts, certified test reports, and any other related items which the designated Authority Representative considers necessary to evaluate the submittal. This logical grouping of documentation necessary to completely cover the subject concerned, shall be known as a submittal package.

- E. Any product, subsystem or layout, shall receive final design approval with no more than one resubmittal. The designated Authority Representative will review the initial submittal and no more than one resubmittal of each product, subsystem, or layout as part of the requirements of this subsection. It shall be the responsibility of the Design-Builder to ensure that in the event a resubmittal of the initial submittal is necessary, he has, in the resubmittal, either:
 - 1. Responded in the manner suggested to all the designated Authority Representative's comments made in the first review, or;
 - 2. Taken exception in writing to any of the designated Authority Representative's first review comments which he believes should not be incorporated by him in his first resubmittal, and responded in the manner suggested to all the designated Authority Representative's other comments made in the first review. When taking exception to the designated Authority Representative's comments, the Design-Builder shall state his reasons for not complying, and offer a workable alternative consistent with the intent of the Specifications.
- F. In instances where a complete submittal or resubmittal is approved by the designated Authority Representative, but is later found to be in error or unworkable, the designated Authority Representative reserves the right to withdraw the earlier approval and require correction and resubmittal of the earlier submittal.
- G. The format and media required for certain submittals shall be as follows:
 - 1. Drawings:
 - a) Submittals of new drawings shall be made with the prescribed number of prints, and on magnetic media in the AUTOCAD 2000 format.
 - b) Changes to existing drawings may be manually marked to show the necessary equipment additions, changes and removals in a clear and comprehensible manner. The submittal shall be made with the prescribed number of prints.
 - 2. Tables, Charts and Data Sheets
 - a) The required tables, charts and data sheets shall be made with the prescribed number of hard copy sets, and on magnetic media in a Corel Quattro Pro 9 (Corel Office 2000) format.
- H. Yard Signal submittals shall be made in accordance with the requirements specified in Section 01113 Systems Integration and Section 16912, ATC Submittal Requirements.

PART 2: PRODUCTS

2.01 FUNCTIONAL DESIGN REQUIREMENTS

- A. YSCI ground equipment will be located along the track where necessary. Other equipment will be located in Yard Train Control Room and/or Yard Control Room.

1. Equipment typically located along the tracks include:
 - a. Track circuit bootlegs
 - b. Track switch machines
 - c. Junction Boxes
 - d. Track switch rod and rail heaters
 - e. Signs or other wayside indication equipment
 - f. Snow melter control cabinets
 - g. Wayside Signals
 - h. Foundations

2. Equipment located in Yard Train Control Room:
 - a. Signal logic circuitry
 - b. Power supplies
 - c. Track circuit components
 - d. Electronic Components

3. Equipment located in the Yard Control Room
 - a. Yard Control Machine

2.02 PRODUCT REQUIREMENTS

- A. Provide a proven and modern signal system in all respects, in both systemwide aspects and component design.
- B. All equipment and material shall be standard products of manufacturers regularly engaged in the production of signal and control equipment and material, and shall conform to the UL, NEMA, ANSI and AREMA standards, where applicable.
- C. Assemblies and components, which perform identical functions within the signal system, shall be mechanically and electrically interchangeable. Standardized commercially available components of multiple sources shall be used whenever possible, particularly for items which require replacement at predictable intervals.
- D. All equipment and material shall be new and free of manufacturing defects.

2.03 SAFETY REQUIREMENTS

- A. The design shall minimize the possibility of unsafe failure arising from procedural error and neglect, including:
 1. Careless adjustment of equipment and controls.
 2. Incorrect assembly of equipment.
 3. Insufficient maintenance.

2.04 IDENTIFICATION METHODS

- A. All signal equipment modules, assemblies, subassemblies and wires shall be identified by means of tags or other means as specified.

2.05 ELECTROMAGNETIC COMPATIBILITY

- A. Ensure that the signal system shall operate within the yard operational environment. The Design-Builder shall further ensure that the signal equipment will operate as intended without either suffering or causing harmful electromagnetic interference, conducted, radiated, or induced.

PART 3: EXECUTION

3.01 DESIGN

- A. The Design-Builder shall develop and furnish to the Authority complete designs for the Yard Signal Control and interlocking System included in this Contract as specified in Section 01112.
- B. The Design-Builder shall complete the final Yard Signal Control and Interlocking System circuit and detail design in conformance with all requirements and restraints specified herein.
- C. The Design-Builder shall provide complete mechanical design for installation of the required wayside Yard Signaling equipment.

3.02 FABRICATION AND PROCUREMENT

- A. Upon receiving approval of required submittals, the Design-Builder shall proceed with the procurement, manufacture, factory testing, shipment and/or storage of all approved material and equipment in such a manner that it is available in good working order, at the time and place scheduled.

3.03 DELIVERY AND STORAGE

- A. The Design-Builder shall be responsible for safe and protected transportation and storage of all Yard Signal System equipment and materials from the time of its manufacture or procurement until such time that it is installed.

3.04 JOINT PRE-INSTALLATION INSPECTION

- A. Prior to the field installation of wayside equipment along the track right-of-way the Design-Builder shall participate with the designated Authority Representative in a joint field inspection to determine:
 - 1. The suitability of the Design-Builder's final design for the installation of wayside equipment relative to existing field conditions, with special emphasis on clearance and sighting considerations;
 - 2. The final, exact location for each piece of Yard Signaling equipment which cannot be installed in the normally specified manner due to some obstruction or restriction.
- B. The Design-Builder shall produce dimensioned sketches to document the final, non-standard equipment locations agreed upon. These sketches shall be initialed and dated by the Design-Builder and the designated Authority Representative, and one copy retained by each.

3.05 INSTALLATION

- A. The Design-Builder shall install all necessary Train Control Room, Yard Signal Control and Interlocking equipment in the TCR's .
- B. The Design-Builder shall install all necessary trackside equipment.
- C. The Design-Builder shall install replacement control machine faceplate panels in the Yard Control Room
- D. All installation work shall be performed in accordance with stamped approved drawings. No installation work shall begin without a copy of the applicable approved drawings on site.
- E. The Design-Builder shall take all measures and perform all work necessary to protect his installed equipment and circuitry from damage due to dust, moisture, heat, cold and other potentially damaging conditions

3.06 FIELD DOCUMENTATION

- A. An as-built copy of the Room Book of Plans shall be kept in each Train Control Room during all phases of installation and test. The room as-built plans shall reflect the current status of room and wayside wiring at all times.
- B. Failure to maintain the room as-built plans will result in suspension of all activities until complete up-dates are made.

3.07 INSPECTIONS AND TESTING

- A. Type Acceptance Testing
 - 1. All Yard Signal Control and Interlocking System equipment proposed for use on the WMATA Metrorail System under this Contract which is not identical to equipment already in regular use on the WMATA Metrorail System shall be subject to Type Acceptance Testing to determine whether it meets the specified requirements in a manner acceptable to the designated Authority Representative.
 - 2. The Design-Builder shall devise, perform and document such tests, subject to the direction and approval of, and observation by, the designated Authority Representative,
 - 3. The decision of the designated Authority Representative with regard to the acceptability of proposed new equipment, equipment configuration, methodology, and circuitry will be final.
- B. Factory Inspections and Tests
 - 1. The Design-Builder shall perform and document factory and procurement inspections and tests on Yard Signal Control and Interlocking System materials, equipment and systems to be installed under this Contract.
- C. Field Inspections and Tests
 - 1. The Design-Builder shall perform and document field inspections and tests on all Yard Signal Control and Interlocking Systems and equipment as specified in



3.08 TIE-INS AND ACTIVATION

- A. The Design-Builder shall work in close cooperation and coordination with the Authority when making the required modifications and additions to existing, operating circuits and equipment in order to place the new Yard Signal Control and Interlocking Systems in operation in a safe and efficient manner without interfering with revenue service or other normal METRORAIL operations
- B. When the expansion to the yard is put into operation, the Design-Builder shall:
 - 1. Disconnect all applicable existing TCR equipment which is no longer required.
 - 2. Remove and deliver to the Authority, in good working condition, all of the Authority's existing yard signaling equipment which is no longer required.

3.09 SAFETY

- A. The Design-Builder shall conduct an System Safety Program for all areas of wayside and trackage equipped under this Contract to ensure the safety of the equipment, circuits and systems installed, and the safety of all personnel involved in the associated installation and testing activities.

3.10 INSTRUCTION AND TRAINING

- A. The Design-Builder shall provide, as a minimum, special instruction and training to thoroughly acquaint appropriate Authority operating and maintenance personnel with equipment and circuits furnished under this Contract which are different from those used on previous operating segments of the METRO system.

3.11 DOCUMENTATION

- A. The Design-Builder shall provide both on-going and final, "AS-BUILT" documentation of all equipment, systems, programs, tests, inspections, installation methods, procedures, and circuits required or necessary under this Contract. Any existing drawings which require revisions to reflect the work performed under this contract, shall be redrawn in CADD format and integrated with new drawings to form a complete set of drawings.

3.12 SYSTEM TESTING SUPPORT

- A. The Design-Builder shall assist the Authority in the system testing of all interface circuits, systems and subsystems.

3.13 INSTALLATION

- A. Unless modified elsewhere in these specifications, the electrical installation shall be governed by the provisions of the NEC Standard of the National Board of Fire Underwriters for Electrical Wiring and Apparatus, and the AREMA manuals. All provisions of these Codes shall be considered applicable whether or not specifically mentioned in these specifications.



3.14 SALVAGED EQUIPMENT

- A. At the discretion of the Engineer, any existing signal equipment to be removed and retired from service shall be salvaged and delivered by the Design-Builder to WMATA.

END OF SECTION

THIS PAGE NOT USED



SECTION 16912

YARD SIGNAL SYSTEM SUBMITTAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the various types of Yard Signals submittals required by the Yard Signal Control and Interlocking Systems portion of this Contract as described in Section 101.111.B, Design-Builder's Submittals and Section 01113, Systems Integration.
- B. The equipment and sub-systems included in the 30%, 90%, and 100% Systems Integration Design approval will not require further approval unless subject to type acceptance.

1.02 TYPES OF YARD SIGNAL SUBMITTALS

The basic types of Yard Signal submittals required include:

- A. Train Control Drawings
- B. Technical Review Documentation
- C. Samples
- D. Certifications
- E. Special Documentation
- F. Inspection Reports
- G. Test Plans and Procedures
- H. Test Reports and Data Sheets
- I. Contract Record Drawings

1.06 INTERPRETATION OF APPROVAL AND REVIEW

The designated Authority' Representative's approval will be for the purpose of minimizing changes and delays in the field and shall in no way relieve the Design-Builder of full responsibility for providing complete, safe, reliable, and coordinated working operating systems and subsystems for Yard Train Control which are compatible with the current METRO Yard Signal system in every respect.

1.07 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01250	Contract Modification Procedures
Section 101.III.B,	Design-Builder's Submittals
Section 16991	Yard Signal Drawings and Tracings.

1.08 REFERENCES

- A. ASTM E329
- B. Military Specification MIL-M-09868
- C. Association for Information and Image Management (AIIM) Specification MS32-1985
- D. ANSI PH1.41-1984.

PART 2 - PRODUCTS

2.01 FORMAT AND MEDIA

- A. The format and media required for the various types of Yard Signals submittals shall be as follows:
1. Yard Signal Control and Interlocking Systems Drawings
 - a. Submittals of the drawings shall be made with the prescribed number of prints on magnetic media in the AUTOCAD format (AUTOCAD Level to be determined by the Authority), or on optical media (format to be determined by the Authority):
 - b. The final submittal of AS-BUILT drawings shall include:
 - 1) Magnetic Media in appropriate AUTOCAD format, or on optical media in a format approved by the Authority
 - 2) Prints
 - c. See Section 16991, Yard Signal Drawings and Tracings.
 2. Technical Review Submittals:

See Section 01113, Systems Integration.
- B. Contract Record Yard Signal Drawings
As-built Yard Signal Drawings:
1. As-built Yard Signal drawings shall include all new Train Control Drawings for the Yard Signal Control and Interlocking System and revisions to all affected existing Authority Record Drawings.
 2. Revisions to Authority Record Drawings shall match the base drawings in line weights, symbols, and lettering style and size. Drawings shall be provided in AutoCAD 2000 magnetic media format.
 3. Completed as-built drawings shall bear the signature of an officer of the Design-Builder organization, certifying compliance with as-built conditions.

AS-BUILT <i>Date</i>	
_____ I certify that this drawing accurately depicts the work as constructed.	
(An Officer of the Design-Builder)	
_____ Signature	_____ Title
Design-Builder'S NAME	

PART 3 - EXECUTION

3.02 TRAIN CONTROL DRAWING SUBMITTALS

- A. Submit, unless otherwise directed, one reproducible and three legible copies of all new and marked-up existing Yard Signal Control and Interlocking System drawings to the designated Authority's Representative for approval. These drawings shall be complete and detailed. Train Control drawings shall include, but not be limited to, the following:
1. Title Sheet
 2. Index Sheets
 3. Nomenclature Description Sheets
 4. Relay/Contact Location Charts
 5. Cable Plans
 6. Double Line Track Plans
 7. Arrangement Plans
 8. Product Drawings
 9. Equipment Installation Drawings
 10. Circuit Drawings
 11. Typical Drawings (circuits and/or equipment layouts)
 12. Energy Distribution Schematics
 13. Wiring Diagrams
 14. System Drawings
 15. Control Panel Drawings (to include Back-Panel Wiring)
 16. Tie-in Drawings
 17. Interface Drawings
 18. Cut-In Drawings (as applicable)
 19. TC Maintenance Telephone System Drawings
 20. Trenching Plans
 21. Technical Documentation:
 - a. Inspection Procedures & Reports
 - b. Spare Material and Equipment Lists.
 - c. Cable Lists.
 - d. Test Equipment Lists.
 - e. Power Tabulation Sheets.
 - f. Operational Descriptions.
 - g. Test Procedures & Reports.
 - h. Cut-In Procedures.
 - i. Progress Reports.
- B. Criteria for the approval of these drawings are set forth in Section 16991, Yard Signal Drawings and Tracings.
- C. Upon approval by the designated Authority Representative, each copy of the Train Control drawings will be identified as having received such approval by being so stamped and dated. One reproducible set of Train Control drawings will be returned to the Design-Builder.

3.05 CERTIFICATION

See Section 01113, Systems Integration.

3.07 INSPECTION REPORTS

See Section 01113, Systems Integration.

3.08 TEST PLANS AND PROCEDURES

See Section 01113, Systems Integration.

3.09 TEST REPORTS AND DATA SHEETS

- A. See Section 01113, Systems Integration.
- B. Submit the original and three copies of pre-printed data sheets in advance of the test report for each required test procedure.
- C. Pre-printed data sheets should include all known variables prior to the collection of any actual test data. Examples:
 - 1. Known expected values (voltages, currents or resistances)
 - 2. Track circuit, signal, switch machine, cable names, etc.
 - 3. Wayside equipment locations and chain markers.
 - 4. Required routes.

3.10 CONTRACT RECORD YARD SIGNAL DRAWINGS

- A. Basic Requirements:

During installation and testing of the Yard Signal Control and Interlocking System, the Design-Builder shall maintain a record set of Yard Signal drawings annotated to show all changes incorporated as work progresses. Information shall include, but not be limited to, the following:

 - 1. Field changes of equipment, dimensions, wiring and detail.
 - 2. Changes accomplished by change orders.
- B. As-built Yard Signal drawings:
 - 1. Shall include all new Train Control Drawings for the Train Control System and revisions to all affected existing Authority Record Yard Signals Drawings.
 - 2. Authority Record Yard Signals Drawings are as-built drawings provided to the Authority under previous or concurrent related contracts. The Design-Builder shall coordinate with the Authority to determine which existing Authority Record Drawings require revision.
 - 3. The Design-Builder shall :
 - a. Submit three sets of prints and three electronic file copies of as-built drawings for initial review and approval.
 - b. Additions and corrections shall be incorporated by the Design-Builder and three sets of prints and three electronic file copies shall be prepared and submitted to the Authority for review and approval.

END OF SECTION



SECTION 16914

ENVIRONMENTAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section describes the environmental conditions under which the Yard Signal equipment and systems furnished and installed under this Contract shall function and specifies certain measures which the Design-Builder shall take to prevent environmental interference with the Yard Signal System.

1.02 PHYSICAL ENVIRONMENT

- A. All Yard Signal equipment housed in Train Control Rooms shall function in accordance with the Specifications over a room temperature range of -22 degrees F to +158 degrees F at relative humidities of 5 percent non-condensing to 95 percent, inclusive.
- B. All wayside Yard Signal equipment not housed in Train Control Rooms shall function in accordance with the Specifications over a temperature range of -40 degrees F to +158 degrees F at relative humidities of 5 percent non-condensing to 95 percent, inclusive.
- C. Wayside Yard Signal equipment not housed in Train Control Rooms shall operate in accordance with the Specifications when subject to the climatic conditions indigenous to the Washington, D.C. metropolitan area within the extreme limits of precipitation and wind force recorded in data published by the United States Government, Department of Commerce, National Oceanic & Atmospheric Administration, Environmental Data Service.
- D. All Yard Signal equipment housed in Train Control Rooms shall be so constructed and installed that it will remain fully operational while being vibrated, with simple harmonic motion having an amplitude, acceleration and frequency as listed below, for a minimum period of 15 minutes in each of three mutually perpendicular planes.

Sweep Frequencies	Peak to Peak Displacement	Acceleration
5-12 Hz	0.02 inches	--
12-1000 Hz	--	0.14g peak or 0.10g rms

- E. Wayside Yard Signal equipment not housed in Train Control Rooms shall be so constructed and installed that it will remain fully operational while being vibrated, with simple harmonic motion having an amplitude, acceleration, and frequency as listed below, for a minimum period of 15 minutes in each of three mutually perpendicular planes.

Sweep Frequencies	Peak to Peak Displacement	Acceleration
5-20 Hz	0.2 inches	--
20-1000 Hz	--	4.2g peak or 3.0g rms

- F. All electrical contacts on Yard Signal equipment (including relay contacts, jack contacts

and switch contacts) shall be protected from dust and moisture.

1.03 ELECTRICAL ENVIRONMENT

- A. Each system and subsystem element will generally be operated in the unfavorable electrical environment of a Rail Rapid Transit System characterized by heavy direct-current propulsion equipment which will cause electrostatic, electromagnetic, inductive, conductive, and radiated interference.
- B. Some of the possible sources of electrical interference are:
 - 1. Alternating current 60 Hz systems
 - 2. Direct current traction power systems
 - 3. Propulsion power contact shoe and third-rail arcing
 - 4. Rotating machinery
 - 5. Lightning discharges
 - 6. Public and private communications systems
 - 7. Wayside and carborne Yard Signal equipment

1.04 REFERENCES

- A. ANSI/IEEE C37.90.2
- B. AREMA Signal Manual, Part 2.4.25
- C. Section16922

PART 2 – PRODUCTS

2.01 PRODUCTS AND MATERIALS

Provide all products and materials necessary for the protection of the Yard Signal System against interference by the physical or electrical environment. The products and materials so used shall not themselves constitute a threat to human health or safety, or interfere with the operation of equipment or systems furnished or installed by other disciplines.

2.02 EQUIPMENT

Provide all wayside Yard Signal equipment which has enclosed, internal air-filled cavities, with appropriate moisture control devices as follows:

- A. Follow the recommendations of Part 2.4.25 of the AREMA Signal Manual to minimize condensation and frost buildup in the wayside Yard Signal equipment.
- B. In items of wayside Yard Signal equipment where the screened, shielded vents and drains or heaters of the AREMA recommendation do not appear to be a practical solution to controlling condensation, exclude moisture-laden air by other means such as true hermetic sealing or displacement of the air by an approved potting compound.
- C. Where wires enter a sealed unit, approved heavy-duty plug couplers with minimal internal air spaces and hermetic headers shall be utilized. Cable connections to such plug couplers shall be potted with an approved, flexible, rubber-like compound.

PART 3 - EXECUTION

3.01 PHYSICAL INTERFERENCE

Include in the design, fabrication, and installation, all additional equipment, systems, and procedures which may prove necessary to prevent external or internal physical interference with the proper operation of the Yard Signal System.

3.02 ELECTRICAL INTERFERENCE

- A. Ascertain (using ANSI/IEEE C37.90.2 as a standard) the specific electrical environment to which the various elements of the Yard Signal System equipment will be exposed in all areas covered by this Contract.
- B. Incorporate such design techniques and installation practices necessary to protect the Yard Signal System furnished under this Contract from any electrostatic, electromagnetic, radiated, or direct electrical interference.

END OF SECTION

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SECTION 16915

BASIC YARD SIGNAL EQUIPMENT REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies certain basic requirements for the design and fabrication of Yard Signal Control and Interlocking System and equipment, the methods which the Design-Builder shall use to mount and wire various types of equipment, and the manner in which equipment components, modules and racks shall be arranged.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16922	Lightning/Surge Protection and Grounding Systems
Section 16941	Basic Yard Signal Electrical and Electronic Component Requirements
Section 16942	Printed Circuit Cards
Section 16943	Vital Relays
Section 16944	Non-Vital Relays and Timers
Section 16945	Plugboards and Cabinets for Relays and PC Cards
Section 16946	Yard Signal Transformers
Section 16947	Ground Detectors
Section 16948	Plug Connectors
Section 16949	Yard Signal Wire and Cable
Section 16971	Racks and Cable Trays
Section 16972	Junction Boxes
Section 16973	Conduit
Section 16974	Locks and Keys
Section 16975	Foundations
Section 16977	Tagging and Marking
Section 16978	Miscellaneous Train Control Components and Materials
Section 16979	Surface Trench

1.03 SUBMITTALS

See Section 16912

PART 2 - PRODUCTS

2.02 PACKAGING OF EQUIPMENT

The mixing of equipment associated with two subsystems in one plug-in assembly will not be acceptable.

2.03 COMPONENT PROTECTION

Components shall be protected from damage in the event a plug-in unit is removed while the equipment is energized.

2.04 ADJUSTMENTS

A. Adjustable components

Potentiometers, adjustable resistors and other adjustable circuit components shall be electrically sized and inserted in the circuits in such a manner that acceptance test results can be achieved by the related circuits when the device is adjusted to no less than 25 percent of its range and no more than 75 percent of its range.

B. Two or more points of adjustment which are required during the same operation shall be located within 12 inches of each other and in such a way that they can be operated by one man. Interacting adjustments shall be avoided.

C. The replacement of a component or PC card with a spare shall not require compensating adjustments to the associated components or modules. If compensating adjustments are required, they shall be limited to the device to be replaced or repaired.

2.05 TEST POINTS

A. Test points for checking essential voltages and wave forms and for injecting test signals shall be provided for trouble-shooting and routine maintenance.

B. Test points shall be provided to detect defective PC boards and equipment modules without the disconnection of wires.

C. All test points shall be readily accessible when the equipment is in the normal operating position and shall be clearly labeled.

D. Test points shall be capable of accepting probes and connectors used with standard test equipment such as voltmeters and oscilloscopes, except where only special test equipment and connectors supplied by the Design-Builder will serve.

2.06 VISUAL INDICATIONS

A. Built-in Go/No-Go indicators or meters shall be provided when frequent observation or adjustments are necessary, or when portable test equipment would not provide the necessary information or accuracy.

B. Visual indicators shall not require removal of covers to view.

C. Exceptions are microprocessors with hinged doors which do not require tools to open.

2.07 ELECTRONIC EQUIPMENT

All electronic equipment used on this Contract shall be semiconductor.

PART 3 - EXECUTION

3.07 EQUIPMENT MOUNTING

- A. All equipment shall be mounted plumb and level.
- B. The Design-Builder shall provide special facilities for required protection and grounding of non-rack-mounted equipment, e.g., wall mounted equipment, at no additional cost to the Authority. The methods and materials used to provide such protection shall be as previously approved by the designated Authority's Representative. See Section 16922.
- C. Unless otherwise specified herein:
 - 1. Equipment shall be anchored to concrete walls, floors, or ceilings by machine-bolt type expansion shields and 1/2 inch minimum diameter bolts.
 - 2. Sufficient bolts shall be used to provide a rigid and safe support, subject to the designated Authority's Representative's approval.
 - 3. Where necessary, concrete bases or pedestals shall be provided by the Design-Builder, with anchor bolts cast in place for the mounting of equipment.

END OF SECTION

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SECTION 16916

BASIC CIRCUIT REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies basic requirements for the various types of vital and non-vital circuits required in the Yard Signal Control and Interlocking System.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

- Section 01113 Systems Integration
- Section 16912 Submittal Requirements
- Section 16915 Basic Yard Signal Equipment Requirements
- Section 16917 Basic Interlocking Requirements
- Section 16941 Basic Yard Signal Electrical and Electronic Component Requirements
- Section 16942 Printed Circuit Cards
- Section 16943 Vital Relays
- Section 16944 Non-Vital Relays and Timers
- Section 16945 Plugboards and Cabinets for Relays and PC Cards
- Section 16946 Yard Signal Transformers
- Section 16947 Ground Detectors
- Section 16948 Plug Connectors
- Section 16949 Yard Signal Wire and Cable
- Section 16958 Computerized Yard Control System
- Section 16989 Yard Tests And Inspections
- Section 16991 Yard Signal Drawings and Tracings

1.03 FAIL-SAFE CIRCUIT DESIGN CRITERIA

A. Vital Circuitry

1. Vital circuits shall be based on closed-loop principles; i.e, broken wires, damaged or dirty contacts, a relay failing to respond when energized, or a loss of power supply energy shall not result in unsafe conditions.
2. Fail-safe circuit design for vital circuits shall be achieved by conforming to the fail-safe design criteria specified in Section 16915, Basic Yard Signal Equipment Requirements, in addition to arranging the circuitry in conformance with the principles specified above.

B. Electronic Circuitry

Electronic fail-safe circuit design shall provide protection against the following types of component failures:

1. Two terminal devices:
 - a. open,
 - b. short,


- c. partial open,
- d. partial short
- 2. Multi-terminal devices - any combination of :
 - a. opens,
 - b. shorts,
 - c. partial opens,
 - d. partial shorts

1.04 VITAL CIRCUITS

- A. The following types of circuits are considered vital to the safety of the Yard Signal system:
 - 1. Track Circuits
 - 2. Switch Operating Circuits
 - 3. Switch Locking Circuits
- B. Regardless of how they are implemented, vital circuits shall be of fail-safe design.
- C. Except when specified otherwise, all circuits which energize a vital relay located outside of a Train Control Room and all circuits which energize a vital relay located inside a Train Control Room but which contain contacts located outside of the Train Control Room in which the relay is located, shall be two-wire, double-break circuits and shall be energized from an ungrounded dc power supply.
- D. In addition to these requirements, if non-vital relays are used in vital circuits, it shall be assumed that these relays can fail so that front contacts weld, back contacts weld, or any combination of these events may occur. It shall be assumed that the welding of a front contact will not prevent back contacts from conducting when the relay is de-energized, and that the welding of a back contact will not prevent front contacts of the relay from conducting when the relay is energized. It shall also be assumed that an armature may stick in any position. None of the above events, when they occur, shall cause unsafe conditions.
- E. Switch Operation circuits shall be two-wire, polar, double-break circuits. Overload Stick Relays shall be circuited to meet the operating requirements established in Section 16943. The remaining vital circuits shall be positive-energy, single-break circuits. All of the relays used in these circuits shall have one side of each relay, or each individually controlled relay coil, connected directly to negative energy (common).
- F. When the number of contacts required in vital circuits demand the use of repeater relays, minor circuits shall be operated by contacts of the repeater relays. Minor circuits are defined as those involved in panel illumination, pushbutton box indication illumination, and other similar circuits. The circuits controlled by the prime relay and its repeaters shall be coordinated so that unsafe or undesirable conditions cannot occur if a repeater relay fails to pick up.

1.05 NON-VITAL CIRCUITS

- A. The following types of circuits are not considered vital to the safety of the Yard Signal System:
 - 1. Route Initiation Circuits
 - 2. Route Selection Circuits except specified Pushbutton Stick Circuits
 - 3. Lever Repeater Circuits
 - 4. Switch Indication Circuits
 - 5. Alarm Circuits

- 
6. Blown Fuse Circuits
 7. Switch Repeater Circuits
 8. Switch Correspondence Circuits
 9. Time Locking Circuits
 10. Route Locking Circuits
 11. Detector Locking Circuits
 12. Traffic Locking Circuits
 13. Signal Control Circuits

- B. All non-vital electrical circuits shall be positive energy, single break circuits of the switching type and shall not depend upon timing or precise voltage control for their proper operation.
- C. All non-vital relays shall have one side of each relay, or each individually controlled relay coil, connected directly to negative energy (common).
- D. When the number of non-vital relay contacts required demands the use of repeater relays, minor circuits shall be operated by the contacts on the repeater relays. Minor circuits are defined as those involving panel illumination, pushbutton box indication illumination, DTS indications, and other similar circuits.

1.06 ELECTRONIC CIRCUITS

- A. Electronic circuits interfaced with, or operating in conjunction with Yard Signal relay circuits shall be designed to perform as required by these Specifications.
- B. When electronic circuits are used, either positive one or negative zero logic shall be employed with ground being the other potential.

1.07 OVERLOAD PROTECTION

- A. The Design-Builder shall incorporate appropriately sized fuses, circuit breakers or resistors into the positive side of all grounded Train Control circuits for overcurrent protection.
- B. The Design-Builder shall incorporate appropriately sized fuses, circuit breakers or resistors into both the positive and negative sides of all un-grounded Train Control circuits for overcurrent protection, unless otherwise specified or specifically authorized by the designated Resident Engineer. Circuit breakers used for such service shall be of the single-unit, dual-breaker type.
- C. The Design-Builder shall, to the greatest extent practicable, provide sufficient protection devices and shall group the Yard Signal circuits in such a manner that the tripping of a circuit breaker or the blowing of a fuse will affect service on only one track or one portion of an interlocking.

1.08 MULTIPLE-FEED PROTECTION

The Design-Builder shall ensure that no circuit is fed from more than one energy bus or from more than one overload protective device on a single energy bus.

1.09 RELAY COIL SNUBBING

Wherever a capacitor is used in parallel with one or more relay coils for snubbing purposes, a resistor shall be used in series with the capacitor to prevent shorting the circuit in case of capacitor failure.

1.10 QUALITY ASSURANCE

- A. See Section 01113, Systems Integration.
- B. All Yard Signal System circuits shall be tested as specified in Section 16989, Yard Tests And Inspections

1.11 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements.

PART 2 - PRODUCTS

2.01 COMPONENTS FOR VITAL CIRCUITS

Vital circuits shall be implemented with:

- A. Relays specified in Section 16943, Vital Relays
- B. Electrical and electronic components specified in Section 16941, Basic Yard Signal Electrical and Electronic Component Requirements
- C. Vital signal wire and cable as specified in Section 16949, Signal Wire and Cable
- D. Combinations of the above devices

2.02 COMPONENTS FOR NON-VITAL CIRCUITS

- A. Non-vital circuits shall be implemented with:
 - 1. Relays and timer equipment specified in Section 16944, Non-Vital Relays and Timers
 - 2. Electrical and electronic components specified in Section 16941, Basic Yard Signal Electrical and Electronic Component Requirements
 - 3. Printed Circuit Cards specified in Section 16942, Printed Circuit Cards
 - 4. Combinations of the above devices
- B. Vital relays specified in Section 16943 may also be used in non-vital circuits.

PART 3 - EXECUTION

3.03 WIRES PER TERMINAL

- A. No more than two wires shall be connected to a single terminal or contact pin other than an AAR terminal unless specifically authorized in writing by the designated Resident Engineer.
- B. No more than three wires shall be connected to a single AAR terminal.

3.04 TRACK CIRCUIT INDICATION

The failure of any track circuit shall result in a "track occupied" indication.

3.05 ENERGY LOOPS

- A. Wherever energy is fed from a bus to more than one equipment point in succession:
 - 1. the energy feed wire shall be looped back to the same bus terminal or another terminal on the same bus.
 - 2. Where the energy feed is through an overload-protective device, both sides of the loop shall originate at the same protective device.

- B. Energy loops shall be subject to the following limitations:
 - 1. No more than 30 equipment points or circuits shall be fed from a given energy loop.
 - 2. No more than four rows of equipment shall be fed from a given energy loop.
 - 3. Each energy loop wire shall be sized to carry the maximum normal load which could be imposed by the equipment and/or circuits fed by that loop.

END OF SECTION

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SECTION 16917

BASIC INTERLOCKING REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the basic requirements for the yard interlockings which the Design-Builder shall furnish, install and test, or partially modify and test under this Contract.
- B. Each interlocking shall be provided with a full complement of safety facilities. These facilities shall meet the requirements of all applicable FRA regulations.
- C. All Yard Signal circuitry for the interlockings shall be as specified in Section 16916, Basic Yard Signal Circuit Requirements, and/or as shown on the Information Drawings.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Submittal Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16941	Basic Yard Signal Electrical and Electronic Component Requirements
Section 16942	Printed Circuit Cards
Section 16943	Vital Relays
Section 16944	Non-Vital Relays and Timers
Section 16945	Plugboards and Cabinets for Relays and PC Cards
Section 16946	Yard Signal Transformers
Section 16947	Ground Detectors
Section 16948	Plug Connectors
Section 16949	Yard Signal Wire and Cable
Section 16971	Racks and Cable Trays
Section 16972	Junction Boxes
Section 16973	Conduit
Section 16974	Locks and Keys
Section 16975	Foundations
Section 16977	Tagging and Marking
Section 16978	Miscellaneous Train Control Components and Materials
Section 16979	Surface Trench
Section 16989	Yard Tests And Inspections

1.03 INTERLOCKING LIMITS

- A. Interlocking limits shall be defined by special track circuit boundaries and controlled wayside signals as indicated on the drawings. These track circuit boundaries will include insulated joints furnished as part of the trackwork installation.

- B. The signal aspects, names and indications to be used by the controlled wayside signals shall be as follows:

ASPECT	NAME	INDICATION
RED over RED	STOP	STOP
LUNAR WHITE (STEADY)	ROUTE CLEAR	PROCEED

1.04 INTERLOCKING TRACK CIRCUITS

- A. Yard interlocking circuits shall be of the AC Power frequency type. Insulated joints will serve as the boundaries of these circuits. The number of insulated joints within each interlocking will be kept to a minimum required to provide for proper operation of the power frequency track circuits.
- B. Track circuits in the new shop lead tracks to the S&I Structure and main storage tracks shall be of the series type.
- C. Loss of shunt protection shall be provided for switch detector tracks. This protection shall consist of a delay in the track relay restoration and shall be provided by a timer circuit as shown on the Information Drawings.
- D. The number, type and boundaries of track circuits to be used within interlockings shall be determined by the Design-Builder subject to the approval of the Authority's Representative.

1.05 TRACK SWITCHES

- A. Interlocking track turnouts and crossovers will be fabricated with 115 lb. RE rail by other disciplines.
- B. The Design-Builder shall furnish and install trailable Alstom Model 6 track switch operating layouts for all newly installed interlocking turnouts and crossovers as specified in Section 16964, and as shown on the drawings.

1.06 SPEED COMMANDS

No speed commands or door-control commands shall be transmitted to the trains, either intentionally or accidentally.

1.07 LOCKING REQUIREMENTS

Electric locking shall be provided to prevent unsafe switch operation and to prevent the clearing of signals for opposing or conflicting routes. The Design-Builder shall provide the following types of locking

- A. Approach Locking - shall be provided to lock switches within a route governed by a cleared wayside signal and to prevent clearing signals for opposing or conflicting routes when a cleared wayside signal is set to STOP and a train is closer than safe braking distance from that signal. Approach Locking shall also prevent simultaneous clearing of opposing signals at a given interlocking. One Approach Locking Relay shall be provided for each wayside signal as shown on the Drawings.

- B. Time Locking - shall be provided to lock switches within a route governed by a cleared wayside signal and to prevent clearing wayside signals for opposing or conflicting routes when a cleared wayside signal is set to stop. Time Locking shall also prevent simultaneous clearing of opposing signals within an interlocking. One Time Locking relay shall be provided for each wayside signal as shown on the Drawings.
- C. Route Locking -shall be provided to lock switches within a route after a train has accepted the wayside signal governing the entrance to the route and to prevent the clearing of opposing signals within the interlockings. Two Route Locking Relays, one for each direction of traffic, shall be provided for each section of track between opposing interlocking signals. Additional Route Locking Relays shall be provided to permit sectional release of Route Locking as required by the Drawings.
- D. Switch Locking (Detector Locking) - shall be provided to prevent operation of a track switch when the track in which the switch is located is occupied, i.e., the track relay is down, or it is otherwise unsafe or undesirable to throw the switch. One Switch Locking Relay shall be provided for each single turnout, for each single crossover, and for each half of a double crossover, all as shown on the Drawings.
- E. Traffic Locking - shall prevent clearing opposing signals into a section of track between two interlockings or intermediate signals, or combinations thereof. Individual Traffic Locking circuits shall be provided for each mainline track between each pair of interlockings, (or intermediate signals) as shown on the Drawings. A signal governing movement into a section of track for which traffic locking is effective shall not clear until traffic direction has been established and locked in the direction of movement for which the signal governs. Traffic Locking shall also prevent the established direction of traffic in a traffic block from being reversed so long as the traffic block is occupied.

1.08 NEGATIVE TRACTION RETURN

See Section 16968 and the Drawings for negative return bonding requirements in the interlocking areas. The Drawings establish the basic guidelines for the Design-Builder's design of the negative traction return system at interlockings.

1.09 ROUTE CONTROL

Route control shall be initiated by the Yard Control Machine and executed when safe.

1.10 QUALITY ASSURANCE

See Section 01113, Systems Integration.

1.11 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements.

PART 2 - PRODUCTS

2.01 ELECTRICAL AND MECHANICAL EQUIPMENT

All electrical and mechanical equipment for track circuits, track switch operating layouts, signal layouts, snowmelter layouts, negative return bonding, signal rail bonding, yard control panels, and vital

and non-vital interlocking circuitry furnished under this Contract shall be as specified in the individual specification sections covering the equipment and as shown on the Drawings.



PART 3 - EXECUTION

3.01 INSTALLATION

The various electrical and mechanical devices composing each interlocking control system shall be installed as specified in the Sections describing those devices and as shown on the Drawings.

3.02 OPERATION

- A. The final operation of interlockings furnished and installed or modified under this Contract shall conform to the operation of similar types of interlockings existing at the yard in which the work is performed.
- B. Control by means of the Yard Control Machine shall be as specified in Sections 16957.

END OF SECTION

SECTION 16921

YARD SIGNAL POWER DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of modifications to the Power Distribution System inside each Train Control Room included in this Contract. The Power Distribution Systems shall include all power supplies, transformers, transfer and bypass equipment, buses, feeders, and mains required to accept electrical energy from the two 3-phase power sources in the Train Control Room, modify this energy as required, and distribute it at the proper voltages to the various pieces of Yard Signal equipment.
- B. Design each Power Distribution System to achieve the best load balance practicable.
- C. Each Power Distribution System shall include a power failure and over current alarm system circuit.
- D. All power supply distribution systems, regardless of rated system voltage, current or frequency, shall deliver the system voltage to the module, device or appliance connected to that system at not less than 95 percent, nor more than 105 percent of the nominal voltage rating of the module, device or appliance.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	System Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16917	Basic Interlocking Requirements
Section 16922	Lightning/Surge Protection and Grounding Systems
Section 16941	Basic Electrical and Electronic Components
Section 16946	Transformers
Section 16947	Ground Detectors
Section 16949	Signal Wire and Cable
Section 16951	Transfer and Bypass Equipment
Section 16952	DC Power Supplies
Section 16971	Racks and Cable Trays
Section 16977	Tagging and Marking
Section 16978	Miscellaneous Train Control Components and Material
Section 16989	Yard Tests And Inspections

1.03 POWER SOURCE

See Section 01113, Systems Integration.

1.04 BASIC TCR POWER DISTRIBUTION REQUIREMENTS

See Section 01113, Systems Integration.

1.05 QUALITY ASSURANCE

See Section 01113, Systems Integration.

PART 2 - PRODUCTS

2.01 SEE SECTION 01113, SYSTEMS INTEGRATION

PART 3 - EXECUTION

3.01 INSTALLATION

See Section 01113, Systems Integration.

3.02 IDENTIFICATION

Tag and label the equipment, cables, and buses comprising the modifications and additions to the Yard Signal Power Distribution System as specified in Section 16977, Tagging and Marking.

3.03 POWER TRANSFER SENSIVITY

The Yard Signal Power Distribution System shall be so configured that normal inrush current during a power transfer by the Automatic Transfer Switch shall not trip any input or output fuses or breakers.

END OF SECTION

SECTION 16922

LIGHTNING/SURGE PROTECTION AND GROUNDING SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing, installation, and testing of lightning protection, surge protection and grounding systems for Train Control Rooms, and the grounding of signals, Train Control equipment cases, junction boxes, and other Train Control equipment or apparatus hereinafter specified or shown on the Information Drawings to require grounding. It is the intent of these Specifications that the Design-Builder shall perform all work and furnish and install all equipment necessary to provide complete, operating lightning protection, surge protection and grounding systems which are effective in protecting all Train Control systems from damage and operational malfunction.
- B. Ground connection to the track rails or use of the neutral conductors of the power company or any signal power supply system will not be permitted.
- C. The Design-Builder's design shall preclude any "closed loops" in the Train Control Room lightning protection and grounding systems.
 - 1. A "closed loop" in these systems is a condition which may occur due to multiple contact points between two or more sections of cable tray, or between any combination of cable tray, cable shielding, ground wire, and ground bus bar.
 - 2. Where shielded cable is used, the cable shield shall be grounded, but no electrically contiguous segment of the cable shielding shall be grounded at more than one point.
- D. Provide a complete system of devices to protect the Train Control circuits and equipment from lightning and other electrical surges.
- E. Within Train Control Rooms:
 - 1. The resistance between earth ground and the room prime ground bus shall not exceed 15 ohms.
 - 2. Grounding bus bars furnished under this contract shall have a minimum cross section of one and one-half by one-quarter inches, and shall be made of hard drawn pure copper having a minimum conductivity of 98 percent per ASTM B187-73.
 - 3. Each bar shall be straight and of rectangular cross section. All surfaces shall be true and free of imperfections. Train Control Room "prime" ground bus bars shall be at least two feet in length.
 - 4. Miscellaneous hardware, including such items as lugs, washers, studs, and bolts used for ground connections, shall be bronze.
- F. Outside Grounding Equipment:
 - 1. When grounding rods are required, the rod and clamp shall be in accordance with requirements for grounding material as specified in Section 16978, Miscellaneous Train Control Components and Materials. The connection between the ground rod and the apparatus shall be No. 6 AWG soft drawn, extra-flexible copper wire, or 4/0 wire if more than one ground rod is necessary.

2. Ground rods installed to meet the 15-ohms-or-less requirement shall be either multiple ground rods or sectional rods. Rods connected in multiple shall be spaced a minimum distance of six feet apart.

1.02 RELATED SECTIONS

Related work specified else where shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16914	Environmental Requirements
Section 16923	TC Maintenance Telephone System
Section 16947	Ground Detectors
Section 16952	DC Power Supplies
Section 16965	Signal Layouts
Section 16969	Snowmelter Layouts
Section 16971	Racks and Cable Trays
Section 16978	Miscellaneous Train Control Components and Material
Section 16989	Yard Tests And Inspections

1.03 QUALITY ASSURANCE

See Section 01113, System Integration.

1.04 SUBMITTALS

See Section 01113, System Integration.

PART 2 - PRODUCTS

2.01 GROUND DETECTORS

Ground detectors shall be as specified in Section 16947.

2.02 LIGHTNING AND SURGE PROTECTION EQUIPMENT

- A. Primary surge arresters shall have the ability to shunt relatively high current surges to ground with relatively little overshoot.
- B. Secondary surge suppressors shall have the ability to shunt-to-ground any surge overshoot from the primary arrester devices.
- C. The intermediate impedance devices shall have characteristics which will allow them to assist the initiation of operation of the primary arresters and protect the secondary surge suppressors, and yet not interfere with the normal operation of the Train Control circuits and equipment they are assisting to protect.

PART 3 - EXECUTION

3.01 GROUNDING OF OUTSIDE EQUIPMENT

- A. The following items of wayside equipment at locations external to Train Control Rooms shall each be grounded in the manner specified:
 - 1. All controlled signals required by the final design.
 - 2. All metallic Train Control equipment cases and cable junction boxes.
- B. No more than three pieces of equipment to be grounded shall be connected to each driven ground.
- C. The ground connection wire from each piece of equipment to its associated ground rod shall be run in as direct a path as practicable. No looping or cascading of ground connection wires will be permitted.
- D. All ground rods shall have the grounding wire attached to the ground rod four inches above grade in order to facilitate maintenance inspection. The ground rod shall be driven in such a location that it does not create a tripping hazard.

3.02 GROUNDING OF INSIDE EQUIPMENT

- A. Train Control equipment located the TCR provided by other disciplines shall be grounded as follows:
 - 1. Each equipment rack and entrance rack shall be grounded via a single point ground to overhead grounding bus bars which shall be installed continuously along each row of racks. Each grounding bus bar shall be properly sized and supported at sufficient intervals to prevent sagging. The grounding bus bars shall be mechanically attached via stand-off insulators to the cable tray support system. Joints in the cable tray shall be bonded and each cable tray, consisting of one, two or more sections so bonded, shall be single-point connected to the adjacent ground bus bar. All ground connections to racks, trays and other equipment shall be arranged to facilitate easy removal to allow the testing of the electrical isolation between each item of equipment and the ground bus. Surfaces of equipment shall be cleaned of paint, rust, corrosion, oil, or other possible insulating material, before ground connections are made. Joints in ground bus bar shall be kept to a minimum. When joints are necessary, they shall be shown in detail on the Design-Builder's design drawings for the grounding system, as approved by the Designated Authority's Representative.
 - 2. The Design-Builder shall make all ground connections in the Train Control Room to a prime ground bus bar furnished and installed by others. This prime ground bus bar will be a minimum of two feet in length and Control system related connections required. It will be of sufficient length to accommodate all Train be mounted on insulating stand-offs on a wall of the Train Control Room, approximately four feet above the floor. This prime ground bus bar will be connected to a number 4/0, six foot pigtail (provided by others) which is the lead to the main ground connection for the applicable room. Each ground wire connected to the room prime ground bus bar shall be identified by an embossed metal tag indicating the wire's origin.
 - 3. Ground bus bars as installed shall be free from sharp edges. All joints shall be assembled with a uniform pressure of 200 pounds per square inch.
 - 4. Items of Train Control equipment:
 - a. Which contain an external ground post, shall be grounded to their respective rack and not directly to the room prime ground.
 - b. Train Control equipment which contains an internal connection to the ac distribution system neutral, shall not be grounded.
 - c. All other individual apparatus not located on racks and shown on the Information Drawings or herein specified to be grounded shall be connected

to the room prime ground bus with individual insulated No. 6 AWG (or larger as necessary) extra-flexible soft drawn copper wire. These connections shall be designed to be of the shortest possible length consistent with good workmanship and the layout of the room.

5. If shielded cable is used as part of the Design-Builder's Train Control System, each electrically continuous segment of cable shielding shall be grounded at only one point.

3.03 LIGHTNING AND SURGE PROTECTION

Conform to all wiring and equipment installation methods and procedures known, and provide all types and levels of lightning arresters and surge protectors necessary, to protect the Train Control equipment from damage or operational interference.

END OF SECTION

SECTION 16923

TC MAINTENANCE TELEPHONE SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Provide all telephone jacks and plugs, terminals, jack boxes, rotary selector switches, interconnecting twisted pair wiring and speaker phones to expand the existing system to incorporate the new equipment provided under this contract. No instrument ringing shall be provided.
- B. Provide TC Maintenance Telephone jacks in or on each of the following pieces of equipment as applicable under this Contract
 - 1. Power, Entrance, and Equipment Racks (2 per rack; front and back)
 - 2. Large Junction Boxes, to include TC/COMM Interface Cabinets and DTS interface boxes or cabinets furnished by other disciplines, and Wayside Interface or Distribution Junction Boxes furnished by the Contractor.
 - 3. Signal Junction Boxes
 - 4. Switch-and-Lock Movements

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16916	Basic Circuit Requirements
Section 16941	Basic Electrical and Electronic Component Requirements
Section 16949	Yard Signal Wire and Cable
Section 16965	Signal Layouts
Section 16969	Snowmelter Layouts
Section 16971	Racks and Cable Trays
Section 16972	Junction Boxes
Section 16989	Yard Tests And Inspections

1.03 QUALITY ASSURANCE

See Section 01113, System Integration.

1.04 SUBMITTALS

See Section 16912, Yard Signaling Submittal Requirements.

PART 2 - PRODUCTS

2.01 TELEPHONE JACKS

Telephone jacks for the TC Maintenance Telephone System shall be Type NL-112B as manufactured by Switchcraft, Inc., or approved equal, except that Type N-112B may be used on racks in the TCRs or on thin sheet metal boxes. Springs shall be silver-plated, nickel silver. A nylon bushing shall be provided to insulate jack sleeves from mounting surfaces. Terminals at all telephone jack locations shall be arranged to accommodate at least two pairs of No. 16 AWG wires.

2.02 EXTERNAL JACKS

All telephone jacks mounted on junction boxes or equipment housings outside of Train Control Rooms shall be enclosed in wired entrance boxes or weatherproof housings and shall be equipped with spring-loaded jack-covers, Switchcraft No. 520, or approved equal.

2.03 TELEPHONE PLUGS

All telephone plugs shall be Type 267 as manufactured by Switchcraft Inc. or approved equal. Plugs shall have solder terminals with built-in strain-relief clamp.

2.04 SPEAKER PHONES

- A. Furnish six speaker phones for each of the TCRs modified under this Contract. Each speaker phone shall operate from either an internal power supply fed by external 120V ac, or a self-contained battery pack using conventional penlite batteries which shall be easily replaceable. Each speaker phone shall be equipped with a call button switch and a push-to-talk button switch.
- B. The speaker phones shall meet or exceed the following specifications:
1. Receive Mode
 - Sensitivity: -30dBm
 - Impedance: 600 ohms, 300 Hz to 3kHz
 - Frequency Response: ± 3 dB from 300 Hz to 3kHz
 - Audio Power: 200mw
 2. Transmit Mode
 - Output: ± 5 dBm
 - Impedance: 600 ohms, 300 Hz to 3kHz
 - Frequency Response: ± 3 dB from 300 Hz to 3kHz
 3. Physical
 - Size: (Maximum) 8 inches x 5 inches x 4 inches
 - Weight: (Maximum) 24 oz. (including batteries)
 4. Battery
 - Type: Dry - Alkaline
 - Cell Size: AA (1.5V penlite)
 - Life: 125 hours minimum
 5. Protection - No damage to the speaker phone shall result from connection across 120V ac or 150V dc.
 6. Leads - shall be six feet long and equipped with type 267 plugs; lead insulation breakdown voltage shall be 600V ac.
- C. An adaptor cable shall be provided with each speaker phone. The adaptor cable shall consist of a six foot length of extra flexible single-pair cable, with an insulated jack to accept the type 267 plug at one end and a pair of insulated alligator clips at the opposite end.
- D. Speaker Phones shall be "Nobelphone Portable Telephone Model P-11" as manufactured by Nobel Co., Ltd., Tokyo, Japan, or approved equal, modified to meet additional requirements specified above.

2.05 SELECTOR SWITCH UNITS

A rotary, six-pole, six position wafer switch shall be furnished to select various combinations of TC Maintenance Telephone connections at each Train Control Room. This switch and a terminal strip of pressure-clamp type communications terminals shall be mounted on a metal plate suitable for installation in a standard size space on the entrance rack. The mounting plate shall be steel with a

black or gray enamel finish, or anodized aluminum. The front of the plate shall be clearly and permanently marked to indicate the various connection combinations available for the various positions of the rotary switch, all as shown on the Information Drawings. The back of the plate shall be marked to indicate the terminal coordinates for the switch plate wiring.

PART 3 - EXECUTION

3.01 INSTALLATION

A. External Jacks

The weatherproof external jacks shall be so mounted on external cases, housings and junction boxes that the jacks may be used without opening the junction box, case or housing. The two wires from the telephone jack shall be terminated on terminals mounted inside the associated case, housing or junction box. The Design-Builder shall make twisted pair connections to other locations from these terminals.

B. External Wiring

1. The Design-Builder shall use No. 16 AWG twisted pair cable, as specified in the non-vital wire portion of Section 16949, Signal Cable and Wire, to connect all the external TC Maintenance Telephone jacks mounted on Yard Signal equipment within the control limits of each TCR to the selector switch in that TCR as shown on the Information Drawings. The Design-Builder shall install a separate twisted pair cable for each track in each direction from the TCR. Each cable shall connect all the TC Maintenance Telephone jacks mounted on Yard Signal and support system equipment located along that particular track within the TCR area limits. The twisted pair installed along each track shall be extended to connect with the corresponding TC Maintenance Telephone pair from each adjacent TCR as shown on the Information Drawings.
2. The Design-Builder shall use one No. 19 AWG twisted pair out of each special control and indication cable to connect the TC Maintenance Telephone jack in each DTS Interface junction box to the TC Maintenance Telephone System in the Train Control Room as shown on the Information Drawings.

C. Internal Wiring

The Design-Builder shall use No. 16 AWG twisted pair cable to connect all of the TC Maintenance telephone jacks on panels, racks and junction boxes located within each TCR, to the selector switch in that TCR. Two individual single-conductor wires twisted together will not be acceptable.

D. Jack and Plug Wiring

All jacks and plugs shall be wired with white insulated wire on the tip side and black insulated wire on the ring side.

- #### **E.**
- In all instances, the TC Maintenance Telephone jacks shall be installed in such a manner that they are easily seen and easily accessible for use. A room-temperature vulcanizing adhesive sealant shall be applied to the threads of phone jacks to prevent them from loosening due to vibration and use.

3.02 FIELD TESTING

- A. Test each TC Maintenance Telephone jack after the system has been installed in the field to assure a minimum resistance of one megohm between each jack and the equipment on which it is mounted.
- B. The TC Maintenance Telephone System provided under this Contract shall be tested to ensure that voice communications with a minimum signal-to-noise ratio of 15dB can be maintained through the extreme ends of all possible TC Maintenance Telephone circuits:
 - 1. Between TCRs located within the new route segment,
 - 2. Between these TCRs and external wayside equipment jacks along each track within the new route segment,
 - 3. Between all the TCRs and wayside equipment jacks located within the route segment provided under this Contract and the nearest adjacent TCR originally equipped under previous contracts,
 - 4. Between all TCRs and DTS junction boxes newly connected under this Contract.
- C. The minimum resistance and minimum signal-to-noise ratio characteristics specified above shall be regarded as part of the criteria for acceptance of the TC Maintenance Telephone System. The Design-Builder shall provide whatever effort and material is required to meet these criteria at no additional cost to the Authority.
- D. Record the results of the above described field tests for submittal to the designated Resident Engineer.

END OF SECTION

SECTION 16929

EVENT RECORDING SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the design, furnishing, installation, testing and documentation by the Design-Builder of changes and additions to the existing Shady Grove Yard Event Recording System which shall monitor, record, store, print and display in various formats, the status of various Yard Train Control functions over a period of time. It is the intent of this Section that the Design-Builder shall perform the detail design, implementation, testing and documentation of a new, microprocessor-controlled monitoring and recording system for the Brentwood Yard Signal Control and Interlocking System that is accurate, user friendly, versatile in output formats, easily expandable, and easy to troubleshoot and maintain, and which meets all stated or implied requirements of these Specifications. It is further the intent of this Section that the Design-Builder shall prepare and present instruction manuals and a comprehensive course of instruction in the operation and maintenance of this system for selected Authority personnel.
- B. The Event Recording System shall consist of:
1. A computer-based processing unit having:
 - a. A storage unit with sufficient capacity to identify and store all specified yard Signal Control and Interlocking System event system event changes over a 32 day period with redundant backup on a hard disk drive and a removable backup media such as a zip drive or tape drive with capacity large enough to store 32 days of data. The minimum storage capability of the storage unit provided shall be one gigabyte.
 - b. An intelligent reading device which, upon interrogation, shall transmit the stored information in various formats to a local or remote display monitor and/or printer. The printed event changes shall be described in plain English with a minimum use of abbreviations and technical terms.
 - c. An internal diagnostic subsystem complete with error detection contact closure wired to external terminals. The contact closure provided shall be adequate for extended operation of an external indication relay.



- d. All necessary interfacing devices for the parallel input and output of information.
- 2. A local, internal VGA CRT display monitor and a 101 key ruggedized keyboard.
- 3. A local plug-in printing device.
- 4. A 1.44 MB floppy disc drive in addition to the primary memory.
- 5. A minimum of two Serial Output Ports and two Parallel Output Ports.
- 6. Applicable power supplies with a built-in standby capacity for two days of operation without external power.
- 7. All specified wired vital and non-vital relay contact closures in the various Yard TCRs (or their computer generated equivalents from the Computerized Yard Control System for non-vital indications) .
- 8. All interfacing wiring and/or data links for the data points to be monitored.
- 9. A rack in the Yard Train Control Room for the mounting of the components of the recording system.
- 10. All applicable software for the operation of the system as specified herein and as approved by the Authority's Representative. This software shall be completely documented with flow charts, definitions of terms used, and written explanations of its operation. The final, as-built version of this software, including any commercially available compiler, shall become the property of the Authority.
- C. A programmable answering feature shall be provided and ancillary devices provided for connecting the Event Recording System to the TCR telephone line. This shall allow the Event Recording System to be interrogated from a remote location and to transmit stored information to a remote monitor and/or printing device.
- D. The Contractor shall provide all equipment, wiring practices and other features necessary to protect all components of the Event Recording System from radio interference, lightning discharges and power surges.
- E. The Contractor shall provide instruction manuals and training courses for designated Authority personnel for the operation and maintenance of this system.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, work specified in the following Sections and documents:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16922	Lightning/Surge Protection and Grounding of Equipment
Section 16942	Printed Circuit Cards

Section 16943	Vital Relays
Section 16945	Plugboards and Cabinets for Relays and PC Cards
Section 16957	Yard Control Machine
Section 16958	Computerized Yard Control System
Section 16971	Racks and Cable Trays
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration.

1.04 SUBMITTALS

See Section 16912 Yard Signal Submittal Requirements.

1.05 DELIVERY, STORAGE AND HANDLING

- A. The various modules included in the event recording system shall be properly crated during shipment. All damages incurred in transit or caused by mishandling or improper storage shall be the Designer-Builder responsibility and shall be corrected to the satisfaction of the Authority's Representative at no additional cost to the Authority.

PART 2 - PRODUCTS AND MATERIALS

2.01 BASIC SYSTEM REQUIREMENTS

- A. The Event Recording System shall meet the following minimum requirements:
1. The system shall be equipped to monitor a minimum of 500 points. Modular construction shall be utilized such that the initial system can be easily expandable in the field to monitor up to 1000 points.
 2. All data points shall be monitorable continually, including during viewing and/or printing, both locally and/or remotely via RS232 interface. One local monitoring device, and two remote test monitoring devices shall be supplied.
 3. All detected changes of state shall be recorded with the device identification, new status, and the time and date of occurrence.
 4. Event printouts and/or displays shall be accurate to 0.1 second.
 5. Displays and printouts shall be menu driven and manually initiated from a local or remote keyboard or other interrogating device.
 6. Displayed and/or printed data shall include the following information in a format easily readable and understandable by Train Control maintenance personnel:
 - a. Type of Event,
 - b. Julian date,
 - c. Time of occurrence,

- d. Point identification, and
 - e. New state.
7. Standby battery shall be provided as an integral part of the Event Recording System to prevent loss of the time base during external power failures or shut-down periods up to two days in duration.
 8. Controls shall be provided for setting the date and the time; for initiating the viewing and/or printing of stored data in the desired format, and; for adding new devices to be monitored.
 9. The printer shall be capable of printing one event per line, two lines per second.
 10. Input wiring to the system shall be easily removable to facilitate testing.
 11. Detection of an error in the Event Recording System (by the internal diagnostic subsystem) shall cause a change in status of the externally wired error detection contact closure.
 12. The system shall include automatic and manually-initiated screen saving.
 13. The Event Recorder shall have a relational database to display related recorded events.
 14. Storage devices and output ports shall be the latest industry standard.
 15. Communications shall be the latest industry protocols.

2.02 INPUT STORAGE

- A. The minimum storage capability of the hard disk drive provided shall be one gigabyte. The Design-Builder shall furnish sufficient storage media for 32 days of events.
- B. The program which controls the hard disk drive storage shall store the yard events in a file format labeled on a daily basis (0000-2400 hours) by date and year, with one separate file for each day. These files shall be further subdivided by the type of event, i.e., switch machines, controlled signals, track occupancy, auxiliary devices, alarms, etc.
- C. The event storage program shall automatically rotate through the storage area, erasing the oldest of the 32 daily files at the start of each new day's recording.

2.03 OUTPUTS

- A. The processor shall have the capability of outputting information to a local or remote monitor, printing device or floppy disc in various menu-driven, operator-selectable formats as approved by the Authority's Representative. These formats shall include, but not be limited to:
 1. Single device status over a selected period of time.
 2. Single device status real time.
 3. Multiple device status over a selected period of time

4. Multiple device status real time
5. Complete file for a particular day
6. All devices, real time

B. The type of format, time period, and device identification shall be selectable by the interrogator from a menu appearing on the monitor. The menu shall also enable the interrogator to select the output device or devices. Output to the local or remote monitors shall have complete scrolling capabilities.

2.04 SPARE MATERIAL

- A. The Design-Builder shall furnish the following spare material for the Event Recording System:
1. For each type of printed circuit card used, ten percent spare cards or one spare card, whichever is greater.
 2. One carton (or not fewer than 6 rolls or fan- fold packages) of print-out paper.
 3. Other spare material as may be recommended by the manufacturer(s) of the various system modules.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The Contractor shall install the major computer components of the Event Recording System on a rack in the Yard (main) Train Control Room in a manner previously approved by the Authority's Representative.
- B. The Contractor shall provide indication contacts on appropriate equipment for use by the Event Recording System. These functions shall include, but not be limited to the following, unless otherwise authorized by the Authority's Representative:

Function	Contact Closure
1. Track occupancy (Except Yard Storage Tracks)	(TR or TYPR)
2. Signal clearing	(HG)
3. Normal switch	(NWC)
4. Reverse switch	(RWC)
5. Switch locked	(LR)
6. Snowmelter control request	(SMZ)

Function	Contact Closure
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7.	Snowmelter "ON" indication	(SMZ and SMYK)
8.	Ground detected	(AC and DC ground detector relays)
9.	Blown fuse or tripped breaker	(BFPK)
10.	Yard Computer Malfunction	(YCMK)
11.	AC Power Transfer	(ATWK)
12.	DC Power off	(POK)
13.	Traffic Locked Normal	(NFR)
14.	Traffic Locked Reverse	(RFR)
15.	Traffic Stick	(FS)
16.	Snowmelter Failure	(SMFYK)
17.	Dragging Equipment	(DEQK)
18.	Yard/Mainline Interface Under Yard Control	(LYDZS)
19.	Yard/Mainline Interface Under Mainline Control	(LBAZS)

- C. The Contractor shall provide plug connector receptacles for the Event Recording System wiring on the racks containing equipment to be monitored in the various Yard TCRs.
- D. The Contractor shall provide the interconnecting cable between the event recording equipment and test contact receptacles on the various racks, and between the rack test contact receptacles and the appropriate test contacts on the equipment mounted on the racks.
- E. The Contractor shall provide all necessary wiring and interfaces between the Event Recording System and the Computerized Yard Control System, if provided.

END OF SECTION

SECTION 16931

YARD SIGNAL MAINTENANCE AND TEST FACILITIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A This Section specifies the furnishing and installation by the Design-Builder of certain storage and maintenance facilities and equipment at the yards modified under this contract. TCR maintenance and test equipment may be substituted with equipment of similar value to satisfy the needs of a particular room, as approved by the Authority's Representative.
- B Provide the following at each Train Control Room and TCER equipped under this Contract:
 - 1. A workbench and stool for reading plans.
 - 2. A wall-mounted storage cabinet for spare parts.
 - 3. A 6-foot fiberglass stepladder.

PART 2 - PRODUCTS

2.01 TCR MAINTENANCE EQUIPMENT

- A Workbench
 - 1. The workbench shall be 42 inches high, 60 inches wide, and 30 inches deep.
 - 2. The framework for the bench shall be 14-gauge cold rolled steel.
 - 3. Side panels shall be 14-gauge cold rolled steel, and the under panels shall be 16-gauge steel.
 - 4. The bench top shall be Formica bonded to three-quarter inch thick plywood.
 - 5. The bench shall have a heavy-duty drawer, supported by the bench frame and capable of storing a Room Book of Plans under the bench top.
 - 6. The drawer shall be steel as specified above and shall have the following minimum dimensions:
 - a. 4 inches high
 - b. 40 inches wide
 - c. 25 inches deep.
- B Stool
 - 1. The stool shall have a 14 inch diameter seat with tubular steel adjusting leg extensions that lock securely at one inch intervals.
 - 2. The legs shall be adjustable from 18 inches to 27 inches.
- C Cabinet
 - 1. The storage cabinet shall be made of steel.
 - 2. It shall be
 - a. 36 inches high,
 - b. 60 inches wide, and
 - c. 16 inches deep, with one shelf.
 - d. Shelf height shall be adjustable. supported every 15 inches.
 - e. The cabinet shall have 4 doors for access.

D Stepladder

The stepladder shall be:

1. heavy-duty, type 1A
2. 6-foot self-supporting
3. fiberglass
4. folding ladder

E Locker

The locker shall be made of steel. The locker shall be 72 inches high, 36 inches wide, and 18 inches deep, and shall have four adjustable-height shelves. The locker shall have a full-height hinge, and lockable double doors.

F Print Storage Rack

The print storage rack shall be wall mounted or mounted on the side of an existing equipment rack. This storage rack shall support the room plans by suspending them from their binding on the left margin. The rack shall be adequately sized to support all bound drawings of the Train Control Room Book of Plans. The rack shall be safely positioned in such a manner that the rack and stored plans do not impede normal access to any Train Control equipment and do not block any personnel passageways in the Train Control Room. The rack shall be mounted at such a height that the bottom of the stored plans is at least 18 inches above the floor.

PART 3 - EXECUTION

3.01 INSTALLATION

- A Install the TCR maintenance equipment in each Train Control Room or as otherwise approved by the designated Resident Engineer.
- B Mount the storage cabinet on the wall above the workbench. The bottom of the storage cabinet shall be no less than 15 inches above the top of the workbench.

END OF SECTION

SECTION 16932

SPARE YARD SIGNAL EQUIPMENT AND SELECTABLE ITEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Specifications for
 - 1. The furnishing of spare Yard Signal equipment for this Contract.
 - 2. The furnishing of a price list of recommended Yard Signal-related tools and equipment components.
 - 3. The method to be used to determine prices to be charged to the Authority for items of Spare Yard Signal Equipment, and for items of Recommended Yard Signal Tools and Equipment Components.

- B. The Design-Builder shall furnish and deliver to the Authority the quantities of spare Yard Signal equipment specified, and the quantities of selectable Yard Signal tools and equipment components chosen by the Authority from the approved price list submitted by the Design-Builder.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 16911	Scope of Work
Section 16912	Yard Signaling Submittal Requirements
Section 16964	Trailable Switch Operating Layouts
Section 16965	Signal Layouts
Section 16969	Snowmelter Layouts

1.03 QUALITY ASSURANCE

See Section 16912, Yard Signal Submittal Requirements.

1.04 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements.

PART 2 - PRODUCTS AND MATERIALS

2.01 SPARE EQUIPMENT

Furnish the following complete items and modules of spare equipment:

- A. One complete Alstom Model 6 track switch operating layout. This layout shall include:

1. All items specified for a track switch operating layout in Section 16964, Trailable Switch Operating Layouts. The specific layout of the switch, i.e. right or left hand, shall be determined by the Authority's Representative.
2. One complete set of special adjusting tools for yard switch machine, and a switch circuit controller to match the above layout.

- B. One each of any items provided under this Contract which have not previously been installed on WMATA property.

2.02 RECOMMENDED YARD SIGNAL TOOLS AND EQUIPMENT COMPONENTS

The Design-Builder shall provide a price list of recommended Yard Signal tools and equipment components required under this Contract.

PART 3 - EXECUTION

3.01 DETERMINATION OF PRICES

- A. Prices for items of Spare Yard Signal Equipment (Part 2.01) and for items of Recommended Yard Signal Tools and Equipment Components (Part 2.02) which are manufactured by the Design-Builder shall not exceed 85% of the Design-Builder's published catalog prices in effect at the time of ordering such equipment.
- B. Prices for items of Spare Yard Signal Equipment (Part 2.01) and Recommended Yard Signal Tools and Equipment Components (Part 2.02) which are not manufactured by the Design-Builder shall not exceed 85% of the published catalog prices in effect at the time of ordering such equipment.

3.03 PREPARATION

- A. All spare equipment provided under this Section shall be packaged or treated to preclude deterioration of the product due to environmental conditions.
- B. All spare equipment, tools and equipment component items shall be properly packaged or crated by the Design-Builder to prevent damage to the items during shipment and storage.

3.04 DELIVERY

- A. Upon notification by the Design-Builder of the delivery schedule, the designated Authority's Representative will furnish WMATA part numbers for all spare Yard Signal equipment, tools and equipment components to be delivered. Each tool, equipment component and piece of spare equipment shall be identified by the Design-Builder with a WMATA identification number prior to delivery to the Authority.
- B. The Design-Builder shall deliver the spare Yard Signal equipment items to the address or addresses designated by the Authority no later than the Contract completion date specified in SECTION 101, Article IX, Commencement, Prosecution and Completion of Work.

END OF SECTION

SECTION 16941

**BASIC YARD SIGNAL ELECTRICAL
AND
ELECTRONIC COMPONENT REQUIREMENTS**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies basic electrical requirements for Yard Signal work, and the characteristics of certain basic electrical components which shall be furnished and installed by the Design-Builder.
- B. This Section specifies basic electronic requirements for Yard Signal work, and the characteristics of certain basic electronic components which shall be furnished and installed by the Design-Builder.

1.02 BASIC ELECTRICAL AND ELECTRONIC COMPONENT REQUIREMENTS

All electrical and electronic components provided under this Contract shall be:

- 1. New and free of manufacturing defects,
- 2. Free of storage and handling damage,
- 3. Clearly and permanently labeled with value and type identification,
- 4. Rated to operate at power, voltage, current and temperature levels at least 20 percent in excess of those to which the components will be subjected in service,
- 5. Available from the manufacturer within 90 days of order, with a guaranteed supply for 20 years.
- 6. Commercially available in the Washington, D.C. area.
- 7. Capable of operating as required in the environmental conditions specified in Section 16914, Environmental Requirements.
- 8. Any Yard Signal module, device or appliance, furnished or provided under this Contract, which requires power to be supplied from a power supply system, regardless of system voltage, current, or frequency, shall be capable of operating satisfactorily and continuously at any voltage throughout the range of plus or minus 8 percent of the rated system voltage.

1.03 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 16911	Scope of Work
Section 16912	Yard Signaling Submittal Requirements
Section 16914	Environmental Requirements
Section 16921	Yard Signal Power Distribution Systems
Section 16931	Yard Signal Maintenance and Test Facilities
Section 16942	Printed Circuit Cards
Section 16978	Miscellaneous Train Control Components and Materials

1.05 QUALITY ASSURANCE

See Section 01113, Systems Integration.



PART 2 - PRODUCTS

2.01 FUSES

- A. Fuses shall be of the non-renewable, fibre-case, time-lag, fusion type.
- B. Fuses for installation on equipment racks and all fuses associated with power supplies shall be of the indicating type.
Note: This does not apply to AC track circuit fuses.
- C. Fuses shall be rated for a minimum of 125 percent of the maximum connected load and derated for an ambient operating temperature of 120 degrees F.

2.05 CIRCUIT BREAKERS

- A. Provide circuit breakers which meet the following requirements:
 - 1. Each breaker shall have a short-circuit current interrupting rating in excess of the short-circuit current capability of the power supply to which it is connected.
 - 2. Each breaker shall have a nominal trip current rating of not less than 125 percent of the maximum steady current required by its load, derated for an ambient operating temperature of 120 degrees F, and in no case, less than two times the current rating of the largest connected branch circuit current limiting device.
 - 3. When the breaker is utilized to supply power to loads with inrush current ratings higher than their steady current ratings, the selected breaker shall have a time-delay characteristic curve suitable for that load, according to the breaker manufacturer's recommendations.
 - 4. The breaker shall have endurance ratings equal to or greater than 5000 operations at rated voltage and current.
- B. The Design-Builder shall select a breaker with characteristics designed to meet environmental conditions encountered in TCRs as stated in Section 16914, Environmental Conditions.
- C. Circuit breakers shall be UL-listed.

2.06 TERMINAL BLOCKS

- A. Basic Characteristics
Terminal blocks shall be modular, with solderless connections of the pressure clamp type. Connection resistance shall not exceed 0.0002 ohms. Terminals of the pressure clamp type shall be suitable for solid or stranded wire. Individual modular blocks shall have the following features:
 - 1. Built-in facility for affixing tags for identification.
 - 2. Terminals cross-connectable by shunt straps or sliding links as applicable.
 - 3. All metal parts recessed below the surface of the insulating material.
- B. Insulation
 - 1. Terminal blocks shall be rated for service at 600 volts minimum.
 - 2. Terminal block insulating material shall meet the requirements of ASTM Specification D-704, Type 6-695

2.07 TERMINALS FOR WIRES AND CABLES

- A. All stranded signal wires of size 6 AWG or smaller to be terminated on terminal posts under this Contract shall be fitted with the approved crimp-on type terminal lugs.
- B. Lugs for wires larger than No. 6 AWG shall be insulated with heat shrink tubing.

2.08 TRANSFORMERS

Transformers shall not emit audible noise in excess of 40 dB referenced to 0.0002 dynes per sq. cm. at a distance of two feet while operating at rated voltage and load.

2.09 SEMICONDUCTOR DEVICES

- A. All transistors, diodes, zener diodes or other semi-conductors furnished under this Contract shall carry a Joint Electron Device Engineering Council (JEDEC) number and shall be used within the published specifications for that number.
- B. All semiconductors furnished under this Contract shall be of the silicon type.
- C. Zener diodes used for voltage regulation or reference levels shall be of such rating that they will not be damaged if the entire load is removed abruptly, and shall have a zener voltage tolerance of plus-or-minus 5 percent or better.

PART 3 - EXECUTION

3.01 ELECTRICAL INSTALLATION

- A. Install all basic electrical components of the correct type, size and rating required to provide the specified operation of the Yard Signal system. This shall include replacement of basic electrical components damaged or burned out in the course of installation and testing.
- B. Fuses shall be installed and removed using a suitable tool designed for such use. Provide a properly sized fuse puller within reach of every fuse in every rack containing fuses. The fuse pullers shall be attached to the racks at intervals not exceeding every third rack by means of non-conductive lanyards of the shortest length sufficient to reach all fuses in the three adjacent racks. These pullers shall be installed prior to commencement of any electrical test activities.
- C. Lugs shall be attached to the conductor with a tool made by the same manufacturer as the lug and/or terminal being used. The tool shall be equipped with a ratchet device which ensures proper application of the lug and which will not release until proper compression is attained. Tools which are excessively worn, damaged, abused, or show evidence of missing parts shall not be used. A minimum of one of each type of crimping tool shall be furnished.
- D. The Design-Builder shall use removable type contacts on plugboards for plug-in relays.
 - 1. The method of attaching the wires to the removable contacts shall be a solderless connection,
 - 2. Plugboards for vital relays may be solderless or soldered.
- E. The method proposed for the application of solderless type terminals to wires of 1000 volt class shall be fully described and submitted to the designated Authority's Representative for approval.

END OF SECTION

THIS PAGE NOT USED

SECTION 16942

PRINTED CIRCUIT CARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the characteristics of printed circuit (PC) cards which shall be furnished and installed by the Design-Builder.
- B. The design and construction of PC cards of the same subsystem shall be of the same design. Cards of different subsystems shall be of the same design and construction wherever practicable.

1.02 RELATED SECTIONS

- A. Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 16929	Event Recording System
Section 16941	Basic Yard Signal Electrical and Electronic Component Requirements
Section 16945	Plugboards and Cabinets for Relays and PC Cards
Section 16957	Yard Control Machine
Section 16958	Computerized Yard Control System

1.03 QUALITY ASSURANCE

- A. See Section 01113, Systems Integration.

1.04 SUBMITTALS

- A. See Section 16912, Yard Signal Submittal Requirements.

PART 2 PRODUCTS

2.01 BASIC DESIGN

- A. The Design-Builder shall arrange the PC card circuitry in such a manner that terminals assigned to a given power supply, common, or ground shall be the same on each PC card in each subsystem.
- B. The Design-Builder shall arrange the remaining PC card circuitry in such a manner that terminals assigned to a given function shall be the same on all PC cards in each subsystem.
- C. PC cards containing circuits performing logic functions which affect train safety or train routing shall be designed and circuited in such a way that removal or insertion of a PC card shall not create an unsafe condition.

2.02 CONSTRUCTION

- A. Printed circuit cards shall be constructed of glass epoxy material meeting the requirements of NEMA Type FR-4.
- B. PC cards shall be of sufficient thickness to permit easy insertion and removal without buckling or breaking.
- C. PC cards shall be mechanically keyed to prevent incorrect interchange, or electrically interlocked to prevent operation in the event of incorrect interchange. They may also be interlocked through software programming.
- D. Conductor material shall be copper and shall be protected from exposure to air.
- E. Circuits shall be formed by etching. The etched circuits of vital PC cards shall conform exactly to the logic of the corresponding vital circuits contained in the Specifications. No external jumpers shall be used on vital PC cards provided under this Contract, either initially, or on replacement cards.
- F. PC cards shall be coated with an approved moisture-proofing compound.

2.03 COMPONENT MOUNTING

- A. PC card-mounted-components which weigh more than one-half ounce or have a displacement of more than one-half cubic inch shall have a structural attachment to the card which is separate from the electrical attachment.

2.04 IDENTIFICATION

- A. Each type of PC card shall be permanently and legibly marked with a unique number identifying that type of PC card.
- B. Each PC card shall be permanently and legibly marked with a unique serial number.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Printed circuit cards shall be installed in 19-inch card file cabinets of the type specified in Section 16945, Plugboards and Cabinets for Relays and PC Cards, or in other special hardware approved by the designated Authority Representative.

END OF SECTION

SECTION 16943

VITAL RELAYS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of all relays to be used in circuits which are vital to the safety of train control or operation. This shall include biased neutral relays, switch operating relays, switch overload relays, vital dc timer relays, vane type ac track relays and special purpose dc neutral relays.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 16911	Scope of Work
Section 16912	Yard Signaling Submittal Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16945	Plugboards and Cabinets for Relays and PC Cards
Section 16971	Racks and Cable Trays
Section 16977	Tagging and Marking
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration.

1.04 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements.

1.05 DELIVERY, STORAGE AND HANDLING

Vital relays shall be shipped separately from the racks in which they are to be mounted.

PART 2 - PRODUCTS

2.01 BASIC REQUIREMENTS

- A. All vital dc relays furnished shall conform to the applicable recommendations established by the AREMA Signal Manual, Part 6.2.1 (Tractive Armature DC Neutral Plug-in Relay) and Part 6.4.1 (DC Relays).
- B. All vital dc timer relays shall conform to the recommendations established by the applicable sections of Part 6.1.20 (Time Element Relay) of the AREMA Signal Manual.

- C. All ac track relays shall conform to the recommendations established by Part 6.4.5 (AC Relays) and Part 6.1.35 (AC Induction Type Relay) of the AREMA Signal Manual.
- D. All vital relays shall be of the US&S PN-150 type or the GRS (Alstom Signaling Inc.) "B" type, or an approved equal.
- E. All vital dc timer relays furnished under this Contract shall be identical and shall be Microchron Timer Relays, Drawing No. 50800-100, GR.2, as manufactured by Alstom Signaling Inc. (formerly General Railway Signal Company) of Rochester, New York, or an approved equal.
- F. All vital relays and their plugboards shall be equipped with mechanical registration devices to prevent relays of the wrong style, contact arrangement, or operating characteristics from being mounted on any given plugboard. These registration devices shall be applied to the vital relays and their plugboards prior to mounting the relays on the plugboards for factory testing of rack wiring.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All vital relays shall be rack mounted.
- B. Relays shall be mounted at their preassigned locations on the racks only after the racks have been permanently mounted in the Train Control Room.

3.02 SPECIAL REQUIREMENTS

- A. Each biased neutral relay and each track relay, or their relay-repeater combinations, shall have at least one spare dependent front-back contact or one spare independent front and one spare independent back contact. This requirement shall be met throughout the installation and test period and at the conclusion of all field corrections.
- B. One Normal and one Reverse Switch Operating Relay shall be provided for each switch movement.
- C. One Switch Overload Relay shall be provided for each switch movement.
- D. Each track relay or track relay-repeater combination shall have one back contact wired out to a plug coupler for use by a track indication panel, as specified in Section 16956, Interlocking Control Panels. If the vital track relay is repeated by a non-vital logic relay, a contact on the non-vital repeater relay may be used for this purpose.
- E. No more than 90 percent of the available relay space in each relay rack shall be filled at the time of installation, and no more than 95 percent of the available relay space in each relay rack shall be filled upon completion of all field corrections and testing.
- F. Where vital relays are added to existing Train Control Room racks, the new relays shall be mounted in conformance with the existing relays, i.e., in such a manner that the fronts of all relays in the rack are in the same vertical plane.

END OF SECTION



SECTION 16944

NON-VITAL RELAYS AND TIMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of relays and timers used in circuitry not considered vital to the safety of train control or operation.

1.02 DESCRIPTION

Non-Vital Relays are specified in three categories as follows:

- A. Non-vital logic relays
- B. Non-vital general purpose interfacing relays
- C. Non-vital heavy duty interfacing relays

1.03 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, work specified in the following Sections and documents:

Section 16911	Scope of Work
Section 16912	Yard Signaling Submittal Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16942	Printed Circuit Cards
Section 16943	Vital Relays
Section 16945	Plugboards and Cabinets for Relays and PC Cards
Section 16971	Racks and Cable Trays
Section 16989	Yard Test and Inspections

1.04 QUALITY ASSURANCE

See Section 01113, Systems Integration.

1.05 SUBMITTALS

See Section 16912 Yard Signal Submittal Requirements.

PART 2 - PRODUCTS

2.01 BASIC NON-VITAL RELAY REQUIREMENTS

- A. Non-vital logic relays shall conform to the recommendations established by the AREMA Signal Manual, Part 6.3.5 (Detachable DC Non-vital Relay).
- B. Non-vital logic relays shall be type "J," as manufactured by the Alstom Signaling, Inc., or type LP-100, as manufactured by the Union Switch & Signal Company, or an approved equal.

- C. All non-vital logic relays furnished under this Contract shall be identical.
- D. Non-vital relays and timers provided shall be available from the manufacturer. Equipment which is no longer manufactured, or equipment for which the manufacture is scheduled to be discontinued shall not be acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

Logic Relays and Heavy-Duty Interfacing Relays

- A. Non-vital logic relays and non-vital heavy interfacing relays shall be mounted in racks or metal cabinets as shown on approved plans. No more than 90 percent of the available relay space in each rack or cabinet shall be filled at the time of installation, and no more than 95 percent of the available relay space in each rack or cabinet shall be filled upon completion of all field corrections and testing.
- B. Cabinets used to mount these relays shall have transparent front plates which do not support combustion. These cabinets shall be mounted in racks as specified in Section 16971.

END OF SECTION

SECTION 16945

PLUGBOARDS AND CABINETS FOR RELAYS AND PC CARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing, installation, and wiring of various mounting devices for vital and non-vital relays and printed circuit cards.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be lifted to, the following Sections:

Section 16911	Scope of Work
Section 16912	Yard Signaling Submittal Requirements
Section 16915	Basic Yard Signal Equipment Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16942	Printed Circuit Cards
Section 16943	Vital Relays
Section 16944	Non-Vital Relays and Timers
Section 16948	Plug Connectors
Section 16949	Signal Wire and Cable
Section 16977	Tagging and Marking
Section 16978	Miscellaneous Train Control Components and Materials

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration.


1.04 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements.

PART 2 - PRODUCTS

2.01 BASIC RELAY PLUGBOARD REQUIREMENTS

- A. Plugboards for vital relays, non-vital logic relays, and non-vital heavy-duty interfacing relays shall have the following characteristics:
1. The plugboard shall be designed for vertical mounting.
 2. The plugboards shall be designed for the insertion of removable contacts attached to the external wiring.
 3. The plugboards shall be designed in such a manner that the removable contacts shall make direct contact with the relay coil leads and the relay contact springs.
 4. Arc suppression, when required, shall be built into the relay plugboards or shall be mounted on the back of the plugboards, if it is not built into the relays themselves.
 5. The back of each vital relay plugboard shall be equipped with a tag to indicate the nomenclature of the relay for which it is wired.

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6. Plugboards shall be identical for each type of plug-in relay.
 7. Plugboards for plug-in relays shall be designed for the insertion of removable contacts. The removable contacts shall be designed for connection to the wires by means of solder less connections.
- B. Plugboards for vital relays shall have the following features in addition to those specified above.
1. Vital relay plugboards shall be equipped with one voltage test post and one combination voltage-and-current test post unless otherwise specified.
 2. Vital relay plugboards for biased-neutral frequency-selection (QR) relays shall be equipped with one voltage test post and one combination voltage-and-current test post for the coil leads of each coil.
 3. Each current test post shall be so designed that ammeter leads can be attached and the test post opened to check the current without interrupting current flow to the relay coil involved.

2.03 CABINETS

- A. Cabinets used to house non-vital relays and printed circuit cards, shall be of rigid metal construction and shall be designed for mounting on standard 19-inch equipment racks.
- B. Cabinets shall be constructed of a non-corroding metal or shall be painted to the manufacturer's standard to match the finish of the equipment racks in which they are to be mounted.
- C. Each cabinet shall have a transparent front dust cover which will permit easy viewing of relay name tags and indication lights.
1. This dust cover shall be made of a shatter-proof material which will not support combustion or emit poisonous or corrosive gases, even when exposed to flame or extreme heat.
 2. The cover shall be hinged or otherwise attached for easy removal from the cabinet.
 - a. Fasteners for the front dust cover shall be of the rugged, metal, half-turn, twist-lock design.
 - b. The rear cover shall either be hinged or secured with screws or fasteners of the half-turn, twist-lock design. The screws for fastening the rear cover shall have slotted heads with knurled finger grips and captive lockwashers for ease of assembly into a captive nut on the module.
- D. Relay and printed circuit board cabinets shall be equipped with plug connectors of the type specified in Section 16948, Plug Connectors.
1. These plug connectors shall be mounted on the back panel of the cabinet.
 2. Internal wiring between these plug connectors and the relay plugboards, or the PC card connectors, shall be as specified for module wiring in Section 16949, Signal Wire and Cable.
 3. Sufficient slack shall be provided in this wiring to permit easy access to the relay plugboards and/or printed circuit card connectors mounted inside the cabinet when the cabinet back panels are open.

PART 3 - EXECUTION

3.01 INSTALLATION OF RELAY PLUGBOARDS

- A. Relay plugboards shall be factory installed and wired. A full complement of non-corroding fasteners shall be used to mount the plugboards on equipment racks or in relay cabinets.

- B. Stripping and crimping tools recommended by the manufacturer of the contacts shall be used to make all wire-to-contact connections. A minimum of one of each type of crimping tool shall be furnished.
- C. Each contact wire shall be of sufficient length to permit the contact to which it is connected to be moved to any contact position on the same relay plugboard. The wiring to each removable contact shall carry an approved tag indicating the relay contact number assigned to the wire.

3.02 INSTALLATION OF RELAY CABINETS

- A. Cabinets for non-vital relays shall either be rack mounted prior to shipment or installed on the racks in the field.
- B. Cabinets shall be marked with their identifying geometric coordinates as specified in Section 16977, Tagging and Marking.

END OF SECTION

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SECTION 16946

YARD SIGNAL TRANSFORMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of all transformers for Yard Signal power distribution and isolation purposes, and for such other purposes as may be required to accomplish the functions specified herein.

1.02 GENERAL REQUIREMENTS

- A. Transformers shall be in accordance with the recommendations of Part 14.2.10 (Transformer, Dry Type) of the AREMA Signal Manual.
- B. The Design-Builder shall furnish transformers having nameplate ratings at least 25 percent in excess of the maximum computed loads they are to supply.

1.03 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 16911	Scope of Work
Section 16912	Submittal Requirements
Section 16921	Yard Signal Power Distribution Systems
Section 16959	Series Type Track Circuit Layouts
Section 16963	Power Frequency Track Circuit Layouts
Section 16965	Signal Layouts
Section 16989	Yard Test and Inspections

1.04 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.05 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements

PART 2 - PRODUCTS

2.01 BASIC TRANSFORMER REQUIREMENTS

- A. Transformers shall not emit audible noise in excess of 50 dB (referenced to .0002 dynes per sq. cm.) at a distance of three feet while operating at rated voltage and load.
- B. Coil conductors shall be continuous with terminations brazed or welded without auxiliary flux material. The entire core and coil assembly shall be predried by heat, impregnated with varnish or other approved compound, and cured at a minimum of 350 degrees F to reduce

hotspots and seal out moisture. Coils shall be protected with an outer layer of glass tape or similar quality insulation.

- C. Yard Signal transformers furnished under this Contract shall have insulation capable of withstanding 3000 volts DC between windings or from winding to core. The insulating material shall be subject to the approval of the designated Resident Engineer.
- D. Yard Signal transformers furnished under this Contract shall be equipped with suitably insulated screw terminals, or standard AAR binding posts, for all primary and secondary lead wires.

2.02 POWER FREQUENCY TRACK TRANSFORMERS

- A. The 60-Hz track circuit transformers required to supply power to track circuits shall meet the following requirements in addition to those specified above:
 - 1. Track transformers shall have a nominal primary voltage of 120 volts,
 - 2. Shall also have primary winding taps and terminals for 110 and 115 volts.
 - 3. The secondary windings shall be provided with taps and terminals to supply voltages in one-volt increments up to a maximum of 15 volts.
 - 4. Track transformers shall be capable of carrying the track circuit load plus 25 percent, but in no case shall they be rated less than 300 VA.

2.03 SERIES TRACK CIRCUIT TRANSFORMERS

- A. Track feed transformers shall have a nominal primary voltage of 120 volts. Track feed transformers shall also have primary winding taps and terminals for 110 and 115 volts.
- B. The Secondary windings of the track feed transformers shall be provided with taps and terminals to supply voltages in one volt increments up to a maximum of three volts.
- C. The windings of the step-up transformers used for track relay pickup purposes shall be wound in the ratio of one-to-forty. No adjusting taps are required on either the input or output windings of these transformers.
- D. The track feed transformers and relay pickup transformers shall be capable of carrying the track circuit load plus 25%, but in no case shall they be rated less than 60 VA for each associated track circuit.

2.04 SIGNAL HEAD TRANSFORMERS

Signal head transformers shall meet the requirements specified in Section 16965, Signal Layouts, in addition to the Basic Transformer Requirements specified above.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Power and isolation transformers shall be rack mounted.
- B. Mounting panels or brackets shall be rigidly designed so that they do not sag under the weight of the transformer.

END OF SECTION

SECTION 16947

GROUND DETECTORS

PART 1 GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of Ground Detectors for the uninterruptible, ungrounded, 120 Vac, and the ungrounded 28 Vdc energy buses in each Train Control Room.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 16911	Scope of Work
Section 16912	Yard Signaling Submittal Requirements
Section 16922	Lightning/Surge Protection and Grounding Systems
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.05 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements

PART 2 PRODUCTS

2.01 BASIC DESIGN REQUIREMENTS

- A. The dc ground detector shall be sensitive enough to detect leakage currents from either terminal of the floating supply to ground through leakage paths having resistances throughout the range of zero to 10,000 ohms.
- B. The ac ground detector shall be sensitive enough to detect currents to ground (from either terminal of the floating supply) which would flow through an impedance of 2000 ohms.
- C. The ground detection schemes utilized shall allow the detectors to be immune to transient current flows that may be the result of charging distributed supply-to-ground capacitances.
- D. The detectors shall also be immune to induced power line ripple which may exist between the supply leads and ground.
- E. The ground detectors shall have a memory capability to provide an indication of a momentary or intermittent supply to ground leakage condition.

- F. The operation of the ground detectors shall not interfere with the operation of power, communication or Yard Signal circuits or equipment.
- G. The ground detector circuits shall meet the fail-safe design criteria with respect to open circuits. The shorting or opening of any component part of the ground detector circuits shall be detectable.
- H. The "made" ground in the ground detecting part of the circuits shall be checked to validate its presence. This check shall be continuously made in a fail-safe manner.
- I. The ground detector repeater relays shall be vital relays and shall be energized when no ground is being or has been detected.
- J. The ground detector circuits shall operate over the specified temperature range and over a voltage range of from zero volts to 10 percent above the rated voltage of the power supply with which they are associated.

2.02 OPERATION AND INDICATIONS

- A. It shall be necessary to manually reset either ground detector to its normal operating condition after a ground has been detected. The ground detector shall not remain in its normal indication position upon reset if the ground condition has not been eliminated.
- B. Each ground detector shall be equipped with two indicator lights:
 - 1. A white indicator to indicate that both buses are clear of grounds.
 - 2. A red indicator to indicate that a ground has occurred.
- C. Each ground detector shall be equipped with an electrically isolated contact to provide remote indication of a detected ground.
- D. Each ground detector shall be equipped with a three-position, center-off, momentary-contact test switch to check the operation of that detector by providing momentary leakage paths from ground to the buses being monitored. The impedance of these paths shall be
 - 1. 10,000 ohms for dc ground detectors
 - 2. 2000 ohms for ac ground detectors.

PART 3 EXECUTION

3.01 INSTALLATION

The Design-Builder shall install ground detectors in any new power racks in each TCR.

END OF SECTION

SECTION 16948

PLUG CONNECTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of multiple position plug connector assemblies required to connect multiconductor cables and/or individual wires to the internal wiring of racks, control panels or equipment modules.

1.02 DESCRIPTION

- A. These assemblies shall hold and insulate individually mated, extractable pin-and-socket contacts which shall be mechanically crimped to individual wires or wire wrap pins.
- B. The connector assemblies shall be easily connected and disconnected by hand and shall be provided with mechanical locking and keying devices.
- C. Two basic types of connectors shall be furnished; a 28 contact, vital circuit type, and a 50 contact, non-vital circuit type.

1.03 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16949	Yard Signaling Signal Wire and Cable
Section 16978	Miscellaneous Train Control Components and Materials

PART 2 - PRODUCTS

2.01 PLUG CONNECTOR ASSEMBLY

Each plug connector assembly shall consist of the following:

- A. A two-part molded plastic connector block equipped to hold an appropriate number of solderless, pin-and-socket contacts.
- B. Devices for the mechanical locking and keying of the connector block halves.
- C. Protective shells for both connector block halves.
- D. A strain relief device for the external wiring portion of the connector assembly.
- E. Solderless, extractable pin-and-socket contacts.

2.02 CONNECTOR BLOCKS

- A. The connector blocks shall consist of molded dielectric plastic shaped to accept the required number and types of contact pins, contact sockets and locking, keying and mounting devices. The dielectric material shall exhibit a minimum insulation resistance of 100 megohms as measured between adjacent pairs of contacts and between the accessory hardware and the closest contacts in each connector assembly half immediately after being exposed to 100 percent relative humidity at 120 degrees F for a period of at least 48 hours.
- B. The contact cavities shall be arranged in a rectangular grid configuration. The opening for each contact shall be uniquely identified by a coordinate molded into both the mating and wiring faces of each part of the connector block.
- C. The 28 contact, vital plug connector blocks shall provide a surface leakage distance of not less than 1/4 inch between contacts and between the contacts and any other metallic part of the connector assembly.

2.03 LOCKING AND KEYING

- A. Each plug connector assembly shall include a device for mechanically locking the two mated parts together.
- B. Mechanical devices and facilities shall also be provided to allow the mating parts of connector assemblies to be keyed in such a manner that they cannot be coupled except when in the correct position relative to each other and cannot be coupled to the mating parts of other coupler assemblies keyed in a different pattern and to no other plug connector assembly within the immediate area.

2.04 PROTECTION AND STRAIN RELIEF

- A. Each half of the plug connector block shall be protected by a metal shield which shall extend beyond the mating surface. These two shields shall overlap when the connector halves are coupled.
- B. The external wiring portion of each plug connector assembly shall be equipped with a device to grip the external wiring firmly in order to prevent strain on the plug connector contacts.

2.05 PIN AND SOCKET CONTACTS

- A. The pin and socket contacts shall be fabricated from commercial bronze or brass and plated with gold over nickel underplate. The retention springs of the pin and socket contacts shall be fabricated from stainless steel.
- B. The contacts shall be fabricated and classified in the required selection of sizes to accept wire sizes 16 through 22, AWG.

- C. Contact current rating and termination resistance shall meet the requirements of the following table with properly sized contacts applied to the wire sizes specified.

WIRE SIZE (AWG)	16	18	20	22
Minimum Current Rating (Amperes)	13.0	10.0	7.5	5.0
Maximum Termination Resistance (Milliohms) at rated current	1.7	2.0	2.7	4.0

- D. Contact termination resistance shall be measured in accordance with Method 307 of MIL-STD-202 at the rated current specified for each wire size.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The 28 way, vital plug connector assembly shall be required where any vital circuits are to be interconnected and the 50 way, non-vital plug connector assembly shall be used where no vital circuits are to be interconnected.
- B. A plug connector may be dedicated to a single 50 or 30 conductor cable or it may be shared by several cables or types of wire. When plug connectors are dedicated to single multiconductor cables, 20 percent of the wires and connector contacts shall be reserved for future working circuits.
- C. When a plug connector is assembled to a multiconductor cable, the strain relief device shall grip the cable outer sheath.
- D. When a vital plug connector is dedicated to a 30 conductor cable, all but two of the cable wires shall be terminated on connector contacts. The two extra wires shall be properly terminated and inserted into any contact cavity of the connector block. These wire ends shall be folded, taped, and stored under the strain-relief clamp for possible future service.
- E. When a non-vital plug connector is dedicated to a 50 conductor cable, each wire shall be terminated properly on a connector contact.
- F. In each case, a uniform scheme shall be followed in assigning specific cable wires to specific connector contacts.
- G. Where a full hand grasp is required to connect or disconnect a plug connector, a minimum of two inches of clear space shall be provided around the connector. A minimum of three-quarters of an inch of clear space shall be provided around connectors which can be connected or disconnected with thumb and fingertips only.
- H. Plug connectors shall be located and installed in such a manner that no part of the plug connector or its cable will extend beyond the wire routing as defined by the wire supports and in no circumstances shall the connector or its cable be permitted to protrude into an aisle.

- I. Each plug connector assembly, as finally installed, shall be marked in such a manner that its mating halves shall be distinctly identified as being related to each other, but to no other plug connector assembly within the immediate area. These identification markings shall be applied in such a manner that they will not be obscured or worn off in normal use.
- J. Tools used to apply plug connector contacts to wire and tools used to extract contacts from the plug connector blocks shall be the size and type recommended by the manufacturer of the plug connector assemblies. A minimum of one of each type of these tools, to include one of each type of tool which may be necessary for the removal and/or replacement of the jack-screws shall be furnished under Section 16978.
- K. The Design-Builder shall furnish and install a mating blank plug coupler, complete with all accessory hardware, for each rack or module plug coupler installed as "future" or "spare."

END OF SECTION

SECTION 16949

YARD SIGNAL WIRE AND CABLE

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section includes specifications for the internal and external wire and cable to be used for the Yard Signal Control and Interlocking Systems.

1.02 INTERNAL SIGNAL WIRE AND CABLE

- A. Internal wire and cable shall be used only for wiring inside train control rooms, signal equipment houses and cases.
- B. Internal wire and cable shall comply with applicable recommendations of the AREMA Signal Manual.
- C. Internal plug connected cable assemblies shall be as specified in this section and in Section 16948. Plug Connectors.

1.03 EXTERNAL SIGNAL WIRE AND CABLE

- A. This Section specifies the furnishing and installation of the three basic groups of cable required for Yard Signal system wiring external to the Train Control Rooms and signal equipment housings. The basic external cable groups are:
 - 1. Signal Cables
 - 2. Special Control and Indication Cables
 - 3. Negative Propulsion Return Cables
- B. The Design-Builder shall provide properly designed, well made, and thoroughly tested external cable for vital and non-vital signal circuit, and negative propulsion return applications, which will render long service life to the Authority.
- C. External cable furnished by the Design-Builder shall be of rugged construction and shall have insulating and jacketing materials capable of a 40 year average service life. These cables shall be suitable for use in the environment to be encountered in the WMATA Rail Rapid Transit System and shall be certified for continuous operation at 90 degrees C in wet or dry locations, whether in trays, troughs, duct bank or conduits, above or below ground, or installed directly in the ground. All external cable furnished by the Design-Builder shall be termite proof.
- D. External signal cables supplied shall meet or exceed the requirements of the current applicable standards of ICEA, NEMA, UL, ASTM, and the recommendations of Part 10.3.19 of the AREMA Signal Manual, with modifications and/or additions as detailed herein. Individual conductor insulation shall be Ethylene Propylene Rubber (EPR) as described in ICEA S-95-658.
- E. Multiconductor external signal cables permitted under this Contract shall have 2, 5, 7, 9, 12, 14, 19, 27, or 37 conductors. Multiconductor Special Control and Indication cables permitted under this Contract shall have 2, 6, 18, 25 or 50 twisted pairs.
- F. Multiconductor external signal cables containing more than two conductors shall contain 20-percent spare conductors or two spare conductors, whichever is greater. Local distribution

cable shall contain ten percent spare conductors or one spare conductor, whichever is greater, except that two conductor local distribution cables (such as track circuit leads) will not require spare conductors.

- G. The requirements of these Specifications shall apply when there is a difference between the requirements of these Specifications and other specifications referenced herein.
- H. All insulation and jacketing compounds offered on this Contract by the cable manufacturer shall be formulated, applied, and, where applicable, vulcanized by the cable manufacturer in his own facilities, except as specified herein.
- I. If the cable manufacturer does not normally compound and otherwise prepare insulating materials in its own plant, it is acceptable for the cable manufacturer to have its proprietary formulations compounded and prepared at another, non-owned facility which complies with the manufacturing and end-product quality requirements specified herein.
- J. The Design-Builder may request the option, on an individual case basis, of providing, conduit, sleeves, pipe, core-boring or other special cable installation facilities approved by the designated Authority Representative, which will either reduce the amount of cable required by providing more direct cable runs, or will provide access where no direct access was provided by others. (The Design-Builder shall inform the designated Authority Representative at least two weeks in advance, and shall obtain approval at least one week in advance, of any core-boring work.)

1.04 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16915	Basic Yard Signal Equipment Requirements
Section 16921	Yard Signal Power Distribution Systems
Section 16922	Lightning/Surge Protection and Grounding Systems
Section 16923	TC Maintenance Telephone System
Section 16948	Plug Connectors
Section 16957	Yard Control Machines
Section 16959	Series Type Track Circuit Layouts
Section 16963	Power Frequency Track Circuit Layouts
Section 16964	Mainline Track Switch and Trailable Yard Switch Operating Layouts
Section 16965	Signal Layouts
Section 16968	Track Bonding Layouts
Section 16969	Snowmelter Layouts
Section 16971	Racks and Cable Trays
Section 16973	Conduit
Section 16977	Tagging and Marking
Section 16978	Miscellaneous Train Control Components and Material
Section 16989	Yard Test and Inspections

1.05 QUALITY ASSURANCE FOR YARD SIGNAL WIRE AND CABLE

- A. All wire and cable manufacturers supplying wire and cable for this Contract must be approved by the designated Authority Representative. The Design-Builder shall provide all of the data necessary for the demonstrations and tests required by the designated Authority Representative. Approval will be based on the following criteria:
 - 1. Past Performance and Experience
The cable manufacturer must have had at least ten years of successful experience

in supplying wire and cable to the railway/rapid transit industry for use as vital circuit signal control cable. A certified list of such installations spanning the past ten years shall be provided by each cable manufacturer desiring to be considered.

2. Quality Assurance Program:

- a. The manufacture of wire and cables shall comply with the requirements of Specification Section 00722, Quality Control/Quality Assurance and shall incorporate a Quality Assurance Program which meets the intent of the ASQC Standard C1-1985 corrected 1987, General Requirements for a Quality Program. Such compliance shall promote the production of properly designed, well made, and thoroughly tested cable which will render long service life to the user. Efficient methods of production, test, and product evaluation shall be used, but prime concern shall be focused on the necessary formal quality requirements to ensure that wire and cable failure cannot be attributed to actions or lack of actions by the manufacturer.
- b. The manufacturers of wire and cable, and, where applicable, the cable insulation and/or jacket insulation material manufacturer(s), must have had a printed Quality Assurance Program, applicable to the type(s) of cable or insulation to be provided under this Contract, continuously in effect for at least seven years.
- c. If the cable manufacturer has its proprietary cable insulation material formulations compounded and prepared at another, non-owned facility, this facility shall be subject to the same Quality Assurance Program procedures, systems, and requirements that have been approved for the cable manufacturer's use in its own facilities, and shall be subject to audit by the Authority.

3. Technical Data

- a. Each manufacturer of wire and cable shall provide full technical data which demonstrates his (and, where applicable, the cable insulation manufacturer's) compliance with the requirements of these Specifications for each specified cable type to be provided.
- b. Each manufacturer of wire and cable shall provide sample pre-printed data sheets which include:
 - (1) a Certified Test Report;
 - (2) an Inspection Sheet for Wire and Cable;
 - (3) a Physical Test Report, and;
 - (4) a Quality Assurance Traceability Schematic.

4. Qualification Tests

- a. Each manufacturer of wire and cable (and, where applicable, the insulation and/or jacket insulation material manufacturer) shall conduct the required qualification or prototype testing which demonstrates compliance with the requirements of these Specifications for each specified cable type.
- b. The Authority reserves the right to witness any or all of the qualification tests and shall be notified two weeks in advance of the testing.

B. After Selection

Each finished wire and cable shall be traceable to the test data on file for each step in its manufacturing process. The tests which must be conducted during manufacture of the wire and cable shall include the following:

1. Physical and mechanical properties for each batch of insulating material, and, where used, for each batch of conductor jacketing material.
2. Physical and mechanical properties for each batch of external cable outer sheath material.
3. Electrical properties for one reel of finished conductor fabricated from each batch or combination of batches of insulating and jacketing material.
4. Electrical properties for one reel of finished external cable from each batch of cable outer sheath material.

5. Specified Flame Test for each conductor size for each batch or combination of batches of insulating and jacketing material.
 6. Specified Flame Test for each conductor size for each batch of cable outer sheath material.
 7. Specified Smoke Density Test for each batch or combination of batches of insulating and jacketing material.
 8. Individual insulated conductors used in external cables, prior to cabling, shall be either AC or DC water tank tested after a minimum immersion time of six hours. For these tests, which shall be conducted per ICEA S-95-658, Section 6.10.1, test voltages shall be applied for a period of five minutes. While still immersed, the insulated conductors shall be subjected to the applicable test voltages as follows:
 - a. Minimum AC Test Voltage = 120 volts per mil of insulation thickness
 - b. Minimum DC Test Voltage = 375 volts per mil of insulation thickness
 9. Voltage tests required for each reel of finished wire or cable after application to the shipping reel shall be either the AC Voltage test or the DC Voltage test. For these tests, which shall be conducted per ICEA S-68-516, Section 6.10.1, test voltages shall be applied for a period of five minutes. The appropriate minimum test voltages shall be as follows:
 - a. Minimum AC Test Voltage = 120 volts per mil of insulation thickness
 - b. Minimum DC Test Voltage = 375 volts per mil of insulation thickness
- C. The Authority reserves the right to witness any or all of the above tests and shall be notified two weeks in advance of each of the above tests.
- D. The Design-Builder shall prepare and certify a report for each of the above tests, to include all pertinent facts concerning the conditions and results of that test, plus the backup information required.

1.06 SUBMITTALS FOR INTERNAL SIGNAL WIRE AND CABLE:

- A. Complete technical data describing the internal wire and cable which the Design-Builder proposes to furnish in compliance with the requirements of this specification section.
- B. Certified test reports of all breakdown tests conducted on finished internal wire and cable as specified.
- C. Certified test reports of all flame tests conducted on finished internal wire and cable as specified.

1.07 SUBMITTALS FOR EXTERNAL WIRE AND CABLE:

- A. The Design-Builder shall submit two certified copies of the following to the designated Authority Representative for approval:
 1. A certified list of each cable manufacturer's railway/rapid transit signal installations for the past ten years.
 2. Each cable manufacturer's (and, where applicable, each insulation and/or jacket material manufacturer's) Quality Assurance Program.
 3. Full technical data for each type of cable which each cable manufacturer intends to supply.
 4. Test procedures for cable and cable insulating material.
 5. Test reports of cable tests conducted in the field in accordance with approved testing procedures.
- B. Information to be supplied by certified cable test reports for external cable shall include, but not be limited to, the following:
 1. Report number
 2. Date and location of test

3. Description of test and test conditions
 4. Complete cable or wire description
 5. Lot, batch, and/or reel identification number
 6. Quantitative test results
 7. Summary of the test results
 8. Information on the components of the cable tested to include batch numbers and physical and electrical properties.
 9. Traceability data.
- C. Submit detailed drawings showing the method and materials he intends to use to support cables in manholes and pull chambers
- D. Submit to the designated Authority Representative a program for maintaining and assuring the mechanical and electrical integrity of cable during cable pulls into pipe or conduit, as recommended by the cable manufacturer.
- E. Submit the manufacturer's recommended pulling tension for each type of cable to be used, for both cable grip and core hitch methods. The formula(s) for determining multi-cable pull calculations shall also be included. This information shall be submitted prior to any cable pull.
- F. Two copies of a "Pull Sheet" for each planned cable pull shall be submitted by the Design-Builder to the designated Authority Representative at least one week prior to each actual cable pull. This "Pull Sheet" shall include the following information:
1. Date of proposed pull
 2. Cable nomenclature(s)
 3. Cable type(s)
 4. Cable routing
 5. Recommended pulling method
 6. Maximum recommended tension (as determined by the type of cable and pulling method, or, for multi-cable pulls, by calculation using the applicable formula(s).
 7. Room for recording the date of the actual pull, the maximum pull tension experienced during the pull, and any other pertinent information concerning the pull.
- G. Approved Pull Sheets will be returned to the Design-Builder prior to the proposed pull. The Design-Builder shall record the date of the actual pull, the actual method used, the maximum tension experienced during the pull, and other pertinent information, and resubmit the Pull Sheet(s) to the designated Authority Representative.

1.07 DELIVERY, STORAGE AND HANDLING FOR YARD SIGNAL WIRE AND CABLE

- A. Shipping, storage and handling of wire and cable shall be in accordance with the recommendations contained in Part 10.4.1 of the AREMA Signal Manual, the applicable cable manufacturer's recommendations, and as further specified herein.
- B. Cables shall be reeled in such a manner that both ends are accessible for testing on the reel.
- C. Mark each single-conductor cable and each multiple-conductor cable to show UL label, size, voltage, manufacturer and number of conductors in accordance with NEC requirements.
- D. Store the cables in a dry and secure facility.
- E. During storage and handling prior to final conductor termination, cable ends shall be sealed to prevent the entrance of moisture.

PART 2 - PRODUCTS

2.01 INTERNAL WIRE AND CABLES

A. Internal Wire Conductors shall meet the requirements specified below:

1. Conductors:

a. Stranded Conductors:

- 1) Conductors shall be soft or annealed copper wire for electrical purposes, per the latest revision of ASTM B-33 and B-3.
- 2) Strands and rope members shall be concentrically stranded using unilay (UNI), concentric (CON), and bunch (BUN) construction as specified in table below:

Conductor Size (AWG)	Stranding (NO/Size)	Strand Type	Conductor Nominal Diameter		Nominal DC Resistance @ 20 Degrees C	
			(mils)	(mm)	(Ohms/1000ft)	(Ohms/km)
24	19/36	UNI	23.6	.599	25.7	84.3
22	19/34	UNI	29.6	.752	15.8	51.8
22	7/30	CON	30.9	.785	16.9	55.4
20	19/32	UNI	37.8	.960	9.63	31.6
18	19/30	UNI	46.7	1.19	6.15	20.2
16	19/29	UNI	53	1.35	4.77	15.6
14	19/27	UNI	66.2	1.68	3.04	9.97
14.	37/30	CON*	71	1.803	3.05	10.0
12	37/28	CON*	87.2	2.19	2.02	6.63
10	37/26	CON*	110	2.8	1.26	4.13
9	37/019	CON*	129	3.27	.83	2.72
9	19x7/.010	UNI/ROPE	148	3.76	.88	2.89
8	19x7/29+	UNI/ROPE	162	4.11	.682	2.24
6	19x7/27+	UNI/ROPE	203	5.16	.433	1.42
4	19x7/25+	UNI/ROPE	257	6.53	.268	.879
2	19x35/30	CON/ROPE	331	8.41	.173	.568
1	19x43/30	CON/ROPE	360	9.15	.146	.479
1/0	19x55/30	CON/ROPE	418	10.6	.111	.364
2/0	19x70/30	CON/ROPE	464	11.8	.0872	.286
3/0	37x43/30	CON/ROPE	531	13.5	.0696	.228
4/0	37x57/30	CON/ROPE	598	15.2	.055	.180
500kcmil	7x19x38/30	BUN/ROPE	988	25.095	.022	.072

* Double Pass Concentric

b. Solid Conductors:

- 1) Conductors shall be soft or annealed copper wire for electrical purposes, per the latest revision of ASTM B-33 and B-3.
- 2) Solid conductors for wire wrap:

Conductor Size (AWG)	Conductor Nominal Diameter		Nominal DC Resistance @ 20degreesC	
	(Mils)	(mm)	(Ohms/1000 ft)	(Ohms/km)
30	10.3	.262	114	374
28	13	.330	70.5	231
26	16.4	.417	44.7	147
24	20.7	.526	27.8	91.2
22	26.1	.655	17.1	56.1
20	32.9	.836	10.5	34.4

4. Insulation for stranded and solid wires:

- a. The insulation material for stranded and solid conductor wires shall be modified ethylene tetrafluoroethylene (ETFE) per ASTM D3159-a, unless otherwise specified.
- 1) All insulation for AWG 12 through AWG 24 shall be Tefzel 200 or equivalent. Tefzel HT-2127 or equivalent may be substituted for Tefzel 200 for enhanced flexibility.
 - 2) All insulation for AWG 10 through 500 kcmil shall be Tefzel 280 or equivalent.
 - 3) All insulation for the solid conductor wire wrap wire shall be Tefzel 750 or equivalent per UL Subject 758, Style 10125 and will include wire sizes AWG 26-30.
- b. Wire Construction: The finished wire diameters, weights, and ampacity ratings:

Stranded Wires Rated 0-600V

Conductor Size (AWG)	Nominal Insulation Thickness		Nominal Wire OD		Nominal Weight		Ampacity
	(mils)	(mm)	(mils)	(mm)	(lbs/M ft)	Kg/Km	
24	15	.381	53.6	1.361	2.8	4.17	1.5
22	15	.381	59.6	1.514	3.9	5.81	4.0
22 (7/30)	15	.381	59.8	1.514	3.9	5.81	4.0
20	15	.381	67.8	1.722	5.6	8.34	6.5
18	15	.381	76.7	1.948	7.9	11.32	19.0
16	15	.381	83	2.108	9.7	14.45	24.0
14 (UNI)	15	.381	96.2	2.443	14.6	21.75	34.0
14 (CON)	15	.381	101.0	2.565	15.3	22.8	34.0
12	15	.381	117.2	2.974	21.7	32.33	43.0
10	17	.432	144.0	3.658	33.7	50.21	55.0
9 (37/.019)	17	.432	163.0	4.14	47.1	70.18	-
9 (19x7/.01)	17	.432	182.0	4.623	47.5	70.78	-
8	17	.432	196.0	4.978	59.3	88.36	76.0
6	20	.508	243.0	6.172	93.4	139.66	96.0
4	24	.610	305.0	7.747	146.0	217.54	143.0
2	26	.660	383.0	9.728	226.0	336.74	160.0
1	28	.711	416.0	10.566	271.0	403.79	186.0
1/0	30	.762	478.0	12.141	358.0	533.42	215.0
2/0	39	.991	542.0	13.767	457.0	680.93	251.0
3/0	50	1.27	631.0	16.027	598.0	891.01	288.0
4/0	50	1.27	698.0	17.729	737.0	1098.12	332.0
500 kcmil	50	1.27	1088.0	27.635	1770.0	2637.28	580.0

Solid Conductor Wire Wrap Rated 0-300V

Conductor Size (AWG)	Nominal Insulation Thickness		Nominal Wire OD		Nominal Weight		Ampacity *
	(mils)	(mm)	(mils)	(mm)	(lbs/M ft)	Kg/Km	
30	6	.152	22.3	.566	.54	.80	-
28	6	.152	25.0	.635	.76	1.13	-
26	6	.152	28.4	.721	1.1	2.09	-
24	6	.152	32.7	.831	1.6	2.38	-
22	6	.152	37.8	.960	2.4	3.58	-
20	6	.152	44.9	1.141	3.7	5.51	-

* Ampacity rating not available for these low amperage circuits.

c. Insulation Thickness shall not be less than 90% per NEMA HP-100-1991, Section 3.2. for Stranded and Solid Wires:

d. Wire Performance Requirements:

1) The insulation shall be applied directly to the surface of the specified conductors and shall adhere tightly to the surface, but shall be free stripping and shall leave the conductor clean.

2) The following tests shall be performed for each production run.

a) Impulse dielectric or direct current spark test 100% of the wire per the following requirements:

	Impulse Dielectric Test Voltage KVAC (Peak)	DC Spark Test Voltage KVDC
Wire rated 0-150V	1.5	3.0
Wire rated 0-300V	5.0	7.0
Wire rated 0-600V	6.5	12.0
Wire rated 0-1000V	8.0	16.0
Wire rated 0-2000V	10.0	20.0

3) The insulation must meet the aging requirements, heat distortion, insulation resistance, and dielectric constant (SIC) requirements of NEMA HP100.2-1991, Table 2-1 and the additional tests specified herein.

e. Color Coding of Wires:

1) Internal wires shall be color coded in accordance with the approved wire manufacturer's standard practice or as described below:

a) Cables of unpaired wires shall be solid color in the color sequence as shown below. The second color is achieved by using a stripe that is clearly identifiable and permanent.

b) Table - Color Code of Individual Wires of Multi-conductor Cables.

1.	Black	26.	Black/Violet
2.	Brown	27.	Black/Gray
3.	Red	28.	Black/White
4.	Orange	29.	Brown/Black
5.	Yellow	30.	Brown/Red
6.	Green	31.	Brown/Orange
7.	Blue	32.	Brown/Yellow
8.	Violet	33.	Brown/Green
9.	Gray	34.	Brown/Blue
10.	White	35.	Brown/Violet
11.	White/Black	36.	Brown/Gray
12.	White/Brown	37.	Brown/White
13.	White/Red	38.	Red/Black
14.	White/Orange	39.	Red/Brown
15.	White/Yellow	40.	Red/Orange
16.	White/Green	41.	Red/Yellow
17.	White/Blue	42.	Red/Green
18.	White/Violet	43.	Red/Blue
19.	White/Gray	44.	Red/Violet
20.	Black/Brown	45.	Red/Gray
21.	Black/Red	46.	Red/White
22.	Black/Orange	47.	Orange/Black
23.	Black/Yellow	48.	Orange/Brown
24.	Black/Green	49.	Orange/Red
25.	Black/Blue	50.	Orange/Yellow

c) In paired cables, one wire of each pair shall be white and the other wire shall be coded in accordance with the sequence of the first 21 wires given in table above, omitting the solid white. This color sequence shall be repeated as required to provide identification of all pairs.

5. Jacket:

a. Jacket of extruded black low density; high molecular weight polyethylene material shall be provided for:

- 1) Single conductor cables.
- 2) Outer jacket of multiple conductor cables.

b. Average jacket thickness on single conductor cables shall be 15 mils minimum.

c. Average jacket thickness for outer or overall jacket on multiple conductor cables shall be 45 mils minimum.

d. Minimum jacket thickness at any point shall not be less than 80 percent of that specified.

2.02 INDIVIDUAL EXTERNAL WIRE CONDUCTORS

A. General Requirements

1. All conductors of external wire and cable, including the individual conductors of multi-conductor signal cables, shall be rated for continuous operation at 90 degrees C in wet or dry locations, whether in trays, troughs or conduits above or below ground, exposed runs, or direct buried. The rated life shall be 40 years.
2. The insulation of external signal cables shall be either Grade E-1 or E-2 ethylene propylene rubber per ICEA S-95-658. Individual conductors shall be insulated with either Type I EPR insulation per Part 2.02.C.1., or Type II EPR Insulation per Part 2.02.D. of this Section. All single conductor external signal cable shall have a jacket which meets the requirements of Part 2.02.D. of this Section.
3. The insulation of negative propulsion return cables shall be Type II ethylene propylene rubber. Negative propulsion return cable shall have a jacket which meets the requirements of Part 2.02.E.2. of this Section.
4. The insulation or insulation system of external wire and cable shall fit tightly to the conductor and shall be free-stripping. Insulation or insulation system thickness shall be in accordance with the following table:

Conductor Size (AWG)	Average Wall Thickness (mils)* (as determined by ICEA S-95-658 Section 6.2)
0 to 600V Service	
16 to 8	78
7 to 2	94
1 TO 1000	109
601 to 2500V Service	
14 to 000 AWG	156
225 to 1000 KCMIL	190

* The minimum wall thickness shall be not less than 90 percent of the average wall thickness.

B. Conductor Requirements

1. Signal Conductors:
 - a. Material - soft annealed copper ASTM B-33
 - b. Construction - stranded ASTM B-8
 - c. Coating - continuous tin alloy
(for vital signal cable only) ASTM B-33
 - d. Resistance - ICEA S-95-658
(NEMA WC 70)
Section 2.3
 - e. Stranding:
 - (1) smaller than 14 AWG ASTM B-8 Cl. B
 - (2) 14 AWG to 00 AWG ASTM B-8 Cl. C
2. Negative Propulsion Return Conductors:
 - a. Material - soft annealed copper ASTM B-33
 - b. Construction - stranded ASTM B-8
 - c. Resistance - ICEA S-95-658
(NEMA WC 70)
Section 2.3

- d. Stranding:
 - (1) Extra-flexible, 1000 KCMIL cable, Class G stranded (427 Strands)
 - (2) Standard 1000 KCMIL cable, Class D stranded (127 Strands)
 - (3) 500 KCMIL Ropelay
- C. Type I Insulation & Insulation System Requirements
1. Primary insulation:
 - a. Material - rubber-like, vulcanized during construction ICEA S-95-658 (NEMA WC 70)
 - b. Chlorine content, maximum % by weight Zero
 - c. Physical properties, original:
 - (1) Tensile strength, minimum psi 1000
 - (2) Elongation at rupture, minimum % 250
 - (3) Tensile stress, minimum psi at 200% elongation 600
 - d. Physical properties after aging: (air oven, at 121 degrees C)
 - (1) Tensile strength, minimum % of original 80
 - (2) Elongation at rupture, minimum % of original 75
 - e. Mechanical water absorption:
 - maximum (mg/sq. in.) after 7 days immersion at 70 degrees C 8
 2. Jacket:
 - a. Material - rubber-like, vulcanized during construction ICEA S-95-658 (NEMA WC 70)
 - b. Chlorine content, maximum % by weight 20
 - c. Physical properties, original:
 - (1) Tensile strength, minimum psi 1800
 - (2) Elongation at rupture, minimum % 300
 - (3) Tensile Stress, minimum psi at 200% elongation 800
 - d. Physical properties after aging: (air oven, at 121 degrees C)
 - (1) Tensile strength, minimum % of original 85
 - (2) Elongation at rupture, minimum % of original 45
 - e. Oil immersion, 18 hours, 121 degrees C, ASTM No. 2 oil:
 - (1) Tensile strength, minimum % of original 70
 - (2) Elongation at rupture minimum % of original 70
 - f. Mechanical water absorption;
 - maximum (mg/sq. in.) after 7 days immersion at 70 degrees C 20
 - g. Oxygen index min. (ASTM D2863) 30
 - h. Smoke Density Rating, as per ASTM E662-83 using a 100 mil slab thickness:
 - (1) Flaming Mode,
 - (a) 4 minute 325 (max.)
 - (b) 20 minute peak 400 (max.)
 - (2) Non-Flaming Mode
 - (a) 4 minute 325 (max.)
 - (b) 20 minute peak 480 (max.)
 3. Primary Insulation and Jacket Combined:
 - a. Flame Resistance, as per ICEA S-95-658, Section 6.8.3 Pass
 - b. Cold Bend, -35 degrees C, for 3 hours, Mandrel diameter = 10 x O.D. No cracks
 - c. Insulation resistance constant (K)
 - minimum at 15.6 degrees C 10,000
 - d. Surface resistivity, minimum (megohms) 200,000
 - e. Electrical stability in water, as per ICEA S-95-658 (NEMA WC 70) Section 9.12

- f. Dielectric constant, SIC:
 - (1) Maximum after 24 hours immersion 3.5 SIC
 - (2) Maximum increase between 1 and 14 days 2.0%
 - (3) Maximum increase between 7 and 14 days 1.5%
 - (4) Maximum Dielectric constant, SIC between 1 and 90 days (with no failure) 3.6 SIC

D. Type II Insulation Requirements

- 1. Material - rubber-like, vulcanized during construction ICEA S-95-658 (NEMA WC 70)
- 2. Chlorine content, maximum % by weight Zero
- 3. Physical properties, original:
 - a. Tensile strength, minimum psi 1500
 - b. Elongation at rupture, minimum % of original 250
 - c. Tensile Stress, minimum psi at 200% elongation 800
- 4. Physical properties after aging:
 - a. 168 hours oxygen pressure, 80 degrees C, 300 psi:
 - (1) Tensile strength, minimum % of original 85
 - (2) Elongation at rupture, minimum % of original 75
 - b. Air pressure heat, 20 hours, 128 degrees C, 80 psi:
 - (1) Tensile strength, minimum % of original 75
 - (2) Elongation at rupture, minimum % of original 50
- 5. Oil immersion, 18 hours, 121 degrees C, ASTM No. 2 oil:
 - a. Tensile strength, minimum % of original 50
 - b. Elongation at rupture, minimum % of original 50
- 6. Mechanical water absorption, maximum (mg/sq. in.) after 7 days immersion at 70 degrees C 15
- 7. Flame Resistance, as per ICEA S-95-658, Section 6.19.6 Pass
- 8. Smoke Density Rating, as per ASTM E-662-83, using a 100 mil slab thickness:
 - a. Flaming Mode,
 - (1) 4 minute 325 (max.)
 - (2) 20 minute peak 400 (max.)
 - b. Non-Flaming Mode,
 - (1) 4 minute 325 (max.)
 - (2) 20 minute peak 480 (max.)
- 9. Cold Bend, -35 degrees C, for 3 hours
Mandrel diameter = 10 x O.D. No cracks
- 10. Insulation resistance constant (K)
Minimum at 15.6 degrees C 25,000
- 11. Surface resistivity, minimum (megohms) 200,000
- 12. Electrical stability in water, as per ICEA S-95-658 (NEMA WC 70) Section 9.12:
- 13. Dielectric constant, SIC:
 - a. Maximum after 24 hours immersion 3.5 SIC
 - b. Maximum increase between 1 and 14 days 2.0%
 - c. Maximum increase between 7 and 14 days 1.5%
 - d. Maximum Dielectric constant, between 1 and 90 days (with no failure) 3.6 SIC

E. Requirements for Negative Propulsion Return Cables

- 1. Insulation:
Ethylene-propylene rubber, ICEA Type E-2, 90°C, suitable for dry and wet locations.
- 2. Jacket:
 - a. Overall nonmetallic jacket of chloro-sulfonated polyethylene, or cross-linked polyolefin.

- b. Cross-linked polyolefin jacket shall comply with the following physical requirements. Properties tested in accordance with Part 6 of ICEA S-95-658 (NEMA WC 70) where ethylene-propylene-rubber (EPR) insulation is used. Jacket material shall be free of PVC and PVC-based compounds.
 - (1) Physical Properties, original:(ASTM D-412)
 - (a) Tensile strength, minimum pounds/square inch:1800
 - (b) Elongation at rupture, minimum percent: 150
 - (2) Physical Properties after aging 168 hours, (ASTM D-573) air oven test at 100 degrees C, +/-1 degree C:
 - (a) Tensile strength, minimum percentage of unaged value: 100
 - (b) Elongation at rupture, minimum percentage of unaged value: 80
 - (3) Oil immersion: 18 hours at 121 degrees C, (ASTM D-471) +/-1 degree C, Table 1, No. 2 oil:
 - (a) Tensile strength, minimum percentage of unaged value: 80
 - (b) Elongation at rupture, minimum percentage of unaged value 80
 - c. Jacket materials other than cross-linked polyolefin shall comply with ICEA S-95-658 (NEMA WC 70). Jacket material shall be free of PVC and PVC-based compounds.
- 3. Additional Requirements:
 - a. Insulation Power Factor: 2 % maximum.
 - b. Bond jacket to insulation to prevent moisture pockets.
 - c. Minimum peel strength of the jacket from insulation:4 lbs/inch width.
 - d. UL labeling: Type RHW-2.
 - 4. Negative propulsion return cable shall demonstrate flame retardancy in accordance with vertical tray flame test, UL44.
 - 5. Negative Propulsion Return Cables shall pass applied ac voltage dielectric strength test, i.e., six-hour water-immersion test, in accordance with Section 6.10.1 of ICEA S-95-658.

2.03 MULTICONDUCTOR SIGNAL CABLE

- A. General
 - 1. Where used in this Section, the term "multiconductor signal cable" shall be interpreted as meaning any multiconductor cable applied in circuits, either vital or non-vital, the function of which has a direct effect upon the operation of trains or the ability of the system or subsystems to implement control upon the trains.
 - 2. All multiconductor external signal cable shall be assembled from conductors which meet the requirements of Part 2.02, Individual External Wire Conductors.
- B. External Cable Assembly
 - 1. External Cable Assembly shall be per ICEA S-95-658 (NEMA WC70), Part 5.
 - 2. Multiconductor external cable shall be made by assembling individual or twisted pairs of insulated conductors into a tight cylindrical form. Individual or twisted pairs in a cable having more than two wires shall be assembled helically and with adjacent layers wound in opposite directions.
 - 3. Twisted pairs shall consist of two individually insulated conductors cabled with a length of lay as short as good construction will permit, but not longer than ten inches. Where more than one twisted pair is included, the length of lay of adjacent pairs shall differ by at least one-half inch.
 - 4. Twisted pairs shall not be provided in combination with individual wires in the same cable.
 - 5. Interstices shall be filled with moisture-resistant fillers.

6. A marker tape printed with sequential footages at one foot intervals shall be placed with the core. In addition to the footages this marker tape shall display, at intervals of no more than 30 inches, the name of the cable manufacturer and the year in which the cable was manufactured. The complete core assembly shall be wrapped with flame-retardant core tape, or tapes, with a 12.5-percent minimum lap. As an option, the core assembly shall be encased in an extruded, flame-retardant, moisture resistant, elastomeric cushion layer of the following thickness:

Core Diameter (inches)	Thickness (mils)
0 - 1.5	47
1.501 & larger	62

7. When an extruded rubber cushion layer is used, a pull cord shall be included beneath the cushion layer to provide for efficient stripping of this layer. This cord shall be compatible with all other components of the cable.
8. The taped cable core shall be covered with suitable bedding tape(s) when flat metal armor tape is used or with an inner jacket when corrugated metal armor tape is used.
9. Multiconductor external cables of 8 or more conductors shall have a 0.005-inch thick bronze (or an 0.008-inch thick zinc) corrugated or flat tape armor which shall be helically applied and overlapped approximately 12 percent. An overall separator tape shall be applied over the armor tape to protect the armor from attack by the overall jacket material.
10. The core, with or without armor, shall be covered with an outer jacket having a nominal thickness in accordance with ICEA S-95-658, Table 4-4. The inner jacket, when corrugated tape armor is used, shall be of sufficient thickness and so formulated to completely fill the voids on the underside of the corrugated metal tape. Cable jacketing material shall conform to the cable jacket specification contained herein.

C. Cable Identification and Conductor Markings

1. In addition to the internal sequential marker tape, the cables shall have the following information imprinted on the surface of the outer jacket at intervals of not more than three feet:
 - a. Manufacturer's name
 - b. Number of conductors
 - c. Size of conductors
 - d. Voltage rating
2. Individual conductors of multiconductor signal cables shall be imprinted at intervals of not more than six inches with the conductor identification. The identification shall be in the form of a number printed in both numeral form and English.
3. The cable and conductor markings shall be of a color which contrasts with the material on which it is imprinted and shall be of sufficient size to be easily recognized. The markings shall be permanent.

D. Cable Jacket Specification

1. Material - rubber-like, vulcanized during construction: ICEA S-95-658
(NEMA WC 70)
2. Chlorine content, maximum % by weight 15
3. Physical properties, original:
 - a. Tensile strength, minimum psi 1800
 - b. Elongation at rupture, minimum % 300
 - c. Tensile stress, minimum psi at 200% elongation 800

4. Physical properties after aging 168 hours, 121 degrees C, air oven;
 - a. Tensile strength, minimum % of original 85
 - b. Elongation at rupture, minimum % of original 45
5. Oil immersion, 18 hours, 121 degrees C, ASTM No. 2 oil:
 - a. Tensile strength, minimum % of original 70
 - b. Elongation at rupture, minimum % of original 70
6. Mechanical water absorption,

maximum (mg/sq. in.) after 7
days immersion at 70 degrees C 20
7. Oxygen Index, minimum (ASTM D2863) 30
8. Smoke density rating, as per ASTM E662-83, using a 100 mil slab thickness:
 - a. Flaming Mode,

(1) 4 minute	325 (max.)
(2) 20 minute peak	400 (max.)
 - b. Non-Flaming Mode,

(1) 4 minute	325 (max.)
(2) 20 minute peak	480 (max.)
9. Cold bend, -35 degrees C, for 3 hours

Mandrel diameter = 10 x O.D. No cracks
10. Surface resistivity, minimum (megohms) 200,000

E. Finished Cables

1. Finished cables having 7 or fewer conductors shall be capable of passing the IEEE Vertical Tray Flame Propagation Test, IEEE Standard 383-1974, or the UL-44 Vertical Tray Flame Test. The test sample shall have 7 or fewer conductors.
2. Finished cables having 8 or more conductors shall be capable of passing the following horizontal flame test. The test sample shall have 8 or more conductors.
 - a. Support a four-foot length of the multi-conductor cable specimen horizontally over a ribbon gas burner. The cable shall be supported parallel to the burner length in a manner which will maintain a spacing of 3/4 inch to two inches between the burner and the cable throughout the test.
 - b. The cable specimen shall be connected to a 3-wire, 120-240 volt circuit such that conductor-to-conductor and conductor-to-metal-armor-tape shorts will be indicated.
 - c. The flame temperature shall be monitored by a thermocouple and the flame temperature output regulated at 1400-1500 degrees F. The thermocouple shall be located in the flame close to, but not touching, the surface of the cable.
 - d. Readings of the thermocouple output shall be recorded each minute during the test.
 - e. The cable will be acceptable if no shorts are detected within six minutes after the flame is ignited.

2.04 SPECIAL CONTROL AND INDICATION CABLE

- F. Multiconductor cable applied in non-vital signal circuits, i.e., signal circuits the functions of which do not control or affect the ability to control operation of trains, shall conform to the following requirements:**
1. Minimum conductor size 19 AWG
 2. Chlorine content of insulation, maximum percent by weight 22
 3. Inner jacket PE or PVC
 4. Metal tape armor, helically applied, bronze or zinc:
 - a. Minimum thickness

(1) Bronze:	5 mils
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	(2)	Zinc:	8 mils
	b.	Minimum overlap	12%
5.		Outer jacket	PVC or XLPVC
6.		Chlorine content of jacketing materials, maximum percent by weight	22

- G. Finished cables shall be capable of passing the IEEE Vertical Tray Flame Propagation Test set forth in IEEE Standard 383-1974, or the Vertical Tray Flame Test in UL 44. In all other respects, cable shall conform to ICEA Pub. No. S73-532 for 600 volt rated cable.

PART 3 - EXECUTION

3.01 CONDUCTOR SIZING

- A. All conductors shall be sized per the National Electrical Code, but shall not be smaller than the minimum conductor sizes specified herein.
- B. Conductors shall be sized in such a manner that voltage drop at the farthest load does not exceed 3 percent during peak load conditions.

3.02 INSTALLATION OF INTERNAL WIRE AND CABLE

- A. Wires and cables shall be installed in a neat, workmanlike manner. Cables in trays or in troughs shall be laid therein and pulled into same. Cables shall be installed with a minimum amount of cross-over in the trays and troughs and shall not be pulled tightly around bends. All exposed wires and cables entering or leaving equipment racks or housings shall be protected from abrasion.
- B. Nylon straps shall be provided and installed for bundling and cabling of conductors where two or more single conductors of the same circuit are exposed in cable trays or cable troughs. Straps shall be installed approximately every five feet along the cable run. Wires of multiconductor cables exposed by the stripping of the cable jacket for terminations shall be trained in a neat, workmanlike manner and tied approximately every three inches with nylon straps.
- C. There shall be no point-to-point redundancy of wires for increased current capacity.
- D. Single conductor No. 14 wire shall be used for interconnecting switch machines and junction boxes, signal junction boxes and lamp compartments, and interconnecting other miscellaneous internal equipment.
- E. The smallest size wire the Design-Builder shall use for power cross termination and power wiring shall be No. 14 AWG. If No. 14 does not satisfy the load current requirements, the wire shall be increased in size according to the load requirements.

3.03 MODULE WIRING

All module wiring shall be accomplished with solderless or solder connections or stranded wire with crimped connections. Minimum wire size shall be No. 22 AWG.

3.04 RACK WIRING

- A. Rack wiring shall be accomplished with solderless connections. Wire used for rack wiring shall be stranded wire, minimum size No. 20 AWG, or multiconductor cables as specified. Where wires of a multiconductor cable are used for intra-rack wiring, any unused conductors shall be folded back and taped.

- B. Rack wiring shall be neatly tied into compact bundles. The main bundles and branches shall be secured to the racks in a manner which shall preclude physical damage due to pressure or abrasion, and prevent the wire weight from being supported by the wire terminations, connections, or plug connectors. The arrangement of the wire bundles and cables shall be such that they do not interfere with visual inspection, troubleshooting, or repair of the rack mounted equipment.

3.05 RACK-TO-RACK WIRING

- A. Rack-to-rack wiring shall be accomplished with solderless connections using multiconductor cables as specified, or single conductors tied into bundles to form unjacketed multiconductor cables.
- B. Unjacketed multiconductor cables shall consist of individual conductors of size 14 AWG or larger wire and shall have a maximum tie spacing of six inches.
- C. All rack-to-rack wiring shall be routed via the overhead cable trays, with one foot of slack between the cable tray and each rack to which the cable is connected.
- D. Cables shall not be pulled into the cable trays, but shall be laid loosely and neatly in the trays with a minimum of crosses.
- E. Cable connections to all racks except the entrance racks shall be via plug connections. Cable connections to the entrance racks may be made in the same manner as field wiring.

3.06 HIGH VOLTAGE WIRING

Internal wire used in circuits directly connected to the rails and internal wire used in circuits which operate at voltages in excess of 600 volts shall meet the requirements of this Section for 601 to 2500 volt service.

3.07 EXTERNAL CABLE APPLICATION

- A. The Design-Builder shall be responsible for the sizing of all conductors greater than the minimum size specified, due to the application of his design or due to voltage losses caused by long cable runs. Where special cable configurations and/or conductor sizes larger than the minimum sizes specified herein are necessary to meet the specified operating conditions of the system, the Design-Builder shall provide same at no additional cost to the Authority. Increases in required conductor size shall be in accordance with the National Electrical Code.
- B. If the Design-Builder's additions to the Yard Signal Control and Interlocking System requires the use of shielded cable, the Design-Builder shall provide the required shielded cables, and all additional related terminating required to provide single-point grounding of the shield at no additional cost to the Authority. The shielded cable supplied shall meet all requirements of these cable specifications and the shield shall be grounded as specified in Section 16922, Lightning/Surge Protection and Grounding Systems. Armor tape shall not be considered as a substitute for a shield. Each electrically contiguous segment of armor tape shall be grounded at only one point.

- C. The Design-Builder shall furnish and install the amounts of specified types of external cable necessary to provide a complete Yard Signal System. The various types of cable and their applications shall include, but not be limited to, the following:
1. GROUP I - SIGNAL CABLES
 - a. TC Maintenance Telephone
Size No.16 AWG twisted pair cable, shall be furnished and installed to connect all telephone jacks of the TC Maintenance Telephone System along the wayside. See Section 16923, TC Maintenance Telephone System, and the Information Drawings.
 - b. Power Frequency Track Circuits
 - (1) One-thousand-volt-class single conductor cable shall be furnished and installed for 60-Hz track circuits. The only exception is that, in areas of high concentration of 60-Hz track leads, these circuits may be accumulated into a dedicated 1000-volt-class multiconductor cable between the TCR and the wayside distribution junction box.
 - (2) Cable for the feed end of each 60-Hz track circuit shall be minimum size No. 10 AWG. Cable for the relay end of such track circuits shall be minimum size No. 14 AWG from the TCR to the wayside junction box.
 - (3) Feed end track circuit leads extending more than 400 feet and relay end track circuit leads extending more than 1000 feet shall be increased in conductor size to compensate for the additional cable length resistance losses.
 - (4) The cables between the wayside junction box and the running rail connections shall be single conductor, size 10 AWG, 1000 volt class, for both direct fixation and ballast construction.
 - (5) Cable used for 60-Hz track circuit signal rail jumpers in crossovers shall be single conductor size 6 AWG, 1000-volt class, as shown on the Information Drawings. The long signal-rail jumper used to connect the two "halves" of the signal rail in a diamond or universal crossover 60-Hz track circuit shall be installed in schedule 80 F.R.E. conduit.
 - c. The common return leads for series type track circuits shall consist of single conductor No.6 AWG, 1000-volt class cables. The track circuit leads for the signal rail of the series track circuit shall consist of a single conductor No.8 AWG, 1000-volt class cable for each signal rail. The series track circuit relay-end cables between the series track equipment case and the train control room shall consist of one or more single, or six twisted pair No. 14 AWG.
 - d. Controlled Signals
A seven conductor, size 14 AWG cable shall be furnished and installed between each controlled signal and its associated Train Control Room or wayside distribution box. See Section 16965, Signal Layouts.
 - e. Trailable Yard Switch Machines
The cables to be furnished and installed between each switch junction box and the TCR (or an interlocking distribution junction box) shall be a single seven conductor (minimum size 14 AWG) for control and indication and a single five conductor (minimum size 10 AWG) for operation, or one composite cable (made up of two or more minimum size 10 AWG conductors) for operation, plus ten or more (minimum size 14 AWG) conductors for control, indication and spares. The minimum size of the two conductors for operation shall be increased to size 8 AWG if the distance from the switch junction box (or interlocking distribution junction box) to the TCR is more than 400 ft., and shall be increased to

size 6 AWG if this distance exceeds 1000 ft. See Section 16964, Yard Trailable Switch Operating Layouts.

- f. Interlocking Control Distribution
The Design-Builder shall furnish and install one or more of the following multiconductor signal cables between each interlocking distribution junction box and its associated TCR to consolidate control, operation, and indication wiring:
 - (1) 12c No. 14
 - (2) 19c No. 14
 - (3) 5c No. 10
 - (4) 7c No. 10
- g. Snowmelter Control and Indication
A nine conductor, size 14 AWG cable shall be furnished and installed between the TCR and each snowmelter control case for control and indication purposes, and for energization of the SM case heaters. See Section 16969, Snowmelter Layouts.
- h. Snowmelter Energy Supply
The Design-Builder shall furnish and install a single conductor, No. 1 AWG (minimum size), 1000-volt-class underground cable between the propulsion power contact rail and the snowmelter control case via the contact rail Fuse Box.
- i. Snowmelter Heating Elements
 - (1) The Design-Builder shall furnish and install:
 - (a) A single conductor, size 6 AWG, 1000-volt-class underground cable between the snowmelter control housing and each running-rail snowmelter heating element controlled from that housing, and;
 - (b) A single conductor, size 10 AWG, 1000-volt-class underground cable between the snowmelter control housing and each switch rod heater unit controlled from that housing.
 - (2) Maximum length for each of these cables shall be 75 feet unless otherwise authorized in writing by the Authority Representative. See Section 16969, Snowmelter Layouts, and the Information Drawings.

2. GROUP II - SPECIAL CONTROL AND INDICATION CABLE

(None required.)

3. GROUP III - NEGATIVE PROPULSION RETURN CABLE

- a. All Negative Propulsion Return Cable shall be rated for 2000 Volts. The insulation shall be Ethylene-propylene rubber, ICEA Type II, 90°C, suitable for dry and wet locations.
- b. The cable shall have an overall nonmetallic jacket of chlorosulfonated polyethylene or cross-linked polyolefin. The jacket shall be bonded to the insulation to prevent moisture pockets. The minimum peel strength of the jacket from the insulation shall be four pounds per inch width for either type of jacketing used.
- c. The insulation power factor shall not exceed two percent.
- d. The cable shall carry UL labeling, Type RHW-2.
- e. Cable furnished and installed for negative-return, compression-bolted rail-web bonding shall be single conductor, 500 KCMIL, Ropelay with 2000-volt-class insulation. See Section 16968, Track Bonding Layouts.

3.08 CABLE INSTALLATION

A. General

1. The installation of wire and cable shall conform to Part 10.4.40 (Wiring) and Part 10.4.1 (Wires & Cables) of the AREMA Signal Manual except as modified herein.
2. The Design-Builder shall notify the designated Authority Representative at least 24 hours prior to installing cables.
3. The Design-Builder shall provide sufficient slack in cable conductors at all terminating posts to enable three reterminations of the conductor due to broken eyelets without reservicing or re-potheading the cable. In types of installation where the cable cannot be constrained, sufficient cable slack shall be provided to prevent damage to the cable due to vibration.
4. Signal cable shall not be bent to a radius less than 20 times the diameter of the cable during installation or as finally installed, except as permitted in writing by the designated Authority Representative.
5. Cable splices will not be allowed.
6. All cable entrance openings in equipment enclosures, manholes and junction boxes shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit, pipe or duct bank. The Design-Builder shall install conduit sealing bushings in the ends of all unused Train Control conduits to prevent fluids or gases in the conduits from entering the enclosure. These bushings shall be Type CSBI as manufactured by O-Z/Gedney, or approved equal.
7. A suitable lubricating medium (Cable Pulling Lubricant), as specified in Section 16978, shall be used when pulling cables into conduit, pipe, or duct bank.
8. Where cable transfers from trays or troughs to conduit the ends of the conduit shall, for guidance, be fitted with plastic end bells to prevent damage to the cable.
9. Wherever multiple conductor cables are terminated the outer sheath of the cable shall be carefully removed to the point of cable entrance. At the end of the cable sheath or covering, two layers of plastic electrical tape shall be applied. This tape shall be Reference No. 88, as manufactured by the 3M Company, or an approved equal. As an alternative, the Design-Builder shall apply a heat shrink sleeve to the end of the cable sheath.
10. The Design-Builder shall be responsible for the dewatering and removal of all dirt and trash from trenches, pipe, manholes, pull chambers, cable trough, surface trench, conduit and duct bank prior to and during the installation of cable, at no additional cost to the Authority.

B. Buried Installation

1. Horizontal runs of buried cable greater than 15 feet shall be installed in PVC conduit per the requirements of this Section.
2. Cable shall be buried to a uniform depth of not less than 30 inches. A bed of sand at least four inches thick shall be provided in the bottom of the trench. The cable shall be laid neatly, but loosely on this sand bed, with a minimum of cable crossings. The cable shall then be covered with a minimum of four inches of sand before backfilling. Loam or clay, free of lumps, stones or other debris, may be substituted for sand only with the prior written approval of the Authority Representative. Backfill shall be compacted to not less than 95 percent of the maximum dry density of the respective materials as determined by AASHTO Test Designation T-99.
3. Cable passing under tracks or under ballast, or within track right-of-way shall be installed in conduit. Track right-of-way is defined as an area encompassing the ties and rail and extending two feet beyond the ends of each tie. The Design-

- Builder shall furnish Schedule 80 PVC conduit for this purpose and shall bury this conduit not less than 30 inches below the ties. See Section 16973, Conduit.
4. In all areas beyond the right-of-way area where cables cannot be buried to a uniform depth of 30 inches, the Design-Builder shall, at no additional cost to the Authority, either install surface trench or install the cable in concrete encased Schedule 80 PVC to the maximum uniform depth allowable by field conditions. At transition areas between buried and non-buried installation, the cable shall be protected by Schedule 80 PVC. Horizontal runs of PVC buried at or greater than a depth of 30 inches will not require concrete encasement.
 5. Where cable leaves the ground at other than buildings, or in foundations or pedestal mounted junction boxes, it shall be protected by heavy duty, two-ply, fiber reinforced rubber hose or Schedule 80 PVC conduit. The top end of each hose or conduit shall be filled with sealing compound where the cable emerges.
 6. The cables used as track leads between the rail connections and the wayside junction box shall be protected by vertical bootlegs of heavy duty, two-ply, fiber reinforced, one-inch I.D. neoprene hose where they pass through the ballast and the subgrade. Cable not extending beyond the far rail shall be placed in heavy duty, two-ply, fiber reinforced, one-half inch I.D. neoprene hose or Schedule 80 PVC conduit which shall be clamped to the side of the crosstie as shown on the Information Drawings.
 7. Cable shall be installed in a steel or wrought iron pipe wherever the cable passes under pavement or roadway. This pipe shall extend two feet beyond the edges of the pavement.
 8. The Design-Builder shall be responsible for all shoring required to prevent undermining and cave-ins during cable burying operations and shall also be responsible for any damages or lost time resulting from inadequate shoring. Any trench over 3 feet deep shall be shored.
 9. Where a buried cable enters a conduit, pipe, pedestal, or concrete foundation, for an equipment case, junction box, or other piece of Train Control equipment in which the cable is to be terminated, or bootlegs for track circuit or snowmelter connections, a five foot slack coil of that cable shall be installed in a trench below the point of entrance.
 10. Cable required to carry current at 600 volts or more shall not be installed in the same trench as signal or other low voltage cable without prior written consent of the Authority Representative.
 11. Install mylar cable marking tape at a depth of six inches while backfilling each cable trench.

C. Non-Buried Installation

1. Installation in Trays, Troughs or Surface Trench
Cable installed in trays, troughs or surface trench shall be laid therein and not pulled into place. Cables installed in trays, troughs and surface trench shall have a minimum amount of crossover and shall not be pulled tightly around bends.
2. Installation in Conduit or Pipe
 - a. Remove any foreign material from conduits by using an appropriate mandrel. The Design-Builder shall then clear or swab dry each conduit or pipe before installing cable therein. It shall be the Design-Builder's responsibility to prove existing conduits prior to use. The Design-Builder shall maintain the conduits and/or pipe in a clean and dry condition during the installation process up to and including the time each conduit or pipe is sealed as specified, at no additional cost to the Authority.
 - b. The Design-Builder shall have an approved Pull Sheet in his possession for each cable pull executed, and shall record thereon the date of the pull, the method used, the maximum pull tension experienced for each applicable pull, and other pertinent data. The Design-Builder shall resubmit a copy of each completed Pull Sheet to the designated Authority

- Representative within one week of the pull. See Part 1.07.F of this Section.
- c. Conduct cable pulls in accordance with the cable manufacturer's recommendations. In the absence of any such specific recommendations, the Design-Builder shall use an approved wire cable grip extending not less than 18 inches back from the end of the cable when pulling cable. The clutch on the pulling device shall be set to slip at 50 percent of the weight per 1000 feet of the cable to be pulled or at the manufacturer's maximum force rating, whichever is less. The equipment used for pulling cable shall be equipped with a dynamometer which shall indicate the pulling force in pounds. An approved cable pulling lubricant, as specified in Section 16978, shall be applied to the cable when installing cable in conduit or pipe.
 - d. Cables shall not cross one another when they are pulled into a conduit or pipe and care shall be taken not to have the conductors pulled tight or kinked in conduit fittings or boxes. All cables to be installed in a given conduit or pipe shall be pulled and installed simultaneously.
 - e. Furnish and install potheads and filling compound where cables enter or leave conduit or pipe. The potheads and filling compounds shall be as specified in Section 16978, Miscellaneous Train Control Components and Materials, and shall be applied in conformance with the manufacturer's instructions.
3. Installation in Manholes and Pull Chambers
- a. Furnish and install clamps or other cable restraining hardware in manholes or other areas where support is needed for cables entering or leaving conduit or pipe or passing through the manhole. Apply an identification tag to each TC cable in every manhole.
 - b. Sufficient slack shall be provided in each cable so that the bending radius of each cable shall not be less than 20 times the diameter of the cable. Where the specified minimum bending radii of cables do not allow strapping or clamping to channel inserts, the Design-Builder shall furnish and install approved manhole racks with insulators to support the cables.
 - c. All mounting and fastening materials used by the Design-Builder shall be stainless steel. Use of anodized channel is unacceptable in manholes and pull chambers.
 - d. Cables shall be installed in a manner which will prevent their injury by persons and equipment entering and exiting the manholes via ladders or other climbing devices.
 - e. Cables shall be installed and supported in manholes and pull chambers in accordance with the approved version of drawings the design Builder has submitted for this work.
4. Special Installation Requirements
- a. Provide sufficient slack in all cable installation runs to prevent damage to the cable or its terminations due to expansion or contraction.
 - b. Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions such as vibration or sharp corners on equipment. The Design-Builder shall be responsible for replacing, at no additional cost to the Authority, any cable he has installed which is subsequently damaged as a result of his failure to provide such special protection.

END OF SECTION

SECTION 16951

TRANSFER AND BYPASS EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of Automatic Transfer and Bypass-Isolation equipment as part of each new TCR Power Distribution system provided under this Contract. For each TCR, this equipment shall include:

- A. A high speed, single phase Automatic Transfer Switch to supply an uninterruptible 120 volt, 60 Hz bus.
- B. A one-way, bypass-to-normal Bypass-Isolation Switch to provide a safe and convenient means of bypassing and isolating the Automatic Transfer Switch for test and maintenance purposes without interrupting Yard Signal functions.
- C. All devices and wiring required to cause the Transfer and Bypass equipment to function as specified herein.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16921	Yard Signal Power Distribution Systems
Section 16922	Lightning/Surge Protection and Grounding Systems
Section 16941	Basic Yard Signal Electrical and Electronic Component Requirements
Section 16989	Yard Test and Inspections

1.03 SWITCHING

- A. The Automatic Transfer Switch shall immediately throw from the Normal to the Reserve service whenever the Normal 120 volt, 60 Hz bus falls below 85 percent of its nominal voltage and the Reserve voltage is 85 percent of nominal or higher.
- B. Once the switch has thrown to the Reserve 120 volt, 60 Hz service, it shall remain in that position until the Normal service voltage returns to at least 95 percent of its nominal value and remains in that range for a time period adjustable from 15 seconds to five minutes, whereupon the switch shall retransfer the load to the Normal service. This "return-delay time" feature shall be nullified and the switch shall immediately retransfer to the NORMAL position if the Reserve service falls below 85 percent of its nominal value and the Normal service voltage is at least 85 percent of its nominal value.

1.04 BYPASS AND ISOLATION

- A. The Bypass-Isolation Switch shall perform two functions:
 - 1. Connect the load directly to the Normal service without interrupting service to the load.
 - 2. Electrically isolate the Automatic Transfer Switch from the load and both services.

- B. Interlocks shall be provided to prevent
 - 1. Moving the bypass switch handle from the AUTOMATIC to the BYPASS-TO-NORMAL position unless the Automatic Transfer Switch is in its NORMAL position and the Normal service is at least 85 percent of its nominal value.
 - 2. Isolation of the Transfer Switch prior to bypassing the load to the Normal service.
 - 3. Removal of the load bypass connection prior to reconnecting of the Automatic Transfer Switch to the load and both services.
 - 4. Moving the bypass switch handle from the BYPASS-TO-NORMAL to the AUTOMATIC position unless the Automatic Transfer Switch is in its NORMAL position.

1.05 QUALITY ASSURANCE

See Section 01113 Systems Integration

1.06 SUBMITTALS

See Section 16912 Submittal Requirements

PART 2 - PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH

- A. The Automatic Transfer Switch shall be of the electrically operated, mechanically held type, rated for continuous duty in an unventilated sheet metal enclosure. All accessory control and indication devices shall be removable from the front of the Transfer Switch without removal of the switch panels from the enclosure and without disconnection of drive linkages or power conductors. The Transfer Switches provided shall meet the requirements of Underwriters Laboratories Standard UL 1008 for Automatic Transfer Switches and other requirements specified herein.
- B. The switching mechanism shall have only two positions, NORMAL and RESERVE, inherently interlocked mechanically and with main contacts mechanically attached to a common shaft. The switching mechanism shall cause the main contacts to transfer the load from one service to another with an output power interruption period of sufficient brevity not to cause any track relays or traffic sticks to drop, and not to cause any other failure in the Yard Signal System.
- C. The main contacts shall be of the brush, segmented, or silver alloy, wiping action type and shall be protected by arcing contacts in sizes above 40 amperes. The "constant current" rating for the main contacts and associated arc-quenching apparatus shall be at least 20 percent higher than the maximum working load computed for the transfer switch by the Design-Builder and approved by the designated Authority's Representative. The contact configuration shall utilize magnetic forces to keep main contacts closed when subject to high fault currents.
- D. The transfer switch shall have the thermal capacity to carry its withstand rating without contact welding or electrical or mechanical damage.
- E. Sensing and control relays shall be continuous duty industrial control type with minimum contact rating of 10 amperes. The voltage sensitive relays shall be of the close differential type, factory adjusted for 95 percent pickup and 85 percent drop-out. The return-delay time relay shall be adjustable from 15 seconds to five minutes in at least eight steps.
- F. Each Automatic Transfer Switch shall be equipped with the following test and adjustment features

1. A spring-return test pushbutton or equivalent which shall, when operated, cause the switch to transfer from the NORMAL to the RESERVE position. The transfer switch shall then remain in the RESERVE position until the test button has been released and the preset return-delay time period has run out. The test pushbutton shall be clearly identified by a metal or phenolic label or approved equal.
 2. Facilities for testing and adjusting the undervoltage sensitivity for both the Normal and Reserve services.
 3. Facilities for testing and adjusting the return-delay time mechanism.
- G. The Automatic Transfer Switch shall be equipped with the following indication features:
1. At least five independent auxiliary contacts shall be provided for transfer switch position indicating use. Three of these contacts shall close when the transfer switch is in the NORMAL position and the other two shall close when the switch is in the RESERVE position. All of these auxiliary contacts shall have 10 ampere minimum continuous contact rating and shall be activated by the switching mechanism.
 2. The Transfer Switch shall include four LED indicating light units:
 - a. One amber LED unit to indicate the availability of Normal service energy of the proper voltage (Normal voltage sensing relay energized)
 - b. A second amber LED unit to indicate the availability of Reserve service energy of the proper voltage (Reserve voltage sensing relay energized)
 - c. A green LED unit to indicate when the transfer switch is in the NORMAL position
 - d. A red LED unit to indicate when the transfer switch is in the RESERVE position
 3. The indications provided by these LED indicators shall be visible from the outside of the Transfer Panel. The LED units shall be, as applicable:
 - a. SP940112-R (RED)
 - b. SP940224-R (GREEN)
 - c. SP940112-R (AMBER)
 - d. As manufactured by Data Display Products of El Segundo, California, or approved equal.
- H. The Automatic Transfer Switch, complete with all its control, test and indication equipment, shall be housed in a non-ventilated NEMA-12 type enclosure constructed of 11 gauge sheet metal. Provision shall be made for locking the doors of this enclosure. The enclosure shall be finished in grey ANSI-61, or approved equal. The switch position and power indicating lights shall be mounted on the front of this enclosure. This assembly of power transfer equipment shall be known as the Transfer Panel.
- I. Each control, test or indicating device mounted on the front of the Transfer Panel shall be clearly identified by a metal or phenolic label firmly attached to the panel.

2.02 BYPASS-ISOLATION SWITCH

- A. Each Bypass-Isolation Switch shall be compatible with its associated Automatic Transfer Switch and shall be designed to the same standards as the Automatic Transfer Switch. The Bypass-Isolation Switch shall have "withstand current" abilities equal to or greater than the associated Automatic Transfer Switch.
- B. The Bypass-Isolation Switch shall be arranged so that one person can perform the bypass and isolation functions through the operation of a maximum of two handles at a common deadfront panel:
1. A handle labeled BYPASS CONTACTS which shall connect the load to the Automatic Transfer Switch when in the AUTOMATIC position, and which shall transfer the load from the transfer switch to the Normal service by means of make-before-break contacts when rotated to the NORMAL position.

2. A handle labeled ISOLATION CONTACTS which shall disconnect the Automatic Transfer Switch from both the Normal and Reserve service leads when moved from the CLOSED to the OPEN position. Provision shall be made for padlocking this handle in the OPEN position.
- C. The Bypass-Isolation Switch shall be equipped with the following indication features:
1. A red indicating LED light (of the same type as used on the Transfer Switch) on the faceplate of the Bypass-Isolation Switch which shall be illuminated when the BYPASS CONTACTS handle is in the BYPASS-TO-NORMAL position.
 2. Sufficient auxiliary contacts to provide remote ac power and bypass indications. One of these contacts shall close only when the BYPASS CONTACTS handle is in the AUTOMATIC position and another contact shall close only when the BYPASS CONTACTS handle is in the BYPASS-TO-NORMAL position. These contacts shall have a 10 ampere minimum continuous contact rating and shall be activated by the bypass mechanism.
- D. The Bypass-Isolation Switch shall be housed in an isolated compartment of the Transfer Panel enclosure. The Bypass-Isolation Switch shall have a metal faceplate of its own. The operating handles and the BYPASS indication light shall be mounted on this faceplate. Housing and faceplate metal which is not inherently non-corrosive shall be finished in grey ANSI-61 or approved equal.
- E. The two operating handles, the two positions for each handle, and the BYPASS indication LED light unit shall all be clearly identified by metal or phenolic labels firmly attached to the faceplate of the Bypass-Isolation Switch.
- F. A fail-safe solenoid lock or similar device shall be included in the Bypass-Isolation Switch to prevent movement of the BYPASS CONTACTS handle except when the Transfer Switch is in the NORMAL position and Normal service energy of the proper voltage is available.

2.03 TERMINALS AND WIRING

The Bypass-Isolation Switch, and the Automatic Transfer Switch together with its accessory control and indication devices, shall be completely factory wired internally.

- A. Auxiliary contacts for external indication of interlocking control purposes shall be wired to external solderless terminals of the pressure clamp type.
- B. All external power, load, control, and indication terminals shall be clearly identified by permanent tags or markings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The Design-Builder shall wall mount the Transfer Switch and the Bypass-Isolation Switch as shown on the approved drawings.
- B. The Transfer and Bypass Equipment shall be wired utilizing single conductor, stranded wire and jumpers.

END OF SECTION

SECTION 16952

DC POWER SUPPLIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of direct current power supplies of various voltages and capacities to supply power to all wayside direct current Yard Signal equipment furnished or installed under this Contract.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration	
Section 16912	Submittal Requirements	
Section 16914	Environmental Requirements	
Section 16915	Basic Yard Signal Equipment Requirements	
Section 16916	Basic Yard Signal Circuit Requirements	
Section 16921	Yard Signal Power Distribution Systems	
Section 16922	Lightning/Surge Protection and Grounding Systems	
Section 16941	Basic Yard Signal Electrical and Electronic Component	Require ments
Section 16949	Signal Wire and Cable	
Section 16989	Yard Test and Inspections	

1.03 QUALITY ASSURANCE

See Section 01113 Systems Integration

1.04 SUBMITTALS

See Section 16912 Yard Signal Submittal Requirements

PART 2 - PRODUCTS

2.01 BASIC DC POWER SUPPLY REQUIREMENTS

All DC power supplies furnished under this Contract shall be immune to external RF energy from portable 2-way radios and personal communications devices such as cellular telephones, and shall meet the following basic requirements:

- A. Transformers used in DC power supplies shall not emit audible noise in excess of 50 dB (referenced to 0.0002 dynes per square cm.) at a distance of three feet when operated anywhere within the range of input and output voltages and currents specified
- B. Power supplies requiring filter capacitors shall be so designed that their filter capacitors can be replaced without removing the power supply from the rack on which it is mounted.

- C. Power supplies shall have sufficient insulation to be cable of withstanding, for one minute, 600 volts, 60 Hz applied
 - 1. Between the input leads (connected together) and the output leads (connected together).
 - 2. Between the input leads (connected together) and the chassis.
 - 3. Between the output leads (connected together) and the chassis.
- D. Power supplies shall be designed for natural convection cooling. No supplementary fans or other cooling devices will be allowed.
- E. The power supplies shall be designed for a continuous duty cycle with the exception of the WHB which shall be designed for an average five percent duty cycle.
- F. Each DC power supply shall be equipped with a failure alarm device which shall detect any internal failure which would impair the ability of the power supply to deliver its full rated load. This device shall be normally energized by a small percentage of the rated load current of the power supply and shall cause two separately wired internal contacts to open when a failure is detected. One of these contacts shall be independently wired to binding posts for an external alarm indication circuit. The second contact shall be used to light an indication lamp or LED indicator mounted on the power supply. (See Section 16955, Track and Alarm Indication Panels, and the Information Drawings.) This circuit shall function even if the output voltage is maintained by a tandem power supply. The power supply shall be so designed that the internal failure indication lamp or LED can be replaced without removing the power supply or any adjacent equipment from the rack.
- G. The power supplies shall not be damaged by a sustained input voltage varying from 0 to 150 percent of the rated input voltage. Nominal supplied input voltages may range from 110V to 125V per leg at the incoming feeder disconnect.
- H. The power supplies shall be sized in such a manner that no individual power supply operates at less than 20 percent of its rated current output during normal operation.
- I. The power supplies shall self-limit their output current to no more than 200 percent of their rated load. Reverse output current protection shall be provided to prevent shorting or sagging of tandem supplies in the event of filter capacitor failure.
- J. Each power supply shall be clearly and permanently labeled with the following:
 - 1. Manufacturer's name
 - 2. Part or model number
 - 3. Serial number
 - 4. Input rating
 - 5. Output rating (Continuous or intermittent)

2.02 POWER SUPPLIES FOR MAJOR DC BUSES

All power supplies used to feed the four major DC buses (B28G, LB, B5G and WHB) shall meet the following requirements in addition to the basic requirements specified in Part 2.01 of this Section:

- A. Each power supply shall be housed in a metal panel-chassis combination with no exposed electrical connections or wires. A perforated protective cover shall be used to provide for convective heat transfer. Metal used in this housing and cover which is subject to corrosion shall be protected by zinc plating or an approved equivalent finish applied after forming.

- B. The front panel shall be designed for use in mounting the power supply in a standard 19-inch rack with EIA hole spacing. All panel mounted indicating, adjusting or protective devices, or openings for such devices, shall be legibly and permanently labeled.
- C. Each power supply shall have an output voltmeter, an output ammeter and a normally illuminated power failure light (lamp or LED) mounted on its front panel. As an option, the Contractor shall provide this metering on a separate panel in the same rack as the power supplies. Meter accuracy shall be ± 2 percent with nominal readings at center scale.
- D. Terminals
 - 1. The power supplies shall be equipped with standard AAR type binding posts (No. 14-24 studs) within the chassis, for the connection of all external input and output power leads. Terminals for external connections to the internal failure alarm contacts shall be of the 8-32 barrier strip type or standard AAR type binding posts. Each terminal shall be permanently labeled. No terminal shall protrude outside the chassis.
 - 2. Where 120-volt input terminals are in close proximity to failure indication terminals, a grounded metal barrier shall be provided to prevent accidental application of 120V to the other terminals.
- E. Internal circuit breakers or fuses shall be easily made and locked from outside the power supply.
- F. Output voltage adjustment over the specified range shall be easily made and locked from outside the power supply.

2.03 LOCAL POWER SUPPLY

- A. These power supplies shall be provided to feed the grounded 28 VDC bus (B28G-N28G or B12G-N12G) for operating Yard Signal logic circuits entirely contained within the Train Control Rooms and non-vital circuits which extend outside the TCRs.
- B. These power supplies shall meet the following requirements in addition to the requirements specified in Parts 2.01 and 2.02 of this Section.
 - 1. Output Current
 - a. These power supplies shall be furnished in no more than three maximum continuous current ratings selected as required by the application.
 - b. Each power supply shall have a short-time overload rating stamped on the nameplate. The overload rating shall be at least 125 percent of rated load sustained for one minute out of any ten consecutive minutes.
 - c. Output current shall be limited to 250 percent of maximum continuous rating. If this short circuit current is sustained for 30 ± 10 seconds, an internal hand-resettable protective device shall operate to disconnect input power, without harm to power supply components. If this short circuit current is sustained for less than the 30 seconds, recovery of normal output voltage shall be automatic upon removal of the short circuit condition.
 - d. Reverse output current shall be prevented by circuitry contained within the power supply. This circuitry shall isolate all of the active components within the power supply (including filter capacitors) from the output terminals of the supply. If a circuit other than a blocking diode is used for control of reverse current, a small amount of reverse current will be allowed; however, this shall not exceed 2 percent of the rated current.
 - 2. Output Voltage (During Warm-Up Period)
 - a. The power supply output shall stabilize within a period of 20 minutes after rated input voltage is applied to the supply. During this period, the output

- voltage shall not be greater than 120 percent of rated DC voltage, regardless of load.
- b. During the warm-up period, ripple shall not exceed 3 percent of the rated voltage (as measured peak-to-peak), and noise shall be limited to 7 percent of the rated voltage (as measured peak-to-peak) at any frequency.
3. Output Voltage (After Warm-Up Period)
- a. The output voltage shall be adjustable to plus or minus 0.1 percent of the system voltage, at rated input voltage, with an ambient temperature of 25 degrees C, when operating at 50 percent of rated output current.
 - b. Regulation of Output Voltage
 - (1) The output voltage at 50 percent load current, shall not vary more than ± 2 percent for input voltage variations of ± 15 percent of rated voltage at constant ambient temperature.
 - (2) The output voltage at 50 percent load current and constant rated input voltage shall not vary more than ± 2 percent over a temperature range of -30 degrees C to +70 degrees C at constant rated line voltage.
 - (3) The output voltage, from no load to full rated load current, at constant rated input voltage and constant ambient temperature, shall not vary from the output voltage at 50 percent load current by more than plus or minus one half of one percent.
 - (4) After the warm-up period and once adjusted to a rated voltage with given constant input and load conditions, the output voltage shall not vary more than ± 0.5 percent in a 72 hour period.
 - (5) With the worst combination of load current and line voltage, and with temperature variation ranging from -30 degrees C to +70 degrees C, the output voltage shall never vary more than ± 12 percent of rated voltage.
 - c. Variation in output voltage due to load changes of up to 50 percent of maximum load and for a 10 millisecond interruption of input power shall be limited to ± 1.0 percent of rated output voltage, peak. Recovery to the point where the waveform stays within the ripple tolerance shall occur within 80 milliseconds of the initiation of the load change.\
 - d. Once the power supply output voltage has stabilized
 - (1) Output ripple, related to the power frequency, shall not exceed one half of one percent of rated voltage.
 - (2) Noise, unrelated to the power frequency, shall be limited to one half of one percent of rated voltage peak-to-peak at any frequency.
 - e. If the circuitry of the power supply is such that failure of one or more components within the supply could cause an output voltage greater than that allowed in the requirements of this article, an overvoltage circuit shall be added which senses this overvoltage condition and shuts the power supply down. Such circuitry may be of the "crowbar" type which causes an overcurrent protection condition resulting in the operation of the unit's overcurrent feature in consequent (manually resettable) shutdown. This circuit shall be designed to limit peak overvoltage conditions to a maximum of 125 percent of the rated continuous voltage.
4. These power supplies shall be designed and rated to operate on 120 or 208 ± 15 volts RMS (Nominal), derived from one or all three phases of a 208Y/120V, 60 Hz, 3-phase, 4-wire grounded neutral service bus.
5. Circuitry shall be provided within the power supply for control of the output voltage in a manner which shall cause the power supply to share the total bus load equally with all other parallel connected (tandem) power supplies feeding a given bus.

6. The 100-ampere power supply units shall have a minimum individual MTBF of 100,000 hours. Supply units of 50 amperes rating and less shall have a minimum individual MTBF of 150,000 hours. MTBF shall be calculated at 50 percent load. The maximum MTTR for any individual local power supply unit shall be one hour.

2.04 LINE POWER SUPPLY (LB-LC)

These power supplies shall be provided to feed the non-grounded DC bus (LB-LC) for operating the 28 Vdc Yard Signal vital logic circuits which extend outside the Train Control Rooms.

2.05 WHB POWER SUPPLIES (WHB-WHC)

- A. These power supplies shall be provided to feed the non-grounded WHB DC bus (WHB-WHC) for trailable switch machine and snowmelter control circuits.
- B. These power supplies shall be rated at a current value sufficient to simultaneously operate five trailable switch machines.
- C. These power supplies shall deliver to the trailable switch machine movements, at any load, or temperature between 0 degrees C and +70 degrees C, their rated voltage (110 Vdc on the specified machines) plus or minus 5 percent, at rated input voltage, and an ambient temperature of 25 degrees C. The output voltage may vary somewhat from its rating during warm-up, but it shall not exceed 120 percent of rated voltage and the warm-up period shall not be greater than 20 minutes.
- D. The ripple and noise of these power supplies shall not interfere with any electrical or electronic system furnished by the Design-Builder or with the Communications Systems.
- E. These power supplies shall be designed and rated to operate on 208 volts RMS, 3 phase, derived from a 208Y/120V, 60 Hz, 3 phase, 4 wire grounded neutral, source. The input voltage may vary as much as ± 15 percent, and the frequency may vary ± 0.5 Hz.
- F. A minimum of three bussed terminals shall be provided for each power supply polarity. Four terminals shall be provided for the output of the two contacts of the failure circuit.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. DC Power supplies shall be rack mounted.
- B. Mounting panels or brackets shall be rigidly designed so that they do not sag under the weight of the power supply.

END OF SECTION

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SECTION 16957

YARD CONTROL MACHINES

PART 1 - GENERAL

- 1.01** Design-Builder shall perform all detail design, construction, factory testing, field installation, field testing and final documentation of the modifications to the existing Yard Control Machines. These modifications shall be designed to permit monitoring of track occupancy, switch position, signal aspects, and traffic direction established for all tracks in the yard expansion area and for local auxiliary switch control and local manual "entrance-exit" control of route selection through the interlockings. These panels shall also include facilities for controlling and monitoring snowmelter layouts, where applicable. The Modified Consoles/Panels are to appear similar to and function as a replacement of the existing Yard Control Machine Panels.
- 1.02** The Design-Builder shall design the modifications to the Yard Control Machines in accordance with the style of the existing Yard Control Machines. As an alternative, the Design-Builder may replace the engraved panels with one or more mosaic tile type panel sections. If this alternative is adopted, the entire panel shall be replaced and equipped with necessary switches, pushbuttons, lamps, fasteners, hinges, locking mechanisms and other hardware. The modified control machine shall appear as a new machine providing a geographical representation of the entire yard.
- 1.03** The modification to the Yard Control Machines shall be designed to control and/or monitor the signals, switches, snowmelters, track circuits, and associated Train Control functions of the expansion to the Yards as described in the Program Criteria. New faceplate panels shall incorporate all existing Yard Signal Control functions.
- 1.04** The Yard Control Machines shall use light emitting diodes (LED) to display the following indications:
- A. Track Occupancy indications for all tracks within the limits of yard control, and for certain mainline tracks in approach to the yard,
 - B. Route Locked indications for all interlockings and running tracks within the Yard Limits.
 - C. "Available Exit" indications,
 - D. Switch Alignment indications,
 - E. Switch Locked and Trained Switch indications
 - F. Signal Status indications,
 - G. Signal Fleeting indications,
 - H. Vital Traffic indications for the Yard Lead tracks,
 - I. Power and Alarm indications,
 - J. Snowmelter Control, and Snowmelter Failure indications

1.05 The Yard Control Machine Consoles and/or Panels shall interface with and/or contain the following as appropriate for the expansion of the yards:

- A. A "SNOWMELTER"* toggle switch to control all snowmelters in the yard.
- B. A "SWITCH POSITION"* pushbutton, located on the control machines as shown on the provided Information Drawings, to cause the current position (NORMAL or REVERSE) of every track switch in the yard to be indicated,
- C. An "INDICATION TEST"* pushbutton, located on the control machines as shown on the provided Typical Drawings, to momentarily energize all indicator lights on the faceplate for test purposes. When this pushbutton is depressed, all RED LEDs shall be illuminated. When this pushbutton is pulled, all WHITE, AMBER, GREEN or other non-RED LEDs shall be illuminated.
- D. An ALARM CUTOFF pushbutton to silence audible alarms generated by the existing alarm circuits and any additional alarms provided under this Contract.

1.06 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signal Submittal Requirements
Section 16914	Environmental Requirements
Section 16915	Basic Yard Signal Equipment Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16917	Basic Interlocking Requirements
Section 16923	TC Maintenance Telephone System
Section 16948	Plug Connectors
Section 16949	Signal Wire and Cable
Section 16958	Computerized Yard Control System
Section 16969	Snowmelter Layouts
Section 16971	Racks and Cable Trays
Section 16974	Locks and Keys
Section 16989	Yard Test and Inspections

1.07 QUALITY ASSURANCE

See Section 01113 Systems Integration.

1.08 SUBMITTALS

See Section 16912 Yard Signal Submittal Requirements.

1.09 DELIVERY, STORAGE AND HANDLING

The Design-Builder shall take whatever measures may be necessary to protect the Yard Control Machine panels from damage or marring during shipment, storage, installation, and testing. Panels which are marred or otherwise damaged prior to acceptance by the Authority shall be replaced by the Design-Builder.

PART 2 - PRODUCTS AND MATERIALS

2.01 Panel Faceplate Construction

- A. The material of the faceplates of the Train Control and Indication panels shall be laminated black/white/black phenolic or approved equal. The track and equipment layout shall be engraved thereon to produce a white configuration on a black background. The strength and thickness of the faceplate material shall be sufficient to ensure that no cracking, warping, separation or significant deflection of the faceplate occurs. The method used to attach the faceplates to their respective frames shall allow easy removal and replacement without damage to the faceplates or frames.
- B. As an alternative, each panel faceplate may be composed of an assembly of small individually engraved 1/8 inch thick black/white/black phenolic plates, supported on a three dimensioned metal grid carrier structure, which shall also support the necessary control and indication hardware modules.
- C. All panel faceplate edges shall be rigidly supported by a metal frame and by the control machine frame. Supplementary cross braces shall be added as necessary to prevent panel deflection.

2.02 PANEL COMPONENTS:

- A. All control and indication modules shall be securely attached to the panel faceplate but shall be removable without damage to the module or faceplate.
- B. All panel hardware including, but not limited to, pushbuttons, switches, levers and indicators shall be new and free of manufacturing defects.

PART 3 - EXECUTION

3.01 PANEL WIRING

- A. Panel wiring between the Train Control Room and the Yard Control Machine shall be terminated in plug connectors to facilitate off-site testing and to expedite the panel replacements.

END OF SECTION

THIS PAGE NOT USED

SECTION 16958

COMPUTERIZED YARD CONTROL SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section permits the substitution of a computer-based Yard Control System for the performance of most of the non-vital functions of the Yard Signal Control and interlocking System, such as the request and indication of routes throughout the yard and on the yard leads, in lieu of a system implemented with non-vital relay circuitry.
- B. It shall be understood that the word "computer", when used in this section, refers to one or more solid state electronic processors, complete with all auxiliary and support equipment, as selected by the design-builder, and approved by the Authority Representative. The "computer" shall have adequate logic capacity to perform the route Entrance-Exit functions and most of the other non-vital functions of the Yard-Signal Control and Interlocking System. It shall not be additionally assigned to functions which require the use of vital relays, as specified in other sections of these specifications, unless specifically authorized in writing by the Authority Representative.
- C. It is the intent of this section to enable the design-builder to make use of the flexibility of the computer to reduce the cost of the yard changes and additions.
- D. The equipment shall comply with the requirements defined by the graph presented on Page TC-7 of the Program Criteria, which specifies the maximum allowable Mean Time To Repair (MTTR) for any Mean Time Between Failures (MTBF) experienced by the equipment and systems comprising the Yard Signal Control and Interlocking System.
- E. The yard operator's Yard Control and Indication Panel (part of the Yard Interlocking Control; Machine) shall be of the type specified in Section 16957, Yard Control Machines.
- F. The Design-Builder shall furnish both conventional and computer-equivalent circuit drawings (or equivalent software logic statements) for all of the non-vital functions that are to be performed by a computer in the Computerized Yard Control system. The logic and operation of the computerized system shall be at least the equivalent, in terms of safety and speed of operation, to the logic and operation of the non-vital relay circuits shown in the Information Drawings.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16914	Environmental Requirements
Section 16916,	Basic Yard Signal Circuit Requirements
Section 16921	Yard Signal Power Distribution Systems

Section 16922	Lightning/Surge Protection and Grounding Systems
Section 16929	Event Recording System
Section 16931	Yard Signal Maintenance and Test Facilities
Section 16941	Basic Yard Signal Electrical and Electronic Component Requirements
Section 16942	Printed Circuit Cards
Section 16957	Yard Control Machines
Section 16978	Miscellaneous Train Control Components and Materials
Section 16989	Yard Tests and Inspections
Section 16991	Yard Signal Drawings and Tracings

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration.

1.04 SUBMITTALS

See Section 16912, Yard Signaling Submittal Requirements

1.05 DESIGN REQUIREMENTS

- A. The Design-Builder shall prepare the following drawings for approval by the Authority Representative prior to fabrication or procurement of yard control system computer equipment:
1. Drawings showing the arrangement of the engraved control and indication panel diagrams, brackets, hinges, symbols and lettering, and the location of all required control and indication hardware mounted thereon.
 2. Complete circuit drawings for the computer assembly and all the required control and indication functions to be performed by the computer.
 3. Complete wiring diagrams for the computer assembly. This shall include complete back-panel wiring diagrams for all control machine control and/or indication panels.
 4. Drawings showing the mechanical details for all the various items of the computer assembly and the control and indication hardware required for the control panels, with the method of mounting these devices on the panel or in the enclosure.
 5. Drawings showing the details of the cable assemblies to be used in connecting the computer assembly to the equipment racks and to the control panels of the Yard Control Machine.
 6. Arrangement plans and assembly drawings having complete parts lists keyed to the assembly or arrangement shown.
- B. The Design-Builder's revised circuit drawings and their software equivalent statements shall be submitted to the Authority Representative for approval within 120 working days following the Notice to Proceed (NTP). The circuits shall be complete and show all interfaces and interface terminal connections between the portions at various locations, and between various pieces of equipment. The circuit drawings shall comply with Section 16991, Yard Signal Drawings and Tracings.
- C. The Design-Builder shall submit a complete software package for the Computerized Yard Control System within 120 working days of NTP. This package shall include, but not be limited to:
1. program functional specifications
 2. program detail specifications

3. a completely documented program printout of the entire program of the computer.
 4. flow charts
 5. a programming manual
 6. a key sheet that lists and defines all symbols and aspects of the program.
 7. complete software equivalent circuits, or equivalent software statements for the non-vital circuits of the Yard Signal Control and Interlocking System. These shall be in Boolean equivalent form.
- D. The computer program shall be broken down in a logical manner, with comments or remarks to provide easily understood sections.
- E. The Design-Builder shall not proceed with fabrication or procurement of the computer, or its associated equipment until it has obtained the Authority Representative's approval of all the drawings, lists, printouts, and key sheets applicable to the assembly.
- F. The Design-Builder shall submit a Factory Test Procedure for the computer assembly. This test procedure shall be in conformance with the requirements specified in Section 16989, Yard Tests and Inspections. The Design-Builder shall obtain the Authority Representative's approval of this procedure prior to manufacture of the computer assembly. Manufacture or procurement of the computer without prior approval by the Authority Engineer shall be at the Design-Builder's risk.
- G. The Design-Builder shall submit a Factory Test Procedure for the testing of the computer and the control machine, with sufficient I-O equipment and the test fixtures to prove the operation of the proposed system. This test procedure shall include provisions for the testing of all operational aspects of the equipment according to the requirements of Section 16916, Basic Yard Signal Circuit Requirements.
- H. The Design-Builder shall submit Factory Test Reports, as stipulated by his approved Factory Test Procedure. The computer shall not be shipped from its point of fabrication until these Factory Test Reports have been approved by the Authority Representative.
- I. The Design-Builder shall furnish a documented test report for each of the boards comprising the computer, or computers furnished, verifying that it operates correctly when subjected (while in monitored operation) to testing throughout the full range of temperature and voltage specified. The I-O boards shall be similarly tested, but the Design-Builder may elect to temperature-test only one I-O board out of five. All I-O boards shall receive an operational test at room temperature.
- J. The Design-Builder shall submit a proposed course outline for the required instruction of Authority personnel in the operation and maintenance of the computer and its related equipment.

1.06 DELIVERY

The Design-Builder shall deliver the complete, corrected and tested software package for the Computerized Yard Control System to the Authority Representative at least 60 calendar days before the scheduled cut-over date for the new Yard Control Panels.

PART 2 - PRODUCTS AND MATERIALS

2.01 COMPUTER REQUIREMENTS

- A. The computer, and its associated equipment shall meet the physical and electrical environmental requirements specified.
- B. The computer Input and Output connections shall be fully isolated from the power supply of the computer.
- C. The cables connect the main Entrance-Exit computer with the equipment at the satellite locations shall be shielded, or of other special construction as may be necessary, but it shall be constructed of the same materials, and to the same quality standards as the other cables specified for this contract. The quantity, size, and arrangement of conductors shall be as required by the Design-Builder for proper operation and protection of approved computer equipment.

2.02 MECHANICAL REQUIREMENTS

- A. The computer shall make use of plug-in printed circuit cards. Each card shall be labeled with its function, a means of application identification, a serial number, and a model drawing number.
- B. The printed circuit cards shall be housed in rigid frames containing a motherboard for the mounting of printed circuit card plug-in receptacles. This motherboard shall be either a printed circuit card or a hard-wired plane. The frame shall contain full length card guides to assure that the plug-in contacts of each plug-in card correctly mate with the motherboard connectors.
- C. Each plug-in location shall be labeled with the identity of the card type intended for that position. The frame shall incorporate a method of keying each location so that cards cannot be inserted in incorrect locations.
- D. Cards which are physically identical, but which differ because of programming contained in Read-Only-Memory (ROM, PROM, or EPROM) shall be considered, for purposes of identification and plug-in interlocking, as different cards.
- E. The Design-Builder shall specifically assess the desirability of removing a printed circuit card while the system has power applied to it. If he determines that this should **not** be allowed, because of a detrimental effect to program or component, he shall equip the card frame with a power interlock guard, which automatically removes power from the system before any card can be removed. This guard may be made card-selective, if advantageous, so that certain cards may be removed, without operation of a power interlock.
- F. The card frame shall be constructed and mounted in a manner that allows adequate air movement to prevent localized hot-spots that would prevent the assembled and mounted equipment from meeting the environmental and reliability requirements of these specifications.
- G. The card frame shall contain electromagnetic shielding, if necessary, to allow the assembled and mounted system to meet the environmental requirement of these specifications.
- H. The card frame shall be mounted in a rack in the Yard (Main) Train Control Room. This section of the rack shall include a Computer Control Panel that shall contain all necessary

housekeeping and testing controls and indications for the computer. This panel shall be mounted at the top of the rack section. If computer equipments located at a satellite field location, the card frame shall be mounted in a rack which meets requirements of these specifications, and is suitable for such mounting.

2.03 ELECTRICAL REQUIREMENTS

- A. The computer, and its associated equipment, shall be powered by conservatively rated power supplies provided as part of this item. These supplies shall meet the temperature and electrical requirements of these specifications. At the Design-builder's discretion, these supplies shall operate from either the 120 V ac supply or the voltage supply provided for the relays. In either case, these supplies shall be equipped with transient protection to protect the supplies, and the computer, from power line transients as high as six kilovolts.
- B. The Design-builder shall include in the design of this system all equipment and wiring configurations known to protect the computer and its ancillary devices from damage due to lightening or other energy surges. Superior lightning and transient protection shall also be provided for any data transfer lines extending from the commuter housing to locations referenced to a grounding system that is not that of the computer housing. See Section 16922, Lightning/Surge Protection and Grounding Systems

2.04 PROGRAMING REQUIREMENTS

- A. Design-Builder shall provide a means of programming the computer, initially , and as subsequent changes, improvements, and replacements warrant. This means may take the form of a test fixture that shall become the property of the authority at the time of yard acceptance, or, upon prior approval by the Authority, it may take the form of a programing service approved by the Authority, utilizing a furnished coupling unit for making corrections (via a telephone connection) from a programming computer on the Design-Builder's, or other designated premises. If the later alternative is selected, the Design-Builder shall agree, by certified letter, to maintain this service for a minimum of fifteen (15) years, or provide, at any time during the period, an alternative programming means that is satisfactory to the Authority Representative. If the programming service is selected, the Design-Builder shall provide the service for the first year after yard acceptance, at no extra cost to the Authority, and thereafter, at a reasonable hourly charge.
- B. The Design-Builder shall provide two forms of diagnostics, as outlined herein, for each location housing a portion of the "Yard Computer". The degree of refinement in each of these regimes is at the discretion of the Design-Builder, but he shall keep in mind that diagnostic are instrumental in attaining the MTTR specified in Article 1.01 of this section, and that the Authority Representative will be looking for evidence of compliance with this requirement.
 - 1. The Design-Builder shall provide a diagnostics routine to continuously monitor the operation of the computer and its peripheral devices. This may be implemented by the solution of a sample argument during the time the computer is not being used in its Entrance-Exit application, or, it mat take some other form suggested by the Design-Builder (and approved by the Authority Representative) to prove the continue validity of the computational results. In any case, the detection of a computer or peripheral failure by this diagnostic routine shall trigger an alarm. This alarm shall be both audible (with reset pushbutton), and visible on the yard control panel, and shall register on the Event Recorder specified in Section 16929, Event Recording System of these specifications. A visible alarm shall also be displayed in the Train Control

Room. This alarm system should identify the printed circuit board to be replaced, as approved by the Authority Representative.

2. The Design-Builder shall provide a diagnostic routine that can be activated by maintenance personnel to locate a defective printed circuit board of the system that has, through failure of some component located thereon, caused a system shutdown, or other failure of the computer, and which has not been specifically detected and reported by the continuous diagnostics monitor, This may take the form of a hand-held, plug-in diagnostic device and LED indicators (located in printed circuit boards) or it may take some other form suggested by the Design-Builder and approved by the Authority Representative. This routine shall be very thoroughly documented in a maintenance manual.

C. Wherever LEDs are used for troubleshooting or diagnostic purposes, they shall be labeled with the function (or malfunction) they represent.

2.05 SPARE REQUIREMENTS

A. The Design-Builder shall provide, in addition to the plug-in printed circuit cards comprising the computer, a set of cards to be used as replacements. This set of "spare" cards shall contain at least one card for every different card type utilized in the operating system. In addition, where more than one card of the same type is utilized in the system, the Design-Builder shall provide either one card, or 20% of the total number of identical cards used in the operating system, whichever is greater.

B. The spare cards shall be identical to, and interchangeable with, the cards in the operating system.

C. Cards that are physically identical, but differ because of onboard programming shall be considered, for the purposes of spare requirements, as different card types.

D. The Design-Builder shall also provide one spare card cage for each unique module in the computerized Yard Control System.

E. One or more rugged and portable carrying cases with hinged and latched covers and a handle on top shall be provided to house and protect all of the spare printed circuit cards. Card guides shall be fitted into the interior of the case to hold each card and prevent unwarranted contact between the components of any two cards. The bottom of the inside of the case shall be fitted with a one-inch resilient foam pad (closed-cell neoprene) for the protection of the cards from impact during insertion into the case or during transit. The maximum weight of any case with its cards installed shall be twenty-five pounds.

F. The Design Builder shall deliver all spare printed circuit cards and associated equipment to the Authority at least 60 days before the Operational Readiness Date (ORD) for the Yard changes and additions.

2.06 TEST FIXTURE REQUIREMENTS

A. The Design Builder shall provide a complete set of test fixtures for the yard computer. This "set" shall consist of one or more portable units, and shall include any special test devices, instruments, or fixtures which are necessary or desirable to set-up, inspect, maintain, or facilitate the repair of any part of the yard control computer.

- B. The "set" of test fixtures shall include the capability to test and troubleshoot all PC boards used in the Computerized Yard Control System, including I/O boards.
- C. Also included shall be such necessities as board extenders, leads, adapters, and special tools. The Design-Builder shall not include or duplicate any test device furnished under another section of these Specifications. Equipment for actual repair of the printed circuit boards shall not be included.

2 .07 SUPPLIES

The Design-Builder shall provide, if necessary for the equipment selected, sufficient paper and ink supplies for one year.

2.08 INSTRUCTION MANUALS

The Design Builder shall provide instruction manuals for all items of hardware and software included in the computer-based Yard Control System.

PART 3 - EXECUTION

3 .01 DELIVERY, STORAGE AND HANDLING

The Design Builder shall take whatever measures may be necessary to protect the computer and its associated equipment from damage or marring during shipment installation, and testing. If the equipment is marred or otherwise damaged prior to acceptance by the Authority, it shall be repaired to the satisfaction of the Authority Representative or be replaced by the Design-Builder at no additional cost to the Authority.

3 .02 INSTALLATION

- A. The Design Builder shall install the computer-based Yard Control system complete with its program and all appliances necessary to provide a system which operates properly, is readily maintained and is in accordance with these Specifications.
- B. The Design Builder shall separate power wiring from control and indication wiring to the greatest extent practicable and install wiring and equipment in conformance with practices known to improve protection from lightning or other electrical surges. See Section 16922, Lightning/Surge Protection and Grounding Systems.

3 .03 TESTING

- A. The Design Builder shall factory test a complete system, in the presence of the Authority Representative, according to the test procedure he has produced and which the Authority Representative has previously approved. This system shall be composed of the equipment specified in Parts 1 and 2 of this Section. This test shall be successfully completed to the satisfaction of the Authority Representative before the equipment to be furnished is shipped from the factory.

- B. Design-Builder shall field test the installed computer-based yard control system according to a test procedure which he has produced and which the Authority Representative has previously approved.
- C. This testing shall be in the presence of Authority-designated personnel. A minimum of two week's notice shall be given before the commencement of testing.
- D. A log book shall be utilized during, and subsequent to, field testing to record the stop-by-step process of making any changes to the program, should they for any reason, be necessary. This log book shall be updated at the conclusion of each day's work. Failure to provide and utilize a log book will prevent approval of all test reports associated with the computer checkout.
- E. Upon satisfactory completion of operational testing of the Computerized Yard Control System and approval of the test results, the Design Building shall deliver to the Authority three copies of a printout of the completely revised program, three copies of the revised flow charts, three copies of all revised documentation, and the up-to-date logbook.
- F. The final revised program shall be entered into the memories of the computer system, as well as the spare boards.
- G. The complete system test shall be run two times
 1. For the system with original boards and, following approval
 2. For the system with its boards replaced by the spare boards.

3 .04 AUTHORITY PERSONNEL INSTRUCTION

The Design Builder shall provide, on the Authority's premises, classroom and hands-on instruction for the operation and maintenance of the Computerized Yard Control System, for twelve persons designated by the Authority. The instruction shall include in-depth information on the basic design of the Computerized yard Control system. this course shall be presented during the final installation stage of the Computer control system at no additional cost to the Authority.

END OF SECTION

SECTION 16959
SERIES TYPE TRACK CIRCUIT LAYOUTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section specifies the furnishing and installation of series type single rail track circuits, utilizing 60 Hz energy for train detection.
- B. Minimum track circuit length, per operating track, shall be 50 feet.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration.
Section 16912	Yard Signal Submittal Requirements
Section 16914	Environmental Requirements
Section 16917	Basic Interlocking Requirements
Section 16941	Basic Component Requirements
Section 16944	Non-Vital Relays and Timers
Section 16946	Transformers
Section 16949	Signal Wire and Cable
Section 16968	Track Bonding Layouts
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113 Systems Integration

1.04 SUBMITTALS

See Section 16912 Yard Signal Submittal Requirements

PART 2 - PRODUCTS

2.01 TRACK TRANSFORMERS

Track transformers shall be as specified in Section 16946, Transformers.

2.02 ADJUSTABLE RESISTORS

Adjustable resistors shall meet the requirements specified in Section 16941, Basic Component Requirements, and be as described below:

- A. The maximum resistance and continuous capacity ratings for the relay pickup resistor shall be matched to the type of non-vital track relay selected.
- B. The relay pickup resistor shall have a slide tap adjustment over its full resistance range.

2.03 TRACK FUSES

Fuses shall be as specified in Section 16941, Basic Component Requirements, and shall be rated for 600 volts and 6.25 amperes.

2.04 TRACK RELAY

The track relay shall be a non-vital, DC relay as specified in Section 16944 Non-Vital Relays and Timers.

2.05 WIRING

Wiring for power frequency track circuits shall be in accordance with Section 16949, Signal Cable and Wire.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Series type track circuits shall be arranged to provide continuous train detection.
- B. The track relay, diodes and relay pickup adjusting resistor for each track circuit shall be located in a train control room.
- C. The track fuse, track feed transformer, and relay pickup transformer for each track circuit shall be located in a train control equipment case on the wayside in close proximity to the applicable track circuit.
- D. Series type track circuits shall be installed as determined by the Design-Builder subject to review and approval by the Authority's Representative.

3.02 OPERATION

- A. Series type track circuits shall operate satisfactorily, without false occupancy indications, down to a minimum ballast resistance of 4 ohms per 1000 feet.
- B. Series type track circuits shall operate in a satisfactory manner under the environmental conditions described in Section 16914, Environmental Requirements.

END OF SECTION

SECTION 16963

POWER FREQUENCY TRACK CIRCUIT LAYOUTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of single-rail track circuit layouts, utilizing 60 Hz energy, for train detection.
- B. Minimum track circuit length, per operating track, shall be 50 feet.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration.
Section 16912	Yard Signal Submittal Requirements
Section 16914	Environmental Requirements
Section 16917	Basic Interlocking Requirements
Section 16941	Basic Component Requirements
Section 16943	Vital Relays
Section 16946	Transformers
Section 16949	Signal Wire and Cable
Section 16968	Track Bonding Layouts
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113 Systems Integration

1.04 SUBMITTALS

See Section 16912 Yard Signal Submittal Requirements

PART 2 - PRODUCTS

2.01 TRACK TRANSFORMERS

Track transformers shall be as specified in Section 16946, Transformers.

2.02 ADJUSTABLE RESISTORS

Adjustable resistors shall meet the requirements specified in Section 16941, Basic Component Requirements, and be as described below:

- A. The resistor in the feed end shall be 3.0 ohms with a continuous capacity of 200 watts. It shall be capable of a current of 10 amperes and shall have taps allowing the selection of 0.5, 1.0, and 1.5 ohms.

- B. The resistor at the relay end shall be 25 ohms with a continuous capacity of 100 watts. It shall be capable of a current of 3 amperes and have taps allowing the selection of 12, 8 and 4 ohms.

2.03 TRACK FUSES

Fuses shall be as specified in Section 16941, Basic Component Requirements, and as described below:

- A. The fuse in the feed end of the track circuit shall be 600 volt, 8 amperes.
- B. The fuse in the relay end of the track circuit shall be 600 volt, 2 amperes.

2.04 TRACK RELAY

The ac track relay shall be as specified in Section 16943, Vital Relays.

2.05 WIRING

Wiring for power frequency track circuits shall be in accordance with Section 16949, Signal Cable and Wire.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Power frequency track circuits shall be arranged to provide continuous train detection.
- B. All power frequency track circuit equipment shall be located in the local Train Control Room, with the exception of wayside junction boxes and cabling.
- C. The track feed transformer and the local coil of the track relay for each power frequency track circuit shall be fed from the same energy source and phase.
- D. Power frequency track circuits shall be installed as determined by the Design-Builder subject to review and approval by the Authority's Representative.

3.02 OPERATION

- A. Shunting sensitivity of power frequency track circuits shall be .06 ohms or more under dry weather conditions.
- B. Power Frequency track circuits shall operate in a satisfactory manner under the environmental conditions described in Section 16914, Environmental Requirements.

END OF SECTION

SECTION 16964

YARD TRAILABLE SWITCH OPERATING LAYOUTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of Yard Trailable Switch Operating Layouts at the locations indicated on the information drawing track plans.
- B. Each Track Switch Operating Layout shall consist of:
 - 1. A Trailable Switch Machine
 - 2. A Switch Circuit Controller
 - 3. An arrangement of rods and hardware to connect the Switch Machine to the switch points for throwing and detecting purposes
 - 4. All the necessary cable, wire, junction boxes and electrical fittings required to connect the Switch Machine and Circuit Controller electrically to the TCR for operation and indication purposes.
- C. The Design-Builder shall install ALSTOM Model 6 Trailable Switch Machines exclusively for this Contract.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signal Submittal Requirements
Section 16923	TC Maintenance Telephone System
Section 16949	Signal Cable and Wire
Section 16972	Junction Boxes
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

- A. See Section 01113, Systems Integration.

1.04 SUBMITTALS

- A. See Section 16912,
- B. Submit mechanical and electrical drawings for each type of Switch Operating Layout proposed for this Contract. The mechanical drawings shall include keyed material lists complete with part numbers. The drawings to be submitted shall include, but not be limited to:
 - 1. Overall mechanical layouts showing relative location of major components
 - 2. Detailed drawings of the various rods, connecting hardware and electrical fittings
 - 3. Control, operating, indicating and internal heating circuits
 - 4. Detailed wiring diagrams for the Switch Operating Layout movement mechanism and its associated wayside junction box.

1.05 DELIVERY, STORAGE AND HANDLING

All unpainted ferrous metal surfaces of Switch Operating Layout equipment shall be coated with NO-OX-ID "E" grease, petroleum jelly or an approved equivalent, before the equipment is shipped from point of manufacture. Parts constructed of a non-ferrous material or having a painted finish will not require this protective coating.

PART 2 - PRODUCTS

2.01 Trailable Yard Switch Movement

- A. A Trailable Switch Machine shall be provided as part of each Switch Operating Layout.
- B. A Switch Circuit Controller shall be provided as part of each Switch Operating Layout.

2.02 Trailable Yard Switch Operating Layouts

This section specifies the final design, furnishing and installation by the Design-Builder of trailable switch operating layouts for guarded-point switches. The specifications included under this subheading are to be considered additions to all other requirements outlined in this document.

- A. A symbol form, shown on the Double Line Track Drawings, is used to indicate various locations where trailable switch operating layouts are to be furnished and installed. The guarded point housing (by others) is located on the "diverging" side of each turnout in the yard.
- B. For this Contract, Alstom Model 6 Switch Machines, DWG. No. 52500-004-18 shall be installed exclusively in all layouts.
- C. The switch circuit controller shall be a separate piece of equipment equipped with four front and four back dependent contacts to check the position of the switch points. It shall be operated by a separate, insulated detector rod attached to a point lug mounted on the switch point nearest to the switch machine and circuit controller housing, whether that switch point is normally open or normally closed.
- D. Threaded parts of the switch operating layouts which require periodic adjustments or maintenance, such as throw rods, detection rods, and mounting bolts, shall conform to American standards. American standards shall also apply to threaded conduit outlets.
- E. Switch mechanisms shall be equipped with 110 volt dc motors. The mechanisms shall be capable of operating the switch points through a full stroke on 80 percent of nominal voltage in not more than 1.5 seconds, and shall exert at least 1000 pounds retaining force on the switch points in both their NORMAL and REVERSE positions.
- F. All trailable switch operating mechanisms shall have a timing relay incorporated within the switch operating network. The timing relay shall remove energy from the NWR and RWR relays if an obstruction is encountered. The timing relay shall operate in no less than three seconds, and no more than five seconds after the point detector contacts open.

- G. The trailable switch operating mechanisms provided by the Design-Builder will be required to operate No. 6 and No. 8 guarded-point switches having a throw of up to 5.00 inches. The layouts for these switches shall be substantially as shown on the Information Drawings.
- H. Each trailable switch operating layout shall be circuited in such a manner that, after being trailed through, it shall be electrically restorable to correspondence, but only by appropriate manipulation of a special, sealed "Trailed Switch Reset" pushbutton located in the Train Control Room. This pushbutton shall be of the same type and manufacture as the pushbuttons specified in Section 16957, Yard Control Machines.

2.03 RODS

- A. Provide the following separate, insulated rods and associated equipment as part of each Track Switch Operating Layout
 1. Throw rod and throw rod basket
 2. Detector rod and point detector lug
- B. No welded components will be allowed. All rods and lugs shall be forged unless otherwise directed in writing by the designated Authority's Representative.
- C. When offsets are required in the rods, the rods shall be offset during manufacture. At least 15 inches of threaded area shall be supplied on each rod to accommodate a wide latitude of operating adjustments.
- D. Insulation required for the above rods and equipment shall be of the type recommended in Part 14.5.3 of the AREMA Signal Manual.
- E. The rods shall be of appropriate length to provide the specified distance from centerline of track to centerline of switch layout. Any modifications necessary to meet this requirement shall be performed by the Design-Builder in a manner satisfactory to the Authority's Representative at no additional cost to the Authority.

2.04 JUNCTION BOX

- A. Each Switch Operating Layout shall include a junction box suitable for terminating the interconnecting wire and cable adjacent to the Trailable Switch Layout.
- B. A cast iron, pedestal mounted junction box shall be furnished for layouts to be situated in ballasted construction areas. See Section 16972, Junction Boxes.
- C. A TC Maintenance Telephone jack shall be installed in the junction box. See Sections 16972 and 16923.
- D. If the switch machine junction box or WJ is located on the opposite side of the track from the switch machine, or if the WJ is located at a distance greater than 12 feet from the switch machine, an additional TCM phone jack (which is accessible without removing any covers) shall be installed at or near the switch machine.

2.05 PULL BOX AND ELECTRICAL FITTINGS

- A. Each Track Switch Operating Layout shall include all the conduit, connectors, terminal blocks and other electrical fittings required for the switch control, operation and indicating wiring between the Trailable Switch Layout and the TCR.

2.06 MISCELLANEOUS HARDWARE

- A. Two cast metal letters, "N" and "R", at least three inches high, painted white, and drilled to provide a means of attaching them, shall be furnished to denote the Normal and Reverse positions of the switch points.
- B. Furnish all screws, bolts, nuts, washers, pins, cotter keys, shims, plates and other hardware required to connect the rods to the Trailable Switch Layout and to the switch points. In ballasted track areas the Design-Builder shall also furnish tie straps as shown on the Information Drawings.

2.07 PAINTING

All equipment described in this Section shall be painted in accordance with the recommendations of Sections 29 and 30 of Part 2.4.30 of the AREMA Signal Manual. The finish color shall be black.

2.08 EQUIPMENT PROVIDED BY OTHER DISCIPLINES

- A. The switch rods of each track switch will be furnished as part of the trackwork.
- B. Switch ties for mounting the switch machine and circuit controller will be furnished as part of the track turnout for each new Track Switch Operating Layout in yard track areas.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Switch Operating Layouts shall be installed as per approved installation drawings.
- B. In ballasted construction areas, the Design-Builder shall be responsible for any ballast removal required to install the switch operating layouts. Excess ballast shall be spread evenly between ties in the vicinity of the track switch. Likewise, the Design-Builder shall be responsible for all drilling, dapping, shifting, relocating or replacement of ties that may be necessary to meet the requirements indicated on the approved drawings. Whenever ties are shifted, relocated or replaced, the Design-Builder shall re-tamp them to a fully stable condition. The Design-Builder shall be responsible for restoring the track to proper alignment and profile at no additional cost to the Authority.
- C. Cables terminating in the switch junction box shall be dressed and potheaded as specified in Section 16949. The individual conductors shall be fanned in a neat workmanlike manner, and properly tagged and terminated. Internal wire, as specified in Section 16949, shall terminate in the switch junction box and also in the switch mechanism in a neat workman like manner.

This wire shall also be properly tagged and terminated. The wire between the switch junction box and the switch mechanism, or switch circuit controller, shall be installed in an appropriate length of flexible hose as specified in Section 16973. The hose shall be fastened to the switch junction box, switch circuit controller, and switch mechanism with stainless steel hose clamps as specified in Section 16973.

- D. Where the switch circuit controller cover opens into the dynamic outline of the transit cars, the Design-Builder shall provide a means for the quick and easy removal of the cover for maintenance purposes.

3.02 IDENTIFICATION

The two cast metal letters "N" and "R" shall be securely mounted inside the running rails, attached to the first tie adjacent to, but not supporting, the switch points to denote the Normal and Reverse positions of the switch points. The letter "N" shall be mounted on the normally open point side as shown on the Information Drawings.

3.03 LUBRICATION

- A. Lubricate all moving parts and bearing points of the switch machine upon switch machine installation, with lubricants approved by the designated Resident Engineer. Any moving parts of the switch layout which are frozen shall be freed prior to being lubricated.
- B. Upon installation of the layout, grease the various rod fittings, thoroughly clean, and apply an Authority approved graphite lubricant to the tie plates under the switch points, and to the inside of the joint bars holding the heels of the switch-point rails. Rusted plates shall be wire brushed to remove any scale prior to being lubricated.
- C. Apply a supplemental coating of NO-OX-ID "E" grease, or approved equivalent, to exposed threaded surfaces to prevent corrosion.

3.04 ADJUSTMENT

- A. Adjust the rods in such a manner that the proper point detector contacts indicate switch closure when a switch point is within 1/8 inch of its stock rail and no point detector contacts are closed when both switch points are 1/4 inch or more from their respective stock rails, with the specified obstruction measurements being made 6 inches back from the switch points.
- B. The adjustment shall result in the switch points being at least 4-3/4 inches, and not more than 5-1/8 inches from the stock rails when in their "Open" position. For guarded-point switches, the adjustments shall result in switch points being at least 3-3/4 inches, and no more than 4 inches from the stock rails when open.
- C. Final adjustment shall result in a complete "tuck" of the point rail under the machined portion of the stock rail, with point-to-stock rail contact.
- D. These adjustments shall be maintained by the Design-Builder from the time of installation until acceptance by the Authority. All of these adjustments shall be verified (and corrected if necessary) by the Design-Builder, not more than 30 days prior to acceptance by the Authority.

3.05 MAINTENANCE

Switch Operating Layouts shall be properly lubricated, adjusted, and maintained by the Design-Builder on a regular timed basis until use and possession of the switches is taken by Authority Rail Systems Maintenance at the time of acceptance by the Authority. The Authority will assume responsibility for switch adjustment and maintenance at that time.

END OF SECTION

SECTION 16965

SIGNAL LAYOUTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of Signal Layouts at the various locations required under this contract, and the final design by the Design-Builder of modifications to standard signal layouts where necessary.
- B. Each Signal Layout shall consist of:
 - 1. A complete color light signal unit
 - 2. All required mounting devices and related hardware
 - 3. All electrical fittings and cable required to provide the specified signal control and/or lighting circuitry for the wayside signal unit.
- C. Types of Signals to be provided: Controlled Signals (Three Lenses - R/LW/R)
- D. All signals shall be identical.
- E. Controlled signals shall be used to govern the movement of trains:
 - 1. Through interlocking plants (Interlocking Signals) (or as "Repeater Signals" for Interlocking Signals where sighting problems or other special situations are encountered.);
 - 2. For entrance to segments of "running tracks" between interlockings (Intermediate Signals), or;
 - 3. From tail track storage areas (Holdout Signals).
- F. Based upon on-site inspection, the Design-Builder shall determine, for every required signal location, if there is a potential sighting, clearance or interference problem for signals installed in the normally specified manner. For every signal location where such a potential problem exists, the Design-Builder shall design and submit thorough documentation for whatever alterations and/or additions to the normal installation layout are necessary to overcome the potential problem.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16914	Environmental Requirements
Section 16915	Basic Yard Signal Equipment Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16923	TC Maintenance Telephone System
Section 16949	Signal Wire and Cable
Section 16972	Junction Boxes
Section 16974	Locks and Keys
Section 16975	Foundations
Section 16978	Miscellaneous Train Control Components and Materials
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration.

1.04 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements.

1.05 DELIVERY, STORAGE AND HANDLING

Signal lamps shall be shipped separately from the signals.

PART 2 - PRODUCTS

2.01 SIGNAL UNITS

A. Each color light signal unit shall consist of the following components.

1. Housing
2. Lenses
3. Lamps and lamp receptacles
4. Adjustable transformers
5. Backlights
6. Terminal boards and wiring
7. Number plate
8. Mounting device
9. Lens hoods
10. Mast and base or wall mounting bracket, as applicable.
11. Ladder or pole steps, as applicable

B. Signal units shall be similar to those depicted on Alstom Signaling Inc. (GRS) Drawing No. 45906-358, Union Switch & Signal Inc. (US&S) Part No. N451357, or approved equal.

2.05 SIGNAL HEAD TRANSFORMERS

The transformers shall have a nominal primary voltage of 120 volts, a nominal secondary voltage of 10 volts and power rating of 60 watts, all at 60 Hz. They shall have input voltage taps for 110 to 125 volts in five-volt steps, and output voltage taps for five to 12 volts in one-volt steps.

2.07 NUMBER PLATES

- A. Equip each Controlled Signal and Marker Signal with a sheet steel number plate. The number plates shall have white reflex-reflecting lettering on a black synthetic enamel background.
- B. The number plate for each Controlled Signal shall have two lines of 2-inch high lettering. The top line shall be the route initial and location designation number, and the bottom line shall be the signal number. The lettering on the plate shall be of similar design, layout and dimensions as found on the existing yard signal number plates.
- C. Number plates shall meet the applicable recommendations established by Part 14.6.1 of the AREMA Signal Manual.

2.09 MAST AND BASE

- A. The mast for each mast-mounted signal shall consist of an approved pipe pole four inches in diameter supported by an approved split cast-iron base of the appropriate type with a junction box.
- B. The cast-iron base shall be of the junction box type. The junction box base shall be equipped with at least six pairs of AAR terminals for the signal lamp wiring and a weatherproof telephone jack for the TC Maintenance Telephone System. The AAR terminals shall be accessible by a cover or door, equipped with provisions for padlocking. Opening this cover or door shall not require the removal of any other part of the signal assembly.

Note: Each type of base shall have four mounting holes suitable for 3/4-inch diameter foundation bolts arranged on 9-1/2 by 9-1/2 inch centers.

2.10 POLE STEPS

Pole steps shall be of the double-sided type, mounted as follows:

- A. The top step shall not be lower than 5 feet below the top of the signal.
- B. The bottom step shall be 1 foot above the pole base.
- C. The maximum distance between steps shall not exceed 12 inches.
- D. Steps shall be uniformly spaced.

2.12 PAINTING

Paint the metal components of each signal layout in accordance with the recommendations of Part 2.4.30 of the AREMA Signal Manual. The finish coat of paint shall be dull black.

PART 3 - EXECUTION

3.01 INSTALLATION

Attach the base for each mast-mounted signal to the concrete foundation by means of anchor bolts cast into the concrete.

3.02 LOCATION AND HEIGHT

- A. Install signals on the right side of the right-of-way (for the direction in which their aspects govern) wherever clearance and sighting conditions permit. Controlled signals shall be located 6 ft. (+0,-1) downstream from the effective Insulated Joint (IJ).
- B. Mast-mounted Controlled signals shall normally be installed with their bottom lens 7'-4" above top-of-rail.

3.03 ALIGNMENT AND FOCUSING

- A. Signals shall be aligned and focused, both horizontally and vertically, in such a manner that the aspects displayed, when viewed from a position seven feet above the top of the right-hand running rail, shall be distinct, unmistakable and continuously visible over a distance of 500 feet upstream from the signals, day or night, under the most adverse environmental conditions indigenous to the Washington, D.C. metropolitan area.
- B. Where track or tunnel curvature, grade change, or other conditions make sighting impossible at 500 feet, the signal shall be mounted, aligned and focused to provide continuous sighting over the greatest distance possible, but under no circumstances shall this continuous sighting distance be less than 300 feet.

END OF SECTION

SECTION 16968

TRACK BONDING LAYOUTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of all negative return bonding required to complete the negative propulsion return system.
- B. This Section specifies the furnishing and installation of "signal rail" joint, switch jumper, and transposition bonding for power frequency track circuits.

1.02 NEGATIVE RETURN BONDING

Negative Return Bonding is required as follows

- A. Around all negative-return rail, bolted or "glued," and non-insulated rail joints in special trackwork areas
- B. To and around trackwork frogs in the negative-return rail, and to isolated pieces of running rail in the frog assemblies
- C. To the heels of negative-return rail track switch points
- D. As a transposition bond in the middle of single crossovers using power frequency track circuits, and wherever the location of negative-return rails must be transposed
- E. As cross bonding between parallel track impedance bonds, and between through track and diverging track impedance bonds at junction switches.
- F. Around all extraneous or abandoned insulated joints in negative-return running rails,
- G. Between the two closure rails of each turnout adjacent to the turnout frog.
- H. At such other locations as necessary to provide an electrically bonded path of adequate capacity for the negative propulsion current around non-insulated, bolted connections in the negative return running rails.

1.03 SIGNAL RAIL BONDING

- A. All signal rail within the limits of power frequency track circuits to be provided under this Contract shall be properly bonded to provide complete power frequency track circuits having the greatest degree of broken-rail protection and shunt detection
- B. Provide all signal rail bonding necessary to provide a series path for the track circuit current through the greatest length of signal rail practicable.

- C. Do not bond around frogs in the signal rail, but provide signal rail bonding to the ends of the frog castings, where necessary, or to frog-flangeway/signal-rails, which are continuous through the frog.
- D. Provide signal rail bonds between the extremities of the two legs of the track circuit signal rail which extend to insulated joints beyond each signal frog of a diamond crossover.
- E. Provide all signal rail bonds and transpositions necessary to produce a single, continuously bonded, maximum-length path through the signal rail and around all bolted or "glued" non-insulated joints in the signal rail.
- F. Where restraining rail is used in conjunction with a signal running rail, bond each end of each individual rail segment of restraining rail to its associated running rail.
- G. Signal rail bonding connections shall be made as close to the rail joints as practicable to ensure maximum broken rail detection.

1.04 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signal Submittal Requirements
Section 16917	Basic Interlocking Requirements
Section 16949	Signal Wire and Cable
Section 16963	Power Frequency Track Circuit Layouts
Section 16978	Miscellaneous Train Control Components and Materials
Section 16989	Yard Test and Inspections

1.05 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.06 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements

PART 2 - PRODUCTS

2.01 NEGATIVE-RETURN-RAIL JOINT BONDS

Negative-return-rail joint bonds shall be fabricated for compression bolting to the web of the rail. They shall consist of 500 kcmil size, insulated, ropelay cable, 48 inches long with Burndy type YA34-L terminal lugs on each end, two for each location, except only one for switch point rail heels.

2.02 1000 KCMIL CABLE BONDS

Substation-return bonding, cross-bonding or switch bonding (to include running-rail-transposition bonding at single switches), shall consist of a 1000 kcmil cable which meets the requirements of

Section 16949, with an appropriate connector which meets the requirements of these Specifications, on each end.

2.03 CABLE-TO-RAIL CLAMPS

Base-of-Rail clamps for connecting negative propulsion return cables to the running rails shall be sized to accommodate 115 RE rail and 1000 kcmil cable, as shown on the Information Drawings. Rail clamps shall be Part Number 115-1000, as manufactured by Connector Products, Inc., Camden/Pennsauken, New Jersey, or approved equal.

2.04 COMPRESSION EYE FITTINGS

H. Compression-eye type terminal fittings shall be used to attach 1000 kcmil cable to impedance bonds and certain other terminating devices. The compression terminal shall be made of drop-forged copper and formed for compression onto the strands of the cable in accordance with approved methods used by manufacturers experienced in this class of manufacture. Terminals shall be of soft ductile copper, drilled for bolting onto the ears of the impedance bonds or other terminating devices without cracking. Care shall be taken in compressing terminals to strands so as not to reduce the cross section of the conductor or to injure any of the individual strands. The strands, at the point where they leave the terminal, shall be sufficiently soft to permit being bent to an angle of 90 degrees with the axis of the cable and back to their normal position without breaking. Auxiliary sleeves of the terminal shall be arranged so as not to pinch the wires entering the sleeves.

2.05 WELDED RAIL HEAD NEGATIVE RETURN BONDS

- A. Prefabricated rail head bonds for welding around joints between consecutive rails shall be 250 kcmil size, 13 inches long, two for each location; as manufactured by Erico Products, Inc., Cadweld Type C bond, or approved equal.
- B. Negative return rail head bonds for welding between adjacent, non-consecutive rails or to frog wing rails shall be 250 kcmil size, of appropriate length for each individual location, with appropriate components as manufactured by Erico Products, Inc., or approved equal.
- C. The welding material shall consist of a copper exothermic mixture appropriate for the types of rail to which the bonds are to be welded.

2.06 MISCELLANEOUS NEGATIVE RETURN BONDING HARDWARE

Fasteners for compression-bolted bond connections shall be 5/8-inch diameter compression fasteners, Huck MFG. Co. C50LR-BR20-16 (for two bonds) or C50LR-BR20-12 (for one bond).

2.07 SIGNAL RAIL JOINT BONDS

- A. Non-insulated signal rail joint bonds shall be commercial bonds as manufactured by Erico Rail Transportation Producers Type SBPAJB-"A" or approved equal, consisting of sixteen extra-galvanized steel wires and three copper wires.
- B. Insulated signal rail joint bonds shall be assembled by the Design-Builder and shall consist of two commercially available track connectors and the required length of insulated cable. The track connectors and cable shall be as close as practicable to the same size/gauge and

composition as the non-insulated signal rail joint bonds.

- C. Signal bond wires shall be as recommended in Part 8.1.25 of the AREMA Signal Manual except as otherwise specified herein.

PART 3 - EXECUTION

3.01 INSTALLATION OF NEGATIVE RETURN BONDING

- A. Provide negative-return bonding around all non-insulated negative-return rail joints and around all extraneous or abandoned insulated joints, both in running tracks and within interlocking limits. Two 500 kcmil insulated cable, compression-bolted rail web bonds (one on each side of the web of the rail) shall be used for this purpose wherever possible. These bonds shall be properly bolted to the center of the web of the rails in the positions indicated on the Information Drawings. The Design-Builder shall drill and de-bur 21/32-inch holes at the center-line of the web of rails for the 5/8-inch fasteners.
- B. Should conditions be encountered where it is not practicable to install either compression-bolted bonds or clamped, base-of-rail bonds, appropriate bond connections of the expansion pin type or the welded rail-head type shall be used.
- C. Install all negative return rail joint bonds, rail transposition bonds, and switch, frog, and cross bonds as specified herein. Joint bonds shall be installed close to the ends of the rail joint bars in order to maximize broken rail detection. All 500 kcmil rail bonds shall be compression-bolted to the rail at the centerline of the web of the rail.
- D. For all rail-head and rail-web bonding, the bond terminal lugs and the surfaces of the rails which are to come in contact with the molten metal or the terminal lugs shall be ground clean with a vitrified grinding wheel. The rail brand shall also be ground off in areas where rail-web bolted bonds are to be applied. After grinding, terminal lugs and rails shall be cleaned with Inhibisol, or other approved, non-toxic solvent, to remove all traces of grease and dirt. The applicator brush shall be kept free of dirt and debris during cleaning operations.
- E. Welded rail-head bonds shall be attached to the rail by an approved exothermic process in such a manner as to ensure the necessary mechanical and electrical connection. The welding mixture shall be appropriate for the type(s) of rail to which the bonds are to be welded.
- F. After thoroughly cleaning the applicable surfaces of the rail and the connector hardware for compression-bolted bonds and base-of-rail clamped bonds, the Design-Builder shall liberally coat the surface of the copper conductor, and the mating surfaces of the rail and the connector hardware with an anti-oxidation compound before assembly. This compound shall be "Kopr-Shield" Part No. CP128, as manufactured by Thomas & Betts or approved equal. The bond shall then be attached to the rail in such a manner as to ensure the necessary mechanical and electrical connection.
- G. Base-of-rail cable clamps, as shown on the Information Drawings, shall be installed as per manufacturer's instructions. The torque recommended by the manufacturer shall be applied by torque wrench to ensure the necessary mechanical and electrical connection.
- H. Compression-bolted rail web bonds shall be installed as per the manufacturers instructions,

using the recommended equipment to attach properly sized terminating devices to the center of the web of the rail.

3.02 INSTALLATION OF SIGNAL RAIL BONDING

- A. Install all signal rail joint bonds, jumpers and transposition bonds as specified herein, in accordance with the manufacturer's instructions, and as shown on the detailed installation drawings submitted by the Design-Builder.
- B. For all signal rail bonding, no hole shall be drilled through the rail brand. Holes shall be drilled perpendicular to the rail by an approved rail drilling machine within plus or minus three-sixteenths inch of the neutral axis of the rail. Holes shall be a maximum of three-eighths inch in diameter. All holes shall be cleaned and deburred before the bonds are installed. Bond wires shall be installed the same day as the hole is drilled. In the event bond wires cannot be installed the same day, the bond hole shall be protected with a suitable plug for protection against the elements. The bond pin shall not be driven to the pin's shoulder. After the bond pin has been driven, a coating of no-oxide grease shall be applied to the surface of the bond where it contacts the rail. Under no circumstances shall any lubricant be applied before the bond has been driven.
- C. Where space does not permit the drilling of the hole into the web of the rail for installation of switch bonds, the hole shall be drilled into the base of the rail.
- D. It shall be the Design-Builder's responsibility to ensure that signal bonding for each given track circuit does not cause the signal rail to become grounded or to contact some extraneous energy source or the signal rail of another track circuit.
- E. Signal rail joint bonds shall be held in place by a protector clips.

END OF SECTION

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SECTION 16969

SNOWMELTER LAYOUTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of snowmelter layouts for all track switches within the limits of this Contract. These locations are indicated on the Information Drawings.
- B. Each snowmelter layout shall consist of:
1. a contact rail fuse box
 2. two tubular electric heating elements (switch point snowmelters) for attachment to the stock rails of turnouts in the switch point area
 3. two power-limiting (auto-therming) switch rod heater units for installation under the throw rod and lock rods
 4. a snowmelter control unit (case) for the wayside control and indication of the snowmelters and switch rod heaters and foundations
 5. all external signal cable, conduit, rail connections and other miscellaneous hardware required to mount this equipment and to interconnect it with the TCR as specified herein, and as shown on the Information Drawings

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signal Submittal Requirements
Section 16916	Basic Yard Signal Circuit Requirements
Section 16918	Special Yard Signal Requirements for Specific Locations
Section 16923	TC Maintenance Telephone System
Section 16932	Spare Yard Signal Equipment and Selectable Items
Section 16941	Basic Yard Signal Electrical and Electronic Components
Section 16949	Signal Wire and Cable
Section 16957	Yard Control Machine
Section 16964	Trailable Yard Switch Operating Layouts
Section 16973	Conduit
Section 16974	Locks and Keys
Section 16975	Foundations
Section 16977	Tagging and Marking
Section 16978	Miscellaneous Train Control Components and Materials
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.04 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements

1.05 SHIPPING AND HANDLING

- A. All snowmelter heating elements furnished under this Contract shall be packed, shipped and handled in such a manor that they are delivered to the Authority work site and installed without bends, kinks or any other damage.
- B. All snowmelter layout parts furnished by the Design-Builder which are damaged in the course of shipment, handling or installation, shall be replaced by the Design-Builder.

PART 2 - PRODUCTS AND MATERIALS

2.01 SWITCH POINT SNOWMELTER HEATING ELEMENTS

The snowmelter heating elements provided under this Contract shall be Chromalox switch point heaters designed specifically for WMATA applications, per Chromalox drawing "Track Switch Heater for WMATA".

2.02 SWITCH ROD HEATER UNITS

- A. The snowmelter heating elements provided under this Contract shall be Chromalox switch point heaters designed specifically for WMATA applications, per Chromalox drawing "Track Switch Heater for WMATA".
- B. Each heater unit case shall bear the following legend on its top surface in three-inch high red letters:

DANGER - HIGH VOLTAGE - THIS SIDE UP

2.03 SNOWMELTER CONTROL UNITS

- A. Snowmelter control case housings shall be of a type as manufactured by Robroy Industries, of Belding, Michigan, or approved equal.
- B. Each Snowmelter Control Unit shall consist of a fiberglass case containing all the components specified herein to control and indicate the operation of the snowmelter heating elements and switch rod heater units for a maximum of two track switches.
- C. Contactors
Snowmelter contactors shall be 60 Amp. 750 Vdc, Part No. LTHS60, as manufactured by Microelettrica Scientifica, or approved equal.
- D. Snowmelter Current Monitoring Devices
Snowmelter Current Monitoring Devices shall be DC Current Monitors, Series 930400 of appropriate amperage as manufactured by Gort Electronics Company, or approved equal.

- E. Case Heaters
Each snowmelter control case shall be equipped with two 100 watt, 500 ohm, 120 volt insulated strip heaters, wired in parallel and mounted as shown on the Information Drawings to control moisture condensation within the housing.
- F. Local Disconnects
 1. Provide a manual knife switch (rated at 1000 volts DC, 100 amps) in an insulated enclosure to enable maintenance personnel to control all high voltage energy to the case, as indicated on the Information Drawings.
 2. Provide an enclosed 250 volt manual breaker switch disconnect for the case heaters, mounted in the case as indicated on the Information Drawings.
- G. Fuses
Fuses shall be Gould-Shawmut A100X form 101 type 4, as manufactured by the Gould-Shawmut Company, of Newburyport, Massachusetts.
- H. Wire
 1. All snowmelter control case internal wiring shall be insulated for 1000 volts and shall meet the applicable requirements specified in Section 16949, Signal Wire and Cable.
 2. Low voltage control, indication and communication wiring shall be run separately from all the 750 volt heater element wiring.
- I. Terminals
 1. Solderless screw type terminals of the appropriate size shall be provided at the bottom or on the hinge side of the control case backboard for the 750 volt wiring terminations.
 2. Standard AAR binding post terminals shall be provided at the top of the latch side of the control case backboard for the low voltage control, indication, case heater, and communication wiring terminations.
- J. Telephone Jack
See Section 16923, TC Maintenance Telephone System.

2.04 CONTACT RAIL FUSE BOX

- A. Contact Rail Fuse Boxes shall be Fused Disconnect, Part No. 350000-8X (up to 60 Amp fuse) or Part No. 350000-9X (60-150 Amp fuse), as manufactured by UniTrac Systems Inc., 100 Impulse Way, P.O. Box 889, Mount Olive, NC 28635, or approved equal.
- B. One contact rail fuse box shall be provided to feed each snowmelter control case required.

2.05 WIRE AND CABLE

Wire and cable for snowmelter layouts shall be as specified in Section 16949, Signal Wire and Cable. All heater element and switch rod heater unit wiring shall be insulated for 1000 volts.

2.06 CONDUIT

Conduit used to protect snowmelter wire and cable surface runs in direct-fixation areas, and for entrance to the snowmelter control cases, shall be schedule 80 PVC or fiberglass reinforced epoxy (FRE), as specified in Section 16973, Conduit.

PART 3 - EXECUTION

3.01 INSTALLATION OF SNOWMELTERS

Install all snowmelter heating elements on the field side of the stock rails in a manner which meets the following requirements

- A. The heater shall be located on the stock rail with the active part extending from two feet ahead of point-of-switch to the vicinity of the heel block.
- B. The heater shall be secured to the lower half of the web of the rail by means of supports spaced 18 inches to 24 inches apart (except at the anti-creep collar). One support shall be located on the rail ahead of the switch point. Special support clamps shall be provided for securing the heater half of the separable connectors to the rail in such a manner that the alignment rib on the connector is visible.
- C. A heater support shall be placed against each end of the anti-creep collar on the heater to prevent longitudinal movement. All other supports shall be arranged to allow longitudinal movement of the heater as a result of expansion and contraction.
- D. All supports shall be secured by means of 3/8 inch corrosion-resistant bolts.
- E. Drill 13/32 inch holes in the web of the stock rails (at the neutral axis) for the 3/8 inch bolts used to secure the heater support clamps and terminal housing support clamps. The bolts shall be inserted from the gauge side of the rail with the washers and nuts installed on the field side of the rail.
- F. Leads between the heating elements and the control case shall be located so as to minimize possible damage. Where necessary, mechanical protection shall be provided.

3.02 INSTALLATION OF SWITCH ROD HEATER UNITS

- A. Install Switch Rod Heater Units and all associated control, operation and indication wiring as specified herein and as indicated on the Information Drawings.
- B. Two Switch Rod Heater Units shall be provided as part of each Snowmelter Layout. One unit shall be installed under the switch throw rod and the other unit shall be installed under the switch lock rod.
- C. The Design-Builder shall remove the ballast to the level of the bottom of the ties in the two cribs under the switch rods, and in a direct line beyond these cribs to provide a drainage path for the crib.

- D. The heater units shall be centered in each crib, with the energy leads located on the end away from the switch machine, as indicated on the Information Drawings. The distance from the bottom of the switch rod to the top of the heater unit shall not exceed two inches.
- E. Plug-connect the heater units to their appropriate energy and negative-return leads and secure the leads and plug connectors to the ties, or to the surface of the concrete slab, as applicable, to prevent the leads from catching on carborne equipment or presenting a tripping hazard to maintenance personnel, all as indicated on the Information Drawings. There is no "polarity" requirement for the individual switch rod heater units, but each unit must be connected in parallel with a snowmelter heating element.
- F. Install tie straps or brackets above each crib containing a Switch Rod Heater Unit to prevent the heater unit from moving upward out of the crib.
- G. Each Switch Rod Heater Unit for a given switch shall be wired in parallel with one of the Snowmelter Heating Elements for that switch.

3.03 INSTALLATION OF SNOWMELTER CONTROL UNIT

- A. Each snowmelter control unit shall be located more than ten feet from other signal and electrical equipment, if practicable, but no closer than six feet from other signal and electrical equipment, and no more than 75 feet from the snowmelter heating elements and switch rod heater units it controls.
- B. Snowmelter control cases shall be mounted on foundations of the type specified in Section 16975, Foundations.
- C. The snowmelter control cases shall be mounted with the front, back and sides vertical and the top and bottom horizontal, all within a tolerance of 1/8 inch.
- D. The cases shall be installed in such a manner that their doors shall open, close, seal and lock properly without binding.
- E. Upon installation, each snowmelter control case shall be locked with a padlock of the type specified in Section 16974, Locks and Keys.

3.04 SNOWMELTER CONTROL CASE CONNECTIONS

Install two vertical conduits in the bottom of each snowmelter control case. Install all high voltage wiring in the conduit near the hinge side of the case and all low voltage control, indication and communication wiring in the conduit near the latch side of the case.

3.05 INSTALLATION OF FUSE BOX

The contact rail fuse box shall be installed as indicated on the Information Drawings.

3.06 RAIL CONNECTIONS

- A. The snowmelter energy supply cable to the contact rail fuse box shall be connected to the power third rail by means of an exothermic weld as shown on the Information Drawings.

- B. The negative return lead for each snowmelter heating element shall be connected to the neutral axis of the nearest negative propulsion return rail by means of an exothermic weld as shown on the Information Drawings.
- C. The negative return lead for each switch rod heater unit shall be connected to the neutral axis of the same negative propulsion running rail as the negative return lead of its parallel-connected snowmelter heating element. Under no circumstances shall the negative return lead for a switch rod heater unit be connected to the opposite running rail from the negative return lead of its parallel-connected snowmelter heating element.

3.07 IDENTIFICATION

- A. The identification letters "SM" and the number(s) for each snowmelter layout controlled from that case shall be stenciled on both the inside and outside of the case door. (The identification number(s) shall correspond to the number(s) of the track switch(es) for which snowmelters are controlled from that case.) The lettering shall be at least two inches high. This stencilling shall be in addition to the embossed metal name tag required on the outside of the case door.
- B. The positive and negative leads of each snowmelter heating element, switch rod heater unit, and both high voltage cables emerging from the contact rail fuse box shall be provided with brass tags engraved with the legend "DANGER - 750 VOLTS".
- C. The brass tags shall be securely attached to the power cable or wire with No. 14 AWG stainless steel wire in such a manner that the insulation on the power leads is not damaged.
- D. Each contact rail fuse box shall have an approved type of label or stencil applied to an outside end of the box, designating the number(s) of the applicable track switch snowmelter layout(s) energized from that box.

3.08 SURFACE MOUNTED CONDUIT

Dedicated conduit runs shall be provided for high-voltage snowmelter energy cables.

3.09 DOCUMENTATION

Place a complete, AS-BUILT set of drawings for the applicable snowmelter layout(s) in the print pocket on the door of each snowmelter control case.

END OF SECTION

SECTION 16971

RACKS AND CABLE TRAYS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of free standing, shock mounted metal racks in the Train Control Rooms to support various types of Yard Signal equipment. Three basic types of racks shall be provided as follows:
1. Entrance racks
 2. Power Racks
 3. Equipment Racks
- B. This Section specifies the design, furnishing, installation and inspection of cable tray systems above and adjacent to racks in and about the Train Control Rooms.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signal Submittal Requirements
Section 16915	Basic Equipment Requirements
Section 16921	Yard Signal Power Distribution Systems
Section 16922	Lightning/Surge Protection and Grounding Systems
Section 16923	TC Maintenance Telephone System
Section 16945	Plugboards and Cabinets for Relays and PC Cards
Section 16948	Plug Connectors
Section 16949	Signal Wire and Cable
Section 16977	Tagging and Marking
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.03 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements

1.04 DELIVERY, STORAGE AND HANDLING

Any cable tray sections damaged during shipment, storage, or handling shall be replaced by the Design-Builder

PART.2 - PRODUCTS

2.01 BASIC RACK CONSTRUCTION

- A. All racks shall have frame weldments constructed of 14-gauge cold-rolled steel and designed to mount standard 19-inch equipment panels. Neither the width nor the depth of the frame unit shall exceed 24 inches. The frame weldment shall be designed to accept universally adjustable panel mounting hardware. The panel mounting angles shall be constructed with standard EIA hole spacing.
- B. The racks shall be mounted on, and secured, to 12-gauge cold-rolled steel bases, floor-supported to make free-standing units. These bases shall be 24 inches deep (front to back) and the same width as the rack, and shall be 3-1/2 inches high. These bases shall provide an insulation resistance between the rack frame and ground of at least 100,000 ohms.
- C. Chassis supports or guides shall be provided for auxiliary support of heavy equipment such as power supplies. The chassis supports shall be made of 11-gauge cold rolled steel. They shall be capable of being mounted directly to the panel-mounting angles and shall permit side-to-side guide adjustment.
- D. Each rack shall be equipped with a ground connector of the bolted type to permit removal of the ground connection for testing insulation between racks. See Section 16922.
- E. The overall height of each rack shall not exceed 7-1/2 feet.
- F. Each rack shall be equipped with two TC Maintenance Telephone Jacks of the type specified in Section 16923, and as shown on the Information Drawings.
- G. All racks shall be painted gray.
- H. Each rack shall be identified by its manufacturer's standard nameplate, as specified in Section 16977, Tagging and Marking. This nameplate shall not extend beyond the edge of the supporting metal to which it is attached.
- I. Each rack shall be further identified, front and back, with its identifying type and location number by means of a painted stencil. (See Section 16977, Tagging and Marking). The "type" and "location" letters and numbers shall be at least 1 inch in height. The various rack types shall be designated as follows:
 - 1. "E" - Entrance Racks
 - 2. "P" - Power Racks
 - 3. "B" - Vital Interlocking Support Racks
 - 4. "J" - Non-Vital Interlocking Support Racks
 - 5. Rack location stenciling shall be located on the racks and not on modules in the racks.

2.02 POWER RACKS

- A. The rear of the panel of the Power Supplies shall be open for ventilation and shall be completely shielded from contact with any external object by small plastic covers, mounted in place over each part, or group of parts. These covers shall be made of 1/4 inch thick shatter-proof plastic material which will not support combustion or emit poisonous or corrosive gases when exposed to flame or extreme heat. Other approved material may be utilized. These covers shall be easily removed and replaced, but the fastenings shall be secure.

- B. The Design-Builder shall permanently mount high-voltage warning signs on the back, front and exposed sides of each power rack.

2.03 EQUIPMENT RACKS AND ENTRANCE RACKS

- A. Equipment racks and Entrance racks shall be enclosed with formed 16-gauge cold-rolled sheet metal on the top, bottom and on both ends of each row of adjacent racks.
- B. Entrance racks shall be equipped with molded terminal blocks which conform to the recommendations of Part 14.1.5 of the AREMA Signal Manual and such other terminal blocks and plug connectors as may be required by these Specifications.

2.04 EQUIPMENT ARRANGEMENT AND MOUNTING

- A. The arrangement of equipment on the racks shall present a neat and orderly appearance. Equipment serving similar functions shall be in the same relative location on all racks.
- B. Relays and equipment modules shall not be mounted at a height exceeding 6 feet from the floor.
- C. Provide a minimum of 10 percent spare module, component and relay spaces, spare terminals, and spare plug-connector points on each rack or group of racks serving a common function. This 10 percent spare equipment space, terminals and plug-connector points shall be in addition to any space, terminals and plug-connector points reserved for specifically designated possible future additions to the TCR.
- D. Track relays for a given track shall be located on the racks so that they reflect the geographical sequence of the actual track circuits they represent.
- E. Track repeater relays shall be located adjacent to the track or repeater relays they repeat or parallel.
- F. Repeater relays for other than track relays shall be located wherever their contacts are most needed in order to keep wire runs to minimum length.
- G. Terminal blocks and plug connectors for inter-rack and external wiring connections shall be located in the top row of each equipment rack. Where terminal blocks or plug connectors are mounted on swing-out "doors," the Design-Builder shall provide a means to prevent accidental contact between such terminals or plug couplers and adjacent equipment.

2.05 RACK WIRING

- A. Internal rack wiring shall be pre-wired prior to installation in the Train Control Rooms.
- B. Internal rack wiring shall be accomplished as specified in Section 16949, Signal Wire and Cable.

2.06 CABLE TRAYS

- A. Cable trays shall be of the "ladder" type, constructed of aluminum, or other suitable material commercially available. Where applicable a cantilevered single "wall-support" type of tray shall be provided.

- B. Cable trays shall be P-W Industries Cable Tray System 064D02, as manufactured by P-W Industries, Inc. (Cornwell Heights, PA 19020), or approved equal, with the following requirements:
1. Rung spacing shall be six inches maximum where rack-to-rack wiring consists of individual conductors of size 14 AWG or larger wire tied into bundles to form unjacketed multiconductor cable routed via the cable trays. Rung spacing shall be six inches minimum where cable tray is used exclusively for jacketed multiconductor cable.
 2. Minimum tray width shall be 6 inches.
 3. All fittings, supports and accessories shall be furnished in accordance with the manufacturer's recommendations.
 4. There shall be no sharp edges or corners on the cable tray which would damage the cables or present a safety hazard to humans.

2.07 FIBERGLASS SUPPORTS FOR CABLE TRAYS

- A. Where the Design-Builder's cable tray layout includes any support mounting to the equipment and entrance racks, such mounting shall be by means of approved fiberglass arms or stand-offs.
- B. Fiberglass support arms, where required to insulate the cable tray from the equipment racks, shall be flame retardant, reinforced polyester laminate Class "B", 130 degrees C electrical sheet, meeting NEMA GPO-2 requirements, ASTM Specification D1532-67T, as manufactured by Hayside Division of Alco Standard Co., or approved equal.

PART 3 - EXECUTION

3.01 RACK INSTALLATION

- A. The Design-Builder shall install the racks in rows with a spacing of 5 feet between centerlines of rows and from wall to row centerline wherever possible. Where 5 foot spacing cannot be obtained, the Design-Builder shall attempt to maintain 4.5 foot minimum spacing for front-to-front oriented rows and 3.5 foot minimum spacing for back-to-back oriented rows. Under no circumstances shall rack row spacing be less than 3.5 feet.
- B. Rows of racks shall be oriented to have adjacent rows either front-to-front or back-to-back wherever possible.
- C. A minimum 2-foot aisle shall be provided between the walls of the TCR and the ends of the rack rows.
- D. The row of racks nearest the wall, if closer than five feet to the wall, shall not face the wall.
- E. The Design-Builder shall shim rack bases as necessary to maintain level rack height within each row.
- F. The Design-Builder shall ground each individual rack to a room ground bus. See Section 16922. The racks shall be insulated from each other and from any supporting framework and

shall only be electrically connected via the common ground connection. The value of the insulating resistance shall be at least one megohm.

- G. Rack-to-rack wiring shall be accomplished as specified in Section 16949.

3.02 CABLE TRAY DESIGN

The Design-Builder shall design and provide a design of changes and additions to the signal cable tray system for each Train Control Room in which wire and cable is installed under this Contract.

3.03 CABLE TRAY INSTALLATION

- A. The cable trays shall be assembled at the site of the work in accordance with the manufacturer's instructions and the approved installation drawings.
- B. Tray supports shall be anchored to ceilings or walls by machine-bolt type expansion anchors and one-half inch minimum diameter bolts.
- C. The Design-Builder shall not use any method of connecting or supporting cable trays which would reduce the rated load carrying capacity of the trays or could possibly result in damage to cables placed in the trays.
- D. Where cable tray splice joints occur in a run, trays shall be supported immediately adjacent to and on both sides of the splice fitting.
- E. All metal cable trays shall be bonded and grounded as described in Section 16922.
- F. All metal cable trays shall be insulated from all walls, ceilings, racks and conduit runs. The value of the insulating resistance shall be at least 1000 ohms.
- G. The final position of cable on the trays shall result in minimal loading eccentricity.
- H. Maximum deflection of the runs shall not exceed 0.25 inches when fully loaded. A fully loaded cable tray is defined as a load consisting of the Contract cable requirement plus the 100 percent for the possible future load.

END OF SECTION

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SECTION 16972

JUNCTION BOXES

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of track-side junction boxes associated with track switch layouts, signal layouts, power frequency and pushbutton layouts, interlocking cable distribution, and other necessary wayside yard signal equipment.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16923	TC Maintenance Telephone System
Section 16963	Power Frequency Track Circuit Layouts
Section 16964	Trailable Yard Switch Operating Layouts
Section 16965	Signal Layouts
Section 16974	Locks and Keys
Section 16977	Tagging and Marking

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.04 SUBMITTALS

See Section 16912, Yard Signaling Submittal Requirements

PART 2 PRODUCTS

2.01 BASIC REQUIREMENTS

- A. All junction boxes shall conform to NEMA-4X and U.L. requirements. Junction boxes shall be constructed of
 - 1. Cast iron - shall have stainless steel or brass cover hardware sheet metal, or fiberglass material approved by the Authority's Representative. Cast iron junction boxes shall have stainless steel or brass cover hardware.
 - 2. Fiberglass - the finish to be Pleogen 2907 ISO Gel-Coat, or similar polyester base material, in thickness of 15 to 20 mils Cast
- B. Covers shall be hinged and gasketed with a neoprene gasket to provide a dustproof and weatherproof enclosure. Covers shall be equipped with a three-point latching arrangement, complete with handle and facilities for accepting the shackle of a padlock of the type specified in Section 16974.

- C. Junction boxes shall be of sufficient size to provide ample space for the specified minimum bending radii of cables and wires.
- D. Junction boxes shall be provided complete with all necessary terminals and a weatherproof Telephone Jack as specified in Section 16923.
- E. Fiberglass junction boxes shall be provided complete with print pockets, sized as per manufacturer's standard, and located on the inside of the junction box cover or door.
- F. Junction boxes shall be equipped with drain plugs.
- G. Cast-iron junction boxes shall be furnished complete with appropriate pedestals.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide junction boxes of appropriate size for the terminals and equipment required.
- B. Junction boxes shall be installed in conformance with the approved installation drawings.
- C. In those instances where there is no room for a person between the box and the dynamic clearance envelope of the transit cars, the Design-Builder shall apply moisture-proof warning labels of an Authority-approved design and size to the inside and outside of the covers of the junction boxes. These labels shall consist of a background of black and luminescent yellow diagonal stripes, and shall bear the legend "NO CLEARANCE" in black letters on a white horizontal stripe.

END OF SECTION

SECTION 16973

CONDUIT

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of conduit and associated fittings.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signal Submittal Requirements
Section 16949	Signal Wire and Cable
Section 16963	Power Frequency Track Circuit Layouts
Section 16964	Trailable Yard Switch Operating Layouts
Section 16965	Signal Layouts
Section 16972	Junction Boxes
Section 16977	Tagging and Marking
Section 16978	Miscellaneous Train Control Components and Materials
Section 16989	Yard Test and Inspections

1.03 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.04 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements

PART 2 - PRODUCTS

2.01 RIGID STEEL CONDUIT AND FITTINGS

- A. All rigid steel conduit and fittings required by these Specifications shall be galvanized. Galvanized steel, rigid conduit shall be used in equipment rooms and beneath paved roadways. This conduit shall be consistent with ANSI C80.1.
- B. Fittings for rigid steel conduit shall be of malleable iron, threaded, and shall be protected by hot-dip galvanizing. Conduit fittings designed for removable covers shall be complete with gaskets and blank covers.

2.02 POLYVINYL CHLORIDE CONDUIT AND FITTINGS

- A. At outdoor or embedded locations where conduit is specifically required to be thick-wall, Schedule 80, polyvinyl-chloride (PVC) conduit shall be furnished and installed. PVC conduit shall not be installed on concrete surfaces exposed to sunlight.
- B. Where conduit elbows are used, they shall be Schedule 80 and of the long radius type.

2.03 FIBERGLASS REINFORCED EPOXY (FRE) CONDUIT

- A. In all confined areas such as tunnels where exposed conduit runs are required, the appropriately sized fiberglass reinforced epoxy (FRE) conduit shall be furnished and installed.
- B. Fiberglass reinforced epoxy conduit shall be FRE Rigid Non-Metallic Fiberglass Conduit as manufactured by FRE Conduit Inc., 1885 Swarthmore Ave., Lakewood, NJ 08701, or approved equal.
- C. FRE conduit installed shall have a minimum dielectric strength of 500 volts per mil, tensile strength (axial) of 11,000 psi, and an "HB" flammability rating.
- D. FRE conduit installed shall have a minimum compressive load withstand rating of 3500 pounds per foot of conduit, and a minimum average impact resistance value of 25 foot-pounds.
- E. FRE conduit and fittings installed by the Design-Builder shall bear nationally accepted testing laboratory approval from U.L. and C.S.A.
- F. Conduit combustion by-products shall not contain chlorine gas in excess of trace levels and always less than safe OSHA limits.

2.04 CORDURA HOSE CONDUIT AND FITTINGS

Flexible hose utilized as conduit shall be furnished and installed where required. It shall be vari-purpose, internal tube hose with braided CORDURA rayon reinforcement and a "HYCAR" neoprene cover as made by the ACME-Hamilton Mfg. Corp., or approved equal. Where so required, the hose ends shall be pushed over suitable fittings, which provide a snug fit, and fastened with stainless steel clamps as manufactured by the W.D. Allen Mfg. Co., or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONDUIT

- A. Conduit shall be installed as specified in the National Electrical Code or as specified herein, whichever is more restrictive.
- B. At wayside train control electrical equipment locations, the Design-Builder shall install lengths of the appropriate type of conduit to extend the embedded conduit installed by others to the proper location.
- C. Wiring in horizontal runs in the trackway in ballasted areas, shall be in Schedule 80 PVC conduit buried at a uniform depth of 30 inches, (42 inches from the top of the rail).

- D. Wiring in vertical runs in the track in ballasted areas shall be in CORDURA Hose Conduit where it runs to a device on the ties or rails, and in Schedule 80 PVC in all other places.
- E. Wiring in runs attached to the sides of ties shall be in Schedule 80 PVC conduit.
- F. All exposed conduit runs shall be installed parallel to walls, floors and ceilings. Conduits shall be supported at intervals not to exceed eight feet for rigid steel conduit and four feet for flexible conduit. PVC conduit (and fiberglass reinforced conduit) shall be supported at intervals dependent upon its diameter as required in Table 347-8 of the National Electrical Code. Cast, single-hole, malleable iron, galvanized pipe straps of the proper size shall be used for the support of individual conduit runs on concrete surfaces. Where conduit is supported on concrete surfaces, rust-proof stud anchors as specified in Section 16978 shall be used. Galvanized conduit spacers (back straps) shall be used with the conduit clamps to space the conduit away from the mounting surface.
- G. Conduit shall be of sufficient size to leave, as a minimum after installation of wire, the percentage of free space specified in the National Electrical Code.
- H. All bends and offsets in rigid conduit shall be made on a forming tool to prevent damage to the conduit. Rigid conduit bends made in the field shall be in accordance with the manufacturer's recommended procedure. Care shall be taken not to overheat rigid conduit during the bending process.
- I. Steel conduit threads shall be painted with anti-seize, anti-corrosion surface treatment compound, such as Thomas & Betts KOPR-SHIELD, or an approved equal to ease assembly, make them watertight, prevent rust and enhance conductivity.
- J. Rigid conduit shall not be clamped or connected to equipment racks or trays in equipment rooms in any manner which results in an electrically conductive path between the conduit and the rack or tray.
- K. Fittings with removable side plates (pull boxes) shall be installed on long conduit runs at intervals of no more than 75 feet. In the less-than-75-foot conduit segments thus formed, an additional fitting of the same type shall be added each time the total number of degrees in bends exceeds 180. All such fittings shall be of sufficient length to allow the installation of wire or cable without exceeding its minimum bending radius, either as installed or during installation. The minimum bending radius shall be as specified by the manufacturer, or as specified in Articles 370-18 or 370-51 (as applicable) of the National Electrical Code, or as necessary to comply with the applicable minimum cable bending radii specified herein, whichever is more restrictive.
- L. Radii of conduit bends shall meet the requirements of the National Electrical Code.
- M. Conduit shall be connected to equipment enclosures and junction boxes in accordance with the approved installation drawings. Proper fittings with appropriate gasketing and protective bushings shall be utilized.
- N. All conduit shall be properly cleaned (before pulling wires or cables) by either blowing compressed air through the run or by swabbing.

- O. All conduit installed by the Design-Builder shall be identified as described in Section 16977, Tagging and Marking.
- P. PVC fittings shall be attached to PVC conduit utilizing both pre-conditioner and cement.
- Q. On long runs of PVC conduit, expansion joints shall be installed at intervals not to exceed 75 feet.
- R. A short (1 to 3 foot) section of liquid-tight flexible metal or CORDURA hose conduit shall be provided where rigid conduit is to be connected to a device which consist of, or contains, a rotating or vibrating mass.
- S. All conduits provided in the TCR for train control, but not used, shall be grounded and closed with a watertight fitting.
- T. Install metallic raceway, fittings, boxes and cabinets, free from contact with reinforcing steel.
- U. To prevent corrosion where aluminum is placed in contact with dissimilar metal or with concrete, separate contact surfaces by means of a gasket, non-absorptive tape or special coating.

END OF SECTION

SECTION 16974

LOCKS AND KEYS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of the various types of locks, keys and key switches required to secure Yard Signaling equipment and apparatus housings furnished under this Contract.
- B. The proprietary "rights" to all locks, keys, key switches and keying combinations furnished under this Contract shall be assigned to the Authority.

1.02 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16914	Environmental Requirements
Section 16964	Yard Trailable Switch Operating Layouts
Section 16965	Signal Layouts
Section 16972	Junction Boxes

1.02 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.03 SUBMITTALS

See Section 16912, Yard Signaling Submittal Requirements

PART 2 - PRODUCTS

2.01 BASIC REQUIREMENTS

- A. The locking mechanism for all locks and key switches furnished under this Contract shall be of the 7-pin cylinder type.
- B. All lock rotation shall be 90 degrees clockwise from locked position at 12 o'clock to unlocked position at 3 o'clock.
- C. The coding of the various types of locks and keys furnished under this Contract shall be identical to the coding presently in use on the WMATA Rail Rapid Transit System.
- D. All locks furnished under this Contract shall be keyed to one of two combinations and to a single master combination

1. The first combination and the master combination shall be provided to key the following locks
 - a. Padlocks
 - b. Cabinet Locks
 - c. Cam Locks
2. The second combination and the master combination shall be provided to key the following locks:
 - a. Key Switch

E. The keys supplied under the terms of this article shall not be reproducible commercially.

2.02 PADLOCKS

- A. Padlocks shall be solid blocks of extruded brass or stainless steel, bored to receive the locking mechanism. The shackle shall be made of case hardened steel. The locking mechanism shall be operable from its own key and the master key, and shall be designed in such a manner that keys can be removed from the padlock in both the locked and unlocked positions.
- B. The lock shackle shall lock at both heel and toe. The steel shackle pull strength shall exceed 2500 lbs.
- C. The length and width of shackle opening shall be sufficient to allow the padlocks to be installed on all pieces of Yard Signaling equipment for which they are required.
- D. Padlocks shall be of a type and quality normally associated with railroad type outdoor services and shall be designed to operate satisfactorily in all weather conditions indigenous to the Washington, D.C. metropolitan area, as described in Section 16914, Environmental Requirements.
- E. Padlocks shall be type 21B722 with AR-3 cylinder as manufactured by Best Lock Corp., or equal.
- F. Padlocks shall be furnished without chains.

2.03 CABINET AND CAM LOCKS

- A. Cabinet and cam locks furnished shall be suitable for mounting on 14 gauge sheet steel, and/or 1/4 inch phenolic panels.
- B. The locking mechanism for cabinet and cam locks shall be so designed that keys can be removed from the locks in both the locked and unlocked positions.
- C. Cabinet locks shall be type BT1004AD as manufactured by Fort Lock Corp., or equal.
- D. Cam locks shall be type N1058AD-186421-1906-49 and/or type N1058AD-186425-2508-49 as manufactured for Fort Lock Corp., or equal.

2.04 KEY SWITCHES

- A. Key switches furnished shall be suitable for flush mounting on 14 gauge steel or 1/4 inch phenolic panels. Each switch shall be supplied with a special two-flange washer to prevent rotation in phenolic panels.
- B. Insertion of the proper key into the tumbler and rotation of the key in a clockwise direction shall cause an internal electrical switch to close. When the key is rotated to this clockwise position, it shall be impossible to remove the key from the tumbler.
- C. Returning the key to the normal position by counter-clockwise rotation shall cause the internal electrical switch to open. When in this position, it shall be possible to remove the key.
- D. The internal electrical switch shall have sufficient current carrying capacity to control a 28 volt (nominal) signal type relay without damage to the switch contacts.
- E. Key switch locks shall be type SW21138AXMKX2KXSC as manufactured for Fort Lock Corp., or equal, and keyed to WMATA Y1A master and appropriate Y001 or Y002 key codes.

2.05 KEYS

- A. The Design-Builder shall furnish three types of keys as follows:
 - 1. Master keys to unlock all types of locks and key switches specified herein.
 - 2. Keys to unlock only the key switches specified herein.
 - 3. Keys to unlock only the padlocks, cabinet locks and cam locks specified herein.
- B. Each type of key shall be distinctly marked for the use intended, but in such a manner that the marking system employed cannot be used for commercial duplication.
- C. Each type of key shall be identical to the corresponding type presently in use on the WMATA rail system.
- D. Keys shall be made of brass or stainless steel.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Padlocks - Padlocks shall be installed at the locations specified on all signals, junction boxes, switch machines, circuit controllers, snowmelter control cases and other wayside Yard Signal equipment housings not equipped with integral cabinet or cam locks.
- B. Key Switches and Cam Locks - Key Switches and suitable cabinet or cam locks shall be installed on Yard Control Panels.

END OF SECTION

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SECTION 16975

FOUNDATIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of foundations for sign, signal, junction box and pushbutton masts, and, where applicable, for snowmelter control cases.

1.02 DESCRIPTION

- A. Foundations for sign, signal, junction box and pushbutton masts shall be precast, reinforced concrete and shall be of either monolithic or sectional construction.
- B. Foundations for snowmelter control cases shall each consist of two identical units, one to support each end of the snowmelter control case, or a single fabricated unit. These units shall be at least four feet high, and shall be constructed of cast iron, hot-dip galvanized steel, reinforced concrete, or some approved combination thereof.
- C. Foundations shall not be procured or constructed by the Design-Builder, until drawings of the proposed foundations have been approved by the designated Authority's Representative.

1.03 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections

Section 01113	Systems Integration
Section 16912	Yard Signal Submittal Requirements
Section 16965	Signal Layouts
Section 16969	Snowmelter Layouts
Section 16972	Junction Boxes
Section 16978	Miscellaneous Train Control Components and Materials
Section 16989	Yard Test and Inspections

1.04 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.05 SUBMITTALS

See Section 16912, Yard Signal Submittal Requirements

1.06 DELIVERY, STORAGE AND HANDLING

Any chipped, cracked or damaged foundations shall be repaired or replaced.

PART 2 - PRODUCTS

2.01 BASIC COMPONENTS

- A. Cement, aggregates, mixing water and reinforcement used for precast foundation units and cast-in-place foundation structures shall conform to the applicable requirements specified in the current edition of the AREMA Manual for Railway Engineering.
- B. Metal used for Snowmelter Control Case foundation units shall be as recommended in the applicable portions of Part 15.1 of the AREMA Signal Manual.

2.02 CONCRETE FOUNDATIONS

- A. Foundations shall be provided complete with anchor bolts, nuts and washers, all in accordance with the applicable portion of Part 14.4 of the AREMA Signal Manual and Section 16978 of these Specifications.
- B. Spacing of anchor bolts shall be as required to properly support the equipment to be mounted.
- C. Precast concrete foundations shall be made of concrete of average compressive strength of 4000 p.s.i., air-entrained for exterior locations.
- D. The concrete used in cast-in-place foundations shall have an average compressive strength of 3000 p.s.i.

2.03 SNOWMELTER CONTROL CASE FOUNDATIONS

Snowmelter control case foundations shall be fabricated in accordance with the detailed drawings submitted by the Design-Builder.

PART 3 - EXECUTION

3.01 PREPARATION

Provide compacted crushed stone bases for all train control equipment foundations installed in ballasted track areas under this Contract.

3.02 INSTALLATION

- A. Train control equipment foundations shall be installed in accordance with the installation drawings approved by the designated Authority's Representative for that purpose. All foundations for yard signal equipment shall be vertical and level, as installed.
- B. Protect all anchor bolt thread, washers, and nuts from damage until such time as the train control equipment is installed.

END OF SECTION

SECTION 16977

TAGGING AND MARKING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section specifies the furnishing and installation of identifying markings on yard signal items furnished under this Contract, either directly on the item or through the use of suitable marking tags properly applied to the item.
- B. These markings shall be of the following types which are described in Part 2 of this Section.
- | | |
|---------|--------------------------------------|
| Type 1 | Cast Metal |
| Type 2 | Sheet Steel - Reflective Coated |
| Type 3 | Embossed Metal |
| Type 4 | Die-Stamped Nameplate |
| Type 5 | Printed Plastic |
| Type 6 | Painted Stencil |
| Type 7 | Ink Stamped |
| Type 8 | Etched Copper |
| Type 9 | Engraved Phenolic |
| Type 10 | Wire Tags Exposed to Direct Sunlight |
| Type 11 | Temporary Tags |
- C. Tagging and marking shall be further in accordance with specific considerations specified in the following listed Related Sections. Also listed are the marking types that generally apply to the equipment specified in each Section.

1.02 RELATED SECTIONS

Section 01113	Systems Integration	Marking
Section 16912	Yard Signaling Submittal Requirements	Type
Section 16922	Lightning/Surge Protection and Grounding Systems (Grounding Cables on Room Prime Bus Bars)	5
Section 16941	Basic Yard Signaling Electrical and Electronic Component Requirements	7
Section 16942	Printed Circuit Cards	7 & 8
Section 16943	Vital Relays	5
Section 16944	Non-Vital Relays and Timers	5
Section 16945	Plugboards and Cabinets for Relays and P.C. Cards	5, 7, 8
Section 16946	Transformers	4
Section 16947	Ground Detectors	4
Section 16948	Plug Connectors (Plug Couplers)	5 or 7
Section 16949	Signal Wire and Cable	5
	- External Cable	10
	- Internal Wire and Cable	5
Section 16951	Transfer and Bypass Equipment	3 or 4
Section 16952	DC Power Supplies	4, 7

Section 16957	Yard Control Machines	9
Section 16963	Power Frequency Track Circuit Layouts	3
Section 16964	Yard Trailable Switch Operating Layouts	1
Section 16965	Signal Layouts	2, 5
Section 16969	Snowmelter Layouts	3 & 6
Section 16971	Racks and Cable Trays (Racks)	4 & 6
Section 16972	Junction Boxes	3
Section 16973	Conduit	3 & 5

1.03 QUALITY ASSURANCE

See Section 01113 Systems Integration

1.04 SUBMITTALS

See Section 16912, Yard Signaling Submittal Requirement

PART 2 - PRODUCTS

2.01 MARKER TYPE 1 - CAST METAL

This marker (used for switch-and-lock movement layouts) shall be at least three inches high and of a thickness to ensure ruggedness. It shall be made of cast metal and shall be painted white. All edges shall be slightly rounded and free of burrs. The casting shall be free of cracks or voids.

2.02 MARKER TYPE 2 - SHEET METAL REFLECTIVE COATED

- A. This marker (used for signal number plates and wayside signs) shall be of a minimum 1/8 inch thickness and a size to allow visibility as specified elsewhere in these Specifications. The reflectorized coatings or appliques shall be applied per the manufacturer's specifications and shall be free of air pockets, cuts, tears, loose edges and blemishes of any kind.
- B. If a ferrous sheet metal is selected, the marker must be fully protected from rusting according to the Design-Builder's standard painting procedures as approved by the designated Authority's Representative. This procedure must include complete corrosion proofing surface preparation before paint application.
- C. If aluminum is selected as the marker material, it must be of sufficient thickness and hardness to remain stiff and straight under field conditions.

2.03 MARKER TYPE 3 - EMBOSSED METAL

- A. This type of marker shall consist of a sheet metal strip approximately one inch wide and of sufficient thickness for ruggedness and durability. It shall be embossed by a stamping machine capable of producing crisp letters approximately one half inch high. The metal shall be lead bearing, galvanized or non-ferrous so that it will not be subject to deterioration by rust.
- B. The marker shall be flat and straight and free from sharp edges.

2.04 MARKER TYPE 4 - DIE-STAMPED NAMEPLATE

- A. This marker shall be the manufacturer's standard nameplate which shall contain pertinent data such as
1. Manufacturer's name
 2. Serial number
 3. Model number
 4. Date of manufacture (where required)
 5. Drawing number
 6. Identifying type and location number (as applicable)
- B. The nameplate shall be made of a non-corroding material. The dies and stamping process shall provide good legibility and permanence.

2.05 MARKER TYPE 5 - PRINTED PLASTIC

- A. This type of marker shall be applied to each conductor and cable not exposed to direct sunlight, and to devices not otherwise identified. (TYPE 10 Markers shall be used for wires and cables exposed to direct sunlight.)
- B. TYPE 5 Markers shall be available in two forms, sleeve and flat
1. Sleeve Tags
 - a. The sleeve form shall be of the heat shrinkable type and shall be sized from 3/32-inch through 1/2-inch diameter to properly fit the wire for which it is intended. The sleeve shall be made from radiation crosslinked polyolefin (for service to 125 degrees C) or modified fluorocarbon (for service to 200 degrees C) tubing which is white in color. The printing shall be done in black and shall be permanently set through the use of a suitable infrared heater. These sleeve tags shall be of the "TMS" type as manufactured by Raychem Corporation, or approved equal.
 - b. The legend on the sleeve tag shall always read from left to right, with the first nomenclature indicating the "from" location and the second nomenclature indicating the "to" location.
 2. Flat Tags
 - a. The flat form shall be made of flat, white, sheet stock with slots for application to large conductors, cables, and conduits (not subject to painting) with nylon tie-wrap fasteners. These tags shall also be used for identifying indicators, relays, and other devices where slide-in holders are provided.
 - b. These tags shall be one and one-half inches long by three-quarter inches wide with one, five sixteenth inch hole located in the center of the width. The distance from the edge of tag to the hole shall be approximately nine thirty-seconds of an inch. The untreated tag shall be milk white "vinylite," or approved equal, approximately seven hundredths of an inch thick.
 - c. The identifying nomenclature space shall allow for three rows of lettering. The tag material shall be capable of receiving typed-on characters by conventional means. The height of the lettering shall be not less than one-eighth inch.
 - d. After lettering, the face side of the tag shall be covered with a clear plastic coating, "vinylite," or approved equal, of at least one hundredth of an inch thickness. The back of the tag shall be covered with a milk white coating "vinylite," or approved equal, of at least one hundredth of an inch thickness.

- e. The nomenclature applied to tags to go on terminal racks and boards shall show the terminal post identification on the top line. The functional nomenclature shall appear on the bottom line, or, if required, on the middle and bottom lines. The terminal posts shall be identified by geometry coordinates, such as rack, row and post number.

2.06 MARKER TYPE 6 - PAINTED STENCIL

This type of marking may be utilized for identification of large objects such as racks or enclosures providing they are not subject to field painting (use type 3 in this case) and providing the mark is clearly and neatly applied. The marking paint shall provide a definite contrast with the surface on which it is applied, e.g., black paint on a gray surface would not be acceptable.

2.07 MARKER TYPE 7 - INK STAMPED

This type of marking shall be utilized for the identification of components not otherwise identified. The color of the ink shall be either black or white, whichever provides the greatest contrast with the background color.

2.08 MARKER TYPE 8 - ETCHED COPPER

This marker type is an alternate to type 7 which may be utilized on printed circuit cards for identification of card or components.

2.09 MARKER TYPE 9 - ENGRAVED PHENOLIC

This marker type shall be utilized for all special purpose panels. The material shall be white phenolic sheet with thin layers of black phenolic laminated to both sides. Panels shall contain no detectable filled areas resulting from errors, mistakes or changes. The panel shall be free from chips or scratches. Where the edges of the panel are visible, they shall be carefully finished with a durable matte black paint. The surface of the panel shall be buffed with a fine abrasive to remove any shininess and produce a matte finish.

2.10 MARKER TYPE 10 - WIRE TAGS EXPOSED TO DIRECT SUNLIGHT

- A. This marker type shall be utilized in lieu of Marker Type 5 to identify wires and cables exposed to direct sunlight. The identifying lettering shall be as specified for MARKER TYPE 5 for similar application, but these markers shall be made of material that will not corrode, rot, melt, or otherwise decay, or lose their legibility, due to moisture or the effects of sunlight.
- B. The Design-Builder may use embossed metal markers as specified for MARKER TYPE 3 for the purpose of identifying wires and cables exposed to direct sunlight.

2.11 MARKER TYPE 11 - TEMPORARY TAGS

This marker type shall be utilized to identify circuit changes, apparatus or any other device when, in the course of testing, an error in the permanent tag or label is noted. These tags shall be of a size and quality to readily identify the wire or apparatus until such time as the permanent tag is available.

PART 3 - EXECUTION

3.01 APPLICATION

- A. The tags and markings shall be applied during manufacture wherever possible or in the field where necessary.
- B. The following special precautions shall be observed when applying tagging and marking per above mentioned type
 1. Marker Type 1 - The cast metal marker shall be suitably applied with rivets or flat head screws. If the fasteners penetrate the surface to which they are applied, suitable sealant shall be utilized to ensure watertight integrity of the unit. When flat head screws are used with nuts and washers, they must be secured in such a manner as to prevent loosening due to vibration with consequent entry, into and fouling of the internal operation of the trailable yard switch mechanism.
 2. Marker Type 2 - The sheet metal, reflective coated marker shall be securely fastened in place utilizing stainless steel hex bolts, lock washers and nuts, of diameter appropriate for marker size. A large stainless steel washer shall be used on the front surface of the sign, with a neoprene gasket between it and the reflective surface, to prevent tearing or gouging of the reflectorized surface. Alternately, the sign may be fastened with a suitable bracket welded or otherwise fastened to the back surface and presenting no discontinuity of the front surface.
 3. Marker Type 3 - The embossed metal marker shall be applied by rivets, screws, stainless steel wire, or an adhesive method, to all field equipment subject to periodic painting or obscuring accumulations of dirt or grime. Examples of this equipment are
 - a. Conduits
 - b. Junction Boxes
 - c. Impedance Bonds
 - d. Track Loops
 - e. Station Stopping Distance Markers
 4. Marker Type 4 - The Die-stamped Nameplate shall be applied by an approved adhesive method or rivets. This marker shall be applied to racks and all equipment or apparatus which requires a test procedure as specified in other Sections.
 5. Marker Type 5
 - a. The printed plastic marker shall be properly installed so that the printed legend indicates the proper identification of the wire terminal adjacent to the sleeve.
 - b. The sleeve form shall be located at the termination of the wire and may be used as insulation over an uninsulated pressure-applied terminal.
 - c. The sleeve shall be oriented on the wire so that the printed legend will start at the terminal, before the heat is applied to shrink the sleeve onto the wire.
 - d. The sleeve shall be used on wires of sizes up to and including No. 0 AWG.
 - e. The sleeve shall also be used to identify multiple conductor cables up to 1/2-inch in diameter.
 - f. The tag form shall be securely fastened to the intended object with nylon tie-wrap fasteners inserted in the slots in a manner that does not obscure the legend, and the tag shall be positioned so that it is right side up and readable when installed. The tie-wrap shall be tight enough to prevent the tag from moving from its desired position.
 6. Marker Type 6 - The Painted Stencil marking shall be applied with a procedure that produces clear, legible letters without voids and without paint running between the

- stencil and the surface being marked. No paint shall be allowed to reach the surface being marked around the outside edge of the stencil.
7. Marker Type 7 - The Ink Stamped markings shall be neatly and uniformly applied. Stamped markings that are not complete as a result of improper positioning of the stamp or that are blurred or smeared will not be acceptable.
 8. Marker Type 8 - The Etched Copper marking utilized on printed circuit cards, shall be legible and shall not be obscured by any component mounted on the card.
 9. Marker Type 9 - The Engraved Phenolic markings on control panels shall be applied with letters, numerals and lines engraved through the black layer and well into the white base to provide clean edges and distinct letters. Panels shall be fastened in place without damage from nicking or chipping. Screwheads shall be flat or oval and shall have a black matte (or black anodized) finish. Screwheads that are burred by a screwdriver shall be replaced.
 10. Marker Type 10 - Tags which will be exposed to direct sunlight shall be attached with material which will not corrode or rot due to moisture, or decompose due to ultraviolet light.
 11. Marker Type 11 - Temporary tags shall be attached with string, generally in the same location as required for the permanent tag. Temporary tags shall be replaced with permanent tags before each of the Authority acceptance levels listed elsewhere in these Specifications.

END OF SECTION

SECTION 16978

MISCELLANEOUS TRAIN CONTROL COMPONENTS AND MATERIALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing and installation of miscellaneous components and materials which form part of train control equipment or systems which are specified in other Sections of these Specifications.

1.02 RELATED SECTIONS

Related Work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	Yard Signaling Submittal Requirements
Section 16915	Basic Yard Signaling Equipment Requirements
Section 16922	Lightning/Surge Protection and Grounding Systems
Section 16971	Racks and Cable Trays
Section 16972	Junction Boxes
Section 16973	Conduit

1.03 QUALITY ASSURANCE

See Section 01113 Systems Integration

PART 2 - PRODUCTS

2.01 BOLTS, NUTS AND WASHERS FOR TRAIN CONTROL WORK

- A. Nuts and threads shall be in accordance with the AREMA Signal Manual, Part 14.6.20, Recommended Design Criteria for Bolts, Nuts and Threads. Plain washers shall be in accordance with the AREMA Signal Manual, Part 14.6.21, Recommended Design Criteria for Plain and Spring Lock Washers. Steel shall be in accordance with the AREMA Signal Manual, Part 15.1.4, Section 1, Recommended Developmental Criteria for Various Types of Steel.
- B. Bolts, nuts and washers shall be hot-dip galvanized, or they shall be made of brass or stainless steel.
 1. Cold galvanizing, plating and anodizing will not be acceptable.
 2. Where regular maintenance requires periodic removal of bolts, the bolts, nuts and washers shall be stainless steel.

2.02 ANCHORS

Stainless steel stud anchors shall be used for mounting Train Control equipment to concrete and masonry structures.

2.03 POTHEADS AND FILLING COMPOUND

- A. Potheads for multiconductor Train Control cable shall have neoprene end seals similar to those manufactured by the Okonite Co., or approved equal.
- B. The filling material shall be "encapsulating resin" as manufactured by Preformed Line Products Company, FX-70 Polymetric Joint Sealant as manufactured by Fox Industries of Baltimore, Maryland, or approved equal, and shall be applied in accordance with the manufacturer's instructions.
- C. At locations where the outdoor end of a conduit entering a TCR or other structure is at a higher elevation than the indoor end, so that water entry is a problem, the Design-Builder shall provide conduit sealing bushings on both ends of the conduit after removing all water and moisture from the conduit. The fitting shall be as manufactured by O-Z/GEDNEY Co., type CSBG or approved equal product. At locations known to have a problem with infiltration of water under pressure, the Design-Builder shall install an additional seal 10 inches inside the end of the conduit. This seal shall be the O-Z type CSBI or approved equal product. Apply Dow Corning No. 96081 RTV to the cables at the locations of the seals. Fill space between the O-Z fittings with Dow-Corning No. 3-6548 Silicone RTV Foam under pressure. O-Z seal screws shall be torqued per the manufacturer's specifications.

2.04 SWITCH PLATE LUBRICANT

Dylon Grade SP-MS All Weather Switch Plate Lubricant, as manufactured by Dylon Industries, Inc., Cleveland, OH 44144, or equal, shall be furnished and applied by the Design-Builder to lubricate switch point tie plates and the inside of the joint bars holding the heels of the switch point rails.

2.05 CORROSION PROTECTION

Protection for machined/finished surfaces, threaded rods and nuts and other parts which are susceptible to rusting, shall be a corrosion-preventive compound, NO-OX-ID "A Special", as manufactured by Sanchem, Inc., or approved equal.

2.06 GROUNDING EQUIPMENT

- A. Driven ground rods shall be copper-clad steel, or the non-rusting type as manufactured by Copperweld Corporation, or approved equal. Each rod shall be at least eight feet in length and at least five-eighths inch diameter.
- B. Ground rod clamps shall be bronze with tamper-proof safety set screws
- C. Connections to ground rods and ground buses shall be made with No. 6 bare copper wire, No. 6 insulated copper wire, No. 4/0 copper wire, or one-eighth inch by one and one-half inch flat, hard drawn, bare copper strip, as applicable to the equipment to be grounded.

2.07 SEALING COMPOUND

Sealing compound shall be "Duxseal" as manufactured by the Manville Company, or an approved equal.

2.08 PAINT AND FINISH

- A. All paint and painting procedures shall be in accordance with the applicable recommendations of Part 2.4.30 of the AREMA Signal Manual, where the recommendations of the AREMA Signal Manual do not conflict with the requirements of these Specifications.
- B. The surface of equipment and material not accessible after mounting shall have the final finish coat applied prior to installation.

2.09 CABLE PULLING LUBRICANT

The cable pulling lubricant shall be compatible with all cable jackets and noninjurious to cable insulation.

PART 3 - EXECUTION

NOT USED

END OF SECTION

THIS PAGE NOT USED

SECTION 16979
SURFACE TRENCH

PART 1 - GENERAL

1.01 SECTION INCLUDES

This Section specifies the furnishing, installation and use of surface trench as an alternative to the use of conventional direct-burial cable trenching.

1.02 DESCRIPTION

- A. The surface trench shall consist basically of channel sections with covers, installed in such a manner that the covers are approximately two inches above the surface of the ground.
- B. Cables shall enter and exit the surface trench runs from the bottom.

1.03 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 01113	Systems Integration
Section 16912	ATC Submittal Requirements
Section 16949	Signal Wire and Cable

1.04 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.05 SUBMITTALS

See Section 16912, ATC Submittal Requirements

PART 2 - PRODUCTS

2.01 TRENCH SECTIONS

Surface trench shall be one of the following, or an approved equal

- A. "Plastibeton Channel System", as manufactured by Synertech Moulded Products, Inc., 332 South Michigan Avenue, Chicago, Illinois 60604
- B. "Fibercrete", as manufactured by Concast, Incorporated, 15325 Babcock Avenue, Rosemont, Minnesota 55068
- C. "Trenwa Precast Concrete Trench System", as manufactured by Trenwa Inc., 1419 Alexandria Pike, Fort Thomas, Kentucky 41075

2.02 ASSOCIATED PARTS AND MATERIALS

Furnish and install all sand backfill required for cable installation in the surface trench runs.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Surface trench units shall be installed in such a manner that the top surface of their covers generally follows the ground contour and is approximately two inches above the final ground level
- B. Surface trench runs shall be installed in accordance with the manufacturer's instructions. The Design-Builder shall take care not to disturb existing direct-buried cable while installing surface trench or installing cable therein.
- C. Where surface trench runs cannot avoid crossing over natural or man-made drainage facilities, the Design-Builder shall provide adequate structure to support the surface trench runs plus an additional load of 500 lbs/sq.-ft. without interfering with the function and capacity of the drainage facilities.
- D. Where surface trench runs must run parallel to natural or man-made drainage facilities, the Design-Builder shall provide adequate structure to prevent undermining, displacement, or other damage to the surface trench runs, and to prevent the surface trench runs from becoming part of the drainage system. This shall be accomplished by providing sufficient drainage for the surface trench runs and by installing the runs in such a manner that surface running water is prevented from entering the runs. Any gaps between the ends of the trench cover sections shall not exceed one-quarter inch.
- E. Install a bed of sand at least three inches deep in the bottom of each surface trench run before installing cable in the run.
- F. The cables laid loosely and neatly in the trench with a minimum of crosses. Cable, during installation and as finally installed, shall not be bent to a radius less than 20 times its diameter, and shall not be pulled tightly around corners. Sufficient slack shall be provided in each cable in each cable trench segment to prevent damage to the cable.
- G. Provide longitudinal dividers in surface trench runs which will contain both high-voltage (greater than 200V) and low-voltage cables, and separate the cables accordingly.
- H. Each cable installed in a surface trench run shall be identified by a weatherproof tag at each end of its run in the surface trench and at intervals not to exceed 100 feet.
- I. The Design-Builder shall not install the surface trench cover sections until the installation of the trench itself, and the installation of all required cables, have been completed.
- J. Remove all trash and ballast from the surface trench before installing the trench covers.

END OF SECTION

SECTION 16989

YARD TESTS AND INSPECTIONS

PART 1 - GENERAL

1.01 SYSTEMS DESIGN INTEGRATION

The Design-Builder shall incorporate the tests and inspections described in this section into his systems integration plans and procedures.

1.02 DESCRIPTION

- A. This Section provides a general description of the inspections and tests which the Design-Builder and/or his sub-contractor shall perform to demonstrate that systems, sub-systems, assemblies, subassemblies, and components supplied under this Contract are in compliance with these Specifications, and specifies certain test equipment to be furnished by the Design-Builder and delivered to the Authority.
- B. Tests and inspections shall be made during the progress of this Contract and after completing the installation of equipment. These tests and inspections shall include:
 - 1. Field inspections and tests
 - 2. Factory tests
 - 3. Circuit breakdown tests
 - 4. Wiring verification tests
 - 5. Continuity tests
 - 6. Resistance tests
 - 7. Voltage and current tests
 - 8. Time tests
 - 9. Operating tests
- C. When a device or system does not meet the Specification requirements, the Design-Builder shall make the necessary corrections and shall be responsible for the total cost of additional tests required to prove compliance.
- D. The Design-Builder shall provide equipment and apparatus required for the tests and shall disconnect and reconnect any connections necessary in performing the tests.
- E. As a general requirement of these Specifications, the test procedures and tests which the Design-Builder develops and performs shall not only ensure that the Train Control equipment, circuits, systems and subsystems are performing the functions which are required, in the manner specified (POSITIVE TESTING), but shall also ensure that the Train Control equipment, circuits, systems and subsystems are NOT allowing or creating conditions which could have an unsafe or undesirable effect upon METRORAIL operations, METRORAIL equipment, METRO workers, or the public in general (NEGATIVE TESTING). While the POSITIVE TESTING requirements and some of the NEGATIVE TESTING requirements are set forth in these Specifications in considerable detail, it shall also be incumbent upon the Design-Builder, based upon past experience and familiarity with his own equipment, to include in the test procedures and tests, requirements for actions and verifications which shall either:
 - 1. Reveal any additional potential or existing unsafe or undesirable conditions, or:
 - 2. Prove that unsafe or undesirable conditions do not exist.

- F. These requirements shall apply not only to conditions inherent to the Train Control system, but to potentially unsafe or undesirable conditions resulting from interaction between the Train Control system and other systems or the operating environment.

1.03 QUALITY ASSURANCE

- A. All inspection and/or test plans, procedures, and reports shall comply with FRA rules and regulations, where applicable. A prerequisite for the approval of any inspection or test procedure will be the approval of the associated inspection or test plan.
- B. Each component and unit of the Yard Signal Control and Interlocking System provided by the Design-Builder shall have an inspection performed at its point of manufacture. Evidence of this inspection and acceptability shall be indicated on the item where practicable.
- C. The Authority Representative reserves the right to witness any or all tests and inspections in the Design-Builder's and/or sub-Contractor's plants. The Design-Builder shall advise the Authority Representative a minimum of two weeks in advance of each factory test. When tests are to be conducted continuously, as a production-line routine, the Design-Builder shall advise the Authority Representative two weeks in advance of the start of such tests and shall indicate the duration period in which such tests will be conducted.
- D. The Design-Builder shall complete all approved component and subsystem tests to demonstrate that the installation meets the Specifications and design requirements prior to any operational testing of systems.
- E. The Authority reserves the right to witness any or all installation inspections and pre-installation quality assurance inspections of equipment. The Design-Builder shall advise the Authority Representative 24 hours in advance of all such inspections.
- F. The Design-Builder shall perform on WMATA property all tests required to ensure the proper and safe operation of all systems and subsystems and to prove the adequacy and acceptability of the total installation specified herein. The tests to be performed shall cause each system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions to prove that the installation complies with all specified fail-safe requirements.
- G. The Authority Representative will have the right to witness any or all field tests conducted. The Design-Builder shall notify the Authority Representative in writing at least 48 hours prior to each field test.

1.04 SUBMITTALS

- A. The Design-Builder shall submit a test plan which shall include the following:
 - 1. The tests to be performed on each type of component or unit.
 - 2. The numbers of each type of component or unit to be tested.
 - 3. Description of how the tests the Design-Builder proposes to perform demonstrate that all equipment supplied under the Contract is in accordance with the requirements of these Specifications.
 - 4. A testing schedule which shall delineate the order in which the various field tests shall be made and indicate how the Design-Builder plans to meet the installation and testing dates required by the Contract. This schedule shall include an estimate of the number of man-days required for each test and the number of men the Design-Builder plans to have available for testing.

- B. The Design-Builder shall submit, no later than 90 days prior to commencement of tests, a test procedure and pre-printed data sheets and/or inspection sheets for each field and factory test. These procedure and data sheets shall be broken down into the following sections:
1. Title Sheet - containing the test procedure, title, number, and revision date. Also included shall be a statement of the purpose of the test contained in a paragraph, or more as required, to present a concise, complete picture of the factors being tested.
 2. Table of Contents.
 3. List of test prerequisites and status of same.
 4. List of abbreviations used in test.
 5. List of test equipment required for the test.
 6. Preliminary information (background information further clarifying the purpose of the test).
 7. Test description.
 8. Data sheets for recording results which include maximum and minimum values describing expected results.
- C. The Design-Builder shall submit, no later than 90 days prior to commencement of tests, a basic test report document for every field and factory test required in these Specifications. This document shall include titled lines for the following information where possible:
1. Verification that:
 - a. The installation is complete and correct.
 - b. All prerequisite tests have been completed successfully.
 - c. All necessary documents are available for the specific test.
 2. Name and number of test.
 3. Date and time of start and conclusion of test.
 4. Names of personnel performing test.
 5. Name of Test Supervisor.
 6. Time Test Supervisor was present during test.
 7. Names, model numbers, calibration dates and serial numbers of all instruments used in test.
 8. Results of test.
 9. List of difficulties encountered in test.
 10. Recommendations and authorization for remedial action and retest.
 11. Signature of test personnel and Test Supervisor.
- D. The Design-Builder shall record the results of each test as herein specified, and deliver this test result documentation to the Authority Representative. The Design-Builder shall also furnish certified test results for tests performed by any sub-contractor when such tests are required within these Specifications. All test reports shall be checked and approved by the Design-Builder prior to submittal to the Authority Representative.

PART 2 - PRODUCTS AND MATERIALS

2.01 TEST EQUIPMENT

- A. Test equipment supplied by the Design-Builder, both for the Authority and for his own use, shall be of the proper type, capacity, range and accuracy to perform the required tests and inspections. This equipment shall be in good working order and properly calibrated at the time the tests or inspections are conducted.

- B. Each piece of Special Test Equipment required by the Design-Builder to inspect, test, adjust, tune or otherwise modify the equipment to be provided under this Contract shall, at the conclusion of all field tests which make use of it, become the property of, and be delivered to, the Authority. This requirement shall be limited to a quantity of one piece of equipment of each type, regardless of the quantity the Design-Builder requires to expedite his testing program. This includes any commercial equipment and any computer software (including service costs and source code) that are utilized in any field test or demonstration.

PART 3 - EXECUTION

3.01 FACTORY TEST PROCEDURES

- A. The Design-Builder shall furnish Factory Test Reports to confirm that either he or his sub-contractor have performed all required factory tests of systems, subsystems, assemblies, subassemblies, and components supplied under this Contract. These tests shall verify design and nameplate ratings, and adequate and proper performance.
- B. All systems, subsystems, and equipment shall be 100 percent inspected and tested.
- C. All components other than those related to fail-safe circuits, may be tested on a sampling basis.
- D. When factory tests require specific meter or test instrument readings, the pre-printed data sheet shall show the allowable range of values for each part of the test. The test report shall also contain a checkoff system for each action and a blank space adjacent to the expected value in which to record the test readings. When tests include observations of pertinent responses that do not require instrument readings, each response shall have its own checkmark. No single checkmark shall be used for groups of responses.
- E. If, during the factory test, a discrepancy is found, it shall be corrected and any affected portion of the test shall be repeated. No piece of equipment with an uncorrected discrepancy shall be shipped.
- F. If, during the factory test, a discrepancy is found which cannot be corrected, testing shall be discontinued and the Authority Representative shall be notified and furnished with the test results and all particulars.
- G. Each device requiring factory test shall be given a model number to which the test documents are keyed. Any change in the organization or construction of the device shall result in a new model number or alternatively, the same model number, but a new series number. Each device requiring factory test shall have a serial number which shall be unique for any given model number. These numbers shall appear on the device.
- H. When test results are not recorded on a test-data plate affixed to the equipment or unit, the Design-Builder shall furnish certified test reports for each item at the time of delivery.

3.02 FACTORY TESTS AND INSPECTIONS - INSTRUMENT RACKS

- A. The entire complement of instrument racks for a given Train Control Room shall be set up at the point of assembly, with all equipment installed. The racks shall be interconnected with plug connector cables, in accordance with the approved drawings. The Design-Builder shall, where required or necessary, furnish and use approved test fixtures to simulate functions

external to the Train Control Room. All functions of the system shall be tested to determine that each function of the system operates as required.

- B. The Design-Builder shall make adjustments and shall correct defects in the rack wiring as necessary to obtain proper operation.
- C. All design changes found necessary to obtain proper operation shall be submitted to the Authority Representative for approval.

3.03 FIELD TEST PROCEDURES

- A. The tests performed shall cause each system and subsystem to be sequenced through POSITIVE and NEGATIVE testing of its required operations to demonstrate that the installation complies with all specified failure design requirements. Simulated tests at the factory for vital equipment such as track circuits will not be acceptable. The Authority Representative must be satisfied that the test procedure adequately determines that the equipment is working properly, in a safe manner, and that it meets or exceeds the requirements of these specifications. The Authority Representative will signify his satisfaction with the test procedure by placing his signature on the first page of the document. Test procedures which have not been signed by both the Authority Representative and the Design-Builder will not be considered valid. Tests conducted in conformance with an invalid procedure will not be approved.
- B. The quality of the installation shall be demonstrated by field tests for continuity, insulation resistance, resistance of ground connections, circuit breakdown, visual inspection and any other tests required by the Authority Representative. These tests shall be performed prior to any operational testing of systems or subsystems. Insulation resistance tests on factory wired equipment may be performed at the equipment manufacturing site.
- C. The Design-Builder's test procedures shall consist of pre-printed data sheets or inspection sheets for each test. When completed by the field test personnel and checked for accuracy and completeness, the sheet shall be submitted as the test report.
- D. When tests require specific meter or test instrument readings, the pre-printed data sheet shall show the allowable range of values for each part of the test. The test report shall also contain a check-off system for each action and a blank space adjacent to the expected value in which to record the test readings. When tests include observations of pertinent responses which do not require instrument readings, each response shall have its own checkmark. No single checkmark shall be used for groups of responses.
- E. The test reports shall also contain a final description sheet on which the Design-Builder shall record discrepancies found and action taken. This documentation shall be furnished to the Authority Representative.
- F. All test reports shall be dated and signed by the responsible employee of the Design-Builder, or sub-Contractor, on the day the test is performed. Space shall also be provided for the signature of the witnessing inspector.
- G. The Design-Builder shall show on his report the specific test instruments used on each test, with the instruments identified by name, type, serial number and calibration date.

- H. If, during field testing, the Design-Builder discovers errors due to field wiring and connections which do not agree with the approved circuit plans, the Design-Builder may correct such errors without prior approval of the Authority Representative.
- I. The Design-Builder shall not, however, make any changes to the approved circuit, as designed, without prior written approval of the Authority Representative.
- J. The Authority Representative will make all final determinations as to whether only a part, or the whole test, shall be re-run when any specific field test does not meet the requirements specified for the test.
- K. Whenever a reference ground is required in the performance of a field test, only grounds of resistance values which conform to those specified in Section 16922. shall be used. The Design-Builder shall identify the test ground used and its resistance value on the data sheets for the test being performed. The use of test grounds of unknown value will not be permitted. Any tests performed by the Design-Builder using unknown grounds will be rejected and must be redone by the Design-Builder.

3.04 FIELD TESTS AND INSPECTIONS

- A. Basic Requirements
 - 1. Field tests and inspections shall include, but not be limited to, the following:
 - a. Ground verification test.
 - b. Power racks - energy distribution system and failure alarm checks.
 - c. Breakdown test of all vital circuitry.
 - d. Wiring verification of all non-vital circuitry.
 - e. Vital function tests.
 - f. Operating test.
 - g. Logic verification tests.
 - h. All applicable inspections and tests prescribed by Part 2.4.1 of the AAR Signal Manual, where the AAR inspections and tests do not conflict with other requirements of these Specifications.
 - 2. The TCR power distribution system shall be tested for crosses and proper energy levels before ground detectors are made operational.
 - 3. The ground detectors shall be operational before circuit breakdown tests and interlocking tests are made.
 - 4. All ground detectors shall be maintained in operation and shall be monitored continuously throughout field testing.
 - 5. The Design-Builder shall submit plotted traces showing actual transfer times. Transfer times shall be measured by interrupting the service under test and measuring the output of the Transfer Switch.
- B. Specific field tests and inspections which the Design-Builder shall perform shall include, but not be limited to, the following:
 - 1. Resistance of Negative Return Bonds (YTP-1)

Electrical tests of negative return rail bonding, cross bonds and negative return traction feeder cable shall be conducted and recorded as herein described using a Biddle Portable Kelvin Bridge, Catalog No. 72-439 or an equivalent test instrument with corresponding range and accuracy.

 - a. Resistance of Compression-Bolted Connections
 - (1) Each complete negative-return rail joint bond of the compression-bolted (double) 500 KCMIL type, shall have an installed resistance not to exceed 0.000160 ohms plus 0.000011 ohms for each foot of

paired 500 KCMIL cables installed. The resistance of each individual bolted connection shall not exceed 0.000080 ohms.

- (2) The Null Balance method of testing shall be employed utilizing the four terminal arrangement, two potential and two current terminals. The C1 and C2 current leads shall be attached to the head of the rail six inches outside of each end of the power bond being tested. The P1 and P2 leads shall then be attached to the base of the rail one inch outside of each end of the power bond being tested. The meter dials shall then be manipulated to achieve a balanced condition of the meter.

(a) A similar procedure shall be followed when testing individual cable-to-rail connections.

- (3) Resistance of Clamped Connections

(a) Prior to performing the resistance test on base-of-rail clamped negative-return rail joint bonds or connections, the cap screw on each cable clamp shall be tightened to the specified pressure with a correctly calibrated torque wrench, according to the approved procedure.

(b) Each complete negative-return rail joint bond of the clamped 1000 KCMIL cable type, shall have an installed resistance not to exceed 0.000160 ohms plus 0.000011 ohms for each foot of installed cable. The resistance of each individual clamped connection shall not exceed 0.000080 ohms.

(c) The Null Balance method of testing shall be employed utilizing the four terminal arrangement, two potential and two current terminals. The C1 and C2 current leads shall be attached to the head of the rail six inches outside of each end of the power bond being tested. The P1 and P2 potential leads shall be applied to the base of the rail one inch outside of each end of the power bond being tested. The meter dials shall then be manipulated to achieve a balanced condition of the meter.

(d) A similar procedure shall be followed when testing individual cable-to-rail connections.

- (4) Cross-Bonding

(a) The installed resistance of each 1000 KCMIL cross bond cable shall not exceed 0.000160 ohms plus 0.000011 ohms for each foot of cable installed. The Null Balance method of testing shall be employed.

2. Inspection and Test of Cable Installation (YTP-2)

The following items shall be checked, as required, during and after installation. The Design-Builder shall determine that:

- a. A visual inspection of the exposed portion of the cable shows the exterior to be free of nicks, gouges or any obvious damage.
- b. The cable is properly installed and supported in the correct location, and adequate slack has been provided to prevent strain on the terminations.
- c. The cable shows adequate insulation resistance (at least one megohm for circuits operating at 600 volts and below, and at least 100 megohms for circuits operating above 600 volts) to ground and between each conductor and all other conductors. (The cables shall be disconnected by opening terminal links, or by other means, for these tests.) These tests shall be conducted using a Biddle No. 212159CL Megger, or approved equal.

- d. Any discrepancy found has been recorded on approved forms and brought to the attention of the Authority Representative.
 - e. The tags have been checked.
 - f. All insulation resistance has been recorded.
 - g. Cable of the proper size, voltage and type has been installed. (If substitution was necessary and was authorized and made, the plans shall show these changes.)
3. Inspection and Tests of Equipment Grounds (YTP-3)
The following items shall be checked and the Design-Builder shall determine that:
- a. The grounding systems called for in these specifications or shown on the Information Drawings are in place and correctly installed.
 - b. A visual inspection shows all ground connections tight, free of paint and suitably protected from physical damage and corrosion.
 - c. A visual inspection shows all ground leads sufficiently heavy (per Specification), short, direct and free of bend radii less than six inches.
 - d. The resistance between each bus and earth ground is not greater than 15 ohms for outside equipment and for Train Control Rooms, using the Ratio Ground Resistance test method. All connections to ground buses shall be tested to verify proper and adequate connections and the absence of ground return loops.
 - e. The resistance from each equipment ground connection to the ground bus has been checked and recorded.
 - f. One path, and only one path, exists between the TCR prime ground bus bar and ground. (Disconnecting the leads from the bar to ground shall show a DC resistance from the bar to ground of over 10 thousand ohms.)
4. Tests of TC Maintenance Telephone System (YTP-4)
The following items shall be checked and the Design-Builder shall determine that:
- a. The Yard TC Maintenance Telephone system is operating properly insofar as the following qualities are concerned:
 - (1) Clarity of tone (distinctness and freedom from distortion) at all normal working levels.
 - (2) Uniform volume level among units at midpoint on the control with a good range of adjustability of the control.
 - b. Each phone jack is installed, properly placed, and wired correctly according to these specifications, and is not a source of hum, noise or static as determined by an actual listening test.
 - c. The system functions as intended and herein specified.
 - d. Each leg of the system, as measured at the farthest jack, has a signal-to-noise ratio of 15 dB or greater.
 - e. The resistance between the conductor pairs and between each conductor and ground is greater than 1 megohm.
5. Tests of Transfer & Bypass Equipment (YTP-5)
The following items shall be checked and the Design-Builder shall determine that:
- a. A complete operational test of the Automatic Transfer and Bypass Equipment indicates that the system functions as intended and herein specified.
 - b. The measured transfer time to transfer the load from one service to another does not exceed .05 second.
6. Power System Operational Test (YTP-6)
- a. The Design-Builder shall determine that energy at all required levels is available in the Train Control Rooms, and properly distributed to equipment requiring it both in the field and in the TCRs. He shall check that no grounds, shorts, open circuits, crosses or misplaced wiring exist in the power

distribution system. Any malfunctions, lack of power, or blown fuses shall be reported for later correction and retesting. All alarm circuits shall be tested by simulating power or equipment failure. All standby or reserve power circuitry shall be checked both for completeness and satisfactory operation.

- b. The Design-Builder's test shall include the following:
 - (1) Check AC power supplies for correct voltage levels, and phasing where required.
 - (2) Check DC power supplies for correct voltage levels and correct polarity.
 - (3) Check and adjust transformer taps where required.
 - (4) Check and make operational all ground detectors.
 - (5) Check for proper voltage and current levels at the various equipment units under both "load" and "no-load" conditions.
- 7. Testing and Adjusting Wayside Signals (YTP-7)
Each signal shall be checked to verify the following:
 - a. The signal displays the proper aspect for the signal control relay positions.
 - b. The intensity and alignment is correct when viewed from an approaching train.
 - c. The signal receives energy at 9 volts and the voltage does not vary beyond the range of +10 percent and -5 percent during normal power supply and load fluctuation.
- 8. Testing and Adjusting Trailable Switch Machines (YTP-8)
Each trailable switch movement shall be checked to verify the following:
 - a. The switch movement is properly placed, installed, lubricated, free of abnormal mechanical resistance, and wired according to the plans.
 - b. The switch movement receives energy at the proper voltage, and the voltage remains within tolerance during operation of the movement.
 - c. That all internal and external mechanisms are in adjustment according to the manufacturer's instructions.
 - d. The movement responds to a blocked point in the manner specified.
 - e. The movement draws the correct current at the voltage supplied as specified by the manufacturer.
 - f. The movement responds in the correct direction according to the control relays and the appropriate repeater relays are energized.
 - g. The movement heater(s) are in place and are not drawing excessive current.
 - h. The movement layout and all its components are tagged and marked as specified in Section 16964, Yard Trailable Switch Operating Layouts.
 - i. If the movement includes a hand-throw feature, the movement can be hand thrown to both extreme positions and cannot be operated electrically with the hand throw feature activated.
 - j. The movement can be hand cranked to both extreme positions and cannot be operated electrically with the crank in place.
 - k. The opposite repeater relay is shunted when the switch is full normal or full reverse, and both repeater relays are shunted when the switch is in neither the full normal nor the full reverse position.
- 9. Track Circuit Tests - 60 Hertz (YTP-9)
 - a. Each track circuit shall be tested to verify the following:
 - (1) Shunting sensitivity of 0.5 ohms at feed end, relay end, and all fouling points.
 - (2) Defective insulated joint protection.
 - (3) Proper relay operation.

- b. The test report shall contain a tabulation of all circuit parameters used to achieve proper operation.
 - c. All applicable tests which are necessary to prove that 60 Hz series track circuits meet the requirements of these Specifications shall be performed by the Design-Builder.
10. Non-Vital Circuit Verification Test (YTP-10)
- a. All circuits shall be tested in their entirety for the correct operation of and response to each contact on each circuit element, such as relays and contactors. Where parallel paths exist, the tests shall validate each path, and circuits shall be opened if required to ensure the proper test.
 - b. Each circuit shall be tested by simulating all operating conditions to verify that the circuit operates in accordance with the Specifications and/or approved drawings.
 - c. As each circuit is checked out, contact by contact, from energy plus to energy minus, the corresponding circuit in the circuit plans shall be delineated with green pencil so that no wire, contact, coil, device or connection is overlooked. All coordinates for identifying apparatus locations shall likewise be checked.
 - d. On relays with exposed contacts, circuits may be checked by placing a thin strip of plastic between the appropriate pair of contacts and checking to see that this break de-energizes the relay of the circuit being checked. These plastic strips shall be configured so that they cannot be inadvertently left in place after the test. These plastic strips can be utilized to separate multiple circuit paths so that each contact in the remaining single circuit path may be checked.
 - e. Where parallel paths exist in a relay circuit, the circuit shall be checked to prove that all paths are energized from the same fuse (or circuit breaker), and only that fuse (or circuit breaker).
 - f. All terminations shall be checked to ensure that no extraneous connections exist.
 - g. Both ends of each wire shall be checked during these tests to be certain that their terminations are solidly applied and that they are properly held in their correct place.
 - h. Wires used for temporary connections for these tests shall be of vividly contrasting color to the rack wire, or alternatively, these wires shall be identified by a green paper tag fastened to the wire with string. These wires shall be removed at the end of the tests.
11. Vital Circuit Verification Test (YTP-11)
- a. Sub-paragraphs a., b., e., f., g., and h., of the non-vital circuit verification test (YTP-10) shall also apply to this test.
 - b. This test shall be done by removing contact terminals from plugboards at each contact and checking to see that the appropriate energized relay(s) drop.
 - c. A brown colored pencil shall be used to checkmark each connection on the set of plans (included with the test submittal) to indicate that each circuit element and termination has been checked as required in this procedure.
 - d. All circuit elements shall be checked in the breakdown test. This shall include, but not be limited to, relay test posts, pushbutton contacts, switch machine contacts, resistors and fuses.
12. Interlocking Plant Test (YTP-12)
- a. Interlocking plant test shall be made to determine the safe and proper operation of all functions of the yard interlocking. The test sequence shall be designed to test each function in accordance with these Specifications and

the applicable requirements of the current edition of "Rules, Standards and Instructions Governing the Installation, Maintenance and Repair of Signal and Train Control Systems, Devices, and Appliances" as published by the Office of Safety, Federal Railroad Administration of the U.S. Department of Transportation.

- b. Interlocking plant tests to be performed shall include, but not be limited to, the following:
 - (1) Time locking,
 - (2) Traffic locking,
 - (3) Route locking and sectional release locking,
 - (4) Verification of timing of time releases,
 - (5) Switch locking,
 - (6) Prevention of preconditioning,
 - (7) Control machine indications,
 - (8) Detector locking, and
 - (9) No premature quick release of route in the event of power failure.
 - c. When more than one type of locking is in effect at the same time, sufficient tests shall be conducted to verify the effectiveness of each type of locking.
 - d. Each route shall be tested for route security. This test shall be made by establishing the routes and falsely picking the Route Check Relay for each opposing or conflicting signal while observing that associated signals stay at STOP and the associated signal clearing relays remain de-energized.
 - e. Tests shall be performed to ascertain that a fuse failure will interfere with the operation of one route only, wherever possible.
13. Interlocking Operational Tests (YTP-13)
- a. Interlocking operational tests shall be made by aligning all possible routes, one at a time, and observing the following conditions:
 - (1) The called-for route clears.
 - (2) All conflicting routes are prevented from clearing.
 - (3) All possible parallel routes can be cleared.
 - (4) Fleeting can be established, where applicable.
 - (5) Response in field is correct.
 - (6) Control machine response is correct.
 - (7) Where applicable, traffic is aligned.
 - (8) When simulating a train movement through the aligned route, the following conditions are observed:
 - (a) Response in field is correct.
 - (b) Control machine response is correct.
 - (c) Where applicable, sectional release of routing is correct and consistent with clearance requirements.
 - (9) When aligning a route, then initiating a cancel of that route, the following conditions are observed:
 - (a) Time locking is in effect for the prescribed time.
 - (b) Conflicting routes cannot be cleared while time locking is in effect.
 - (c) Control machine response is correct.
 - b. The Design-Builder shall also perform a "Route Stability" test, where applicable, to ensure that the provisions of Section 16952. have been complied with, as they relate to the simultaneous operation of switch machines. This test shall be performed as follows:
 - (1) In each route which contains three or more switch machines, all the turnouts and crossovers in the route shall be pre-positioned with their respective test keys so that simultaneous movement of all of these

switch machines will occur when the route is called for by the entrance-exit circuits. As the route aligns, the Design-Builder shall observe to verify that:

- (a) There is no resulting excessive voltage drop in any portion of the power distribution system.
 - (b) There is no resulting excessive current in any portion of the power distribution system.
 - (c) There is no resulting tripping of circuit breakers or blowing of fuses.
- (2) If the simultaneous movement of the switches for the called route does cause excessive voltage drops, excessive current, the tripping of breakers, or the blowing of fuses, these facts shall be noted and recorded on the data sheets for the equipment in the route under test, and the Design-Builder shall notify the Authority Representative of this fact within 48 hours. If no such problem occurs. The Design-Builder shall certify this to be true on the data sheets for the equipment in the route under test. If such a problem exists, the Design-Builder shall submit proposed corrective measures to the Authority Representative within 15 days, for approval. Upon making any corrections necessary to obtain the Authority Representative's approval, the Design-Builder shall promptly implement the approved corrective measures and retest the problem area at no additional cost to the Authority.
14. Snowmelter Operational Test (YTP-14)
Each snowmelter layout shall be checked to verify the following:
- a. Controls and indications on the Yard Control Panel operate properly.
 - b. Each snowmelter heating element and switch rod heater unit is energized from the proper fuse and is supplying the correct amount of heat. Temperatures shall be obtained using infrared heat gun or strap-on thermometers and shall be recorded on the data sheets.
 - c. The door interlock circuits on the Snowmelter Control case function properly.
 - d. The snowmelter control case heaters are functioning properly.
15. Insulated Joint Tests (YTP-15)
Each insulated joint in the running rails, gauge plates, switch rods, throw rods, and circuit controller rods shall be tested by the ratio method, using a track quality meter, as manufactured by General Railway Signal Company, or approved equal.
- a. With a standard 1000 ohm resistor placed across the joint, and with audio frequency current supplied by the track quality meter, the ratio between the current flowing through the insulated joint and the current flowing through the standard resistor shall be determined by use of the current probe of the track quality meter.
 - b. Utilizing this ratio, calculations shall be made by an approved formula to determine the resistance of the insulated joint itself.
 - c. If the resistance so determined is less than 5000 ohms, the insulated joint will be regarded as defective, and the Design-Builder shall notify the Authority Representative of this defect.

3.05 Acceptance Testing and Safety Certification

- A. The following tests will be conducted by WMATA as part of the Acceptance and Safety Certification.
 - 1. Track Circuit Verification

- a. Power Frequency (AC) Track Circuit
- b. Series Track Circuit
2. Cable Integrity Test
 - a. Switch Cable
 - b. Signal Cable
3. Switch Tests
 - a. Switch Detector Locking
 - b. Prevention of Switch Pre-conditioning
4. Time & Route Locking
 - a. Route Locking
 - b. Time Locking
5. Opposing Signal Tests
6. Traffic Locking Test
7. Detector Test
8. Loss of Shunt Test
9. Two Track Release Test
10. Sectional Release Test

END OF SECTION

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SECTION 16991

YARD SIGNAL DRAWINGS AND TRACINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. This Section contains specifications for the production and furnishing of Yard Signal Control and Interlocking System tracings, drawings, and CD-ROMs, and describes the general format of the drawings, types of drawings, and the manner in which information shall be displayed on these drawings.
- B. Drawings shall be prepared and submitted separately for each respective yard in which work is included in this contract

1.02 BASIC DESCRIPTION

- A. Drawings shall be divided into two basic types. Each type shall be furnished in a separate book. The typical drawings common to all TCR locations shall be contained in a "Book of Typical Plans." Drawings specific to a particular TCR location shall be contained in a "Room Book-of-Plans" for that particular room.
- B. Drawings for the existing Yard Signaling systems are on file at the Authority's offices. The Design-Builder may refer to these drawings and may obtain prints of any of these drawings required for completion of work under this Contract.
- C. When the work requires alteration or additions to existing Drawings, the Authority will furnish the Record Drawings which require revisions. From these the Design-Builder shall produce new drawings or CDROM's to replace or supplement the existing drawings, all as specified herein.
- D. The effective date and identification number, to be inscribed on the final tracings, will be furnished by the Authority Representative prior to the time the tracings reach As-Built condition and are ready for the Design-Builder's final processing.
- E. The Design-Builder shall produce the various types of drawings required by these specifications in a manner similar to that depicted on the corresponding typical drawings or example existing yard drawings included in the Information Drawings.

1.03 RELATED SECTIONS

Related work specified elsewhere shall include, but not be limited to, the following Sections:

Section 16911	Scope of Work
Section 16912	Yard Signal Submittal Requirements
Section 16916	Basic Circuit Requirements
Section 16931	Yard Signal Maintenance and Test Facilities

1.04 TYPES OF DRAWINGS

The types of drawings to be provided shall include, but not be limited to, the following as applicable:

- A. Drawings indicating the track configuration including the location of pertinent items of Yard Signaling related facilities, such as signals, trailable switch layouts, junction boxes, snowmelter control housings, equipment cases, ductbanks, manholes, cable surface trench, TCRs, Shop Buildings, and other relevant wayside equipment and ancillary facilities. These drawings shall be drawn in a geographical representation of the yard and tracks and shall be known as Double Line Track Plans.
- B. Drawings showing the arrangement of equipment, facilities, or components in a room, rack, junction box, housing, cabinet, or module - These drawings shall be known as Arrangement Plans.
- C. Drawings showing the dimensions and internal mechanical and electrical details of particular pieces of equipment or assemblies - These drawings shall be known as Product Drawings, but shall bear the title of the particular piece or type of equipment shown.
- D. Drawings on which detailed information is shown for the mechanical installation of Train Control equipment, such as signals, trailable switch machine layouts and snowmelter layouts - These drawings shall be known as Installation Drawings.
- E. Drawings which indicate the point-to-point cable runs and identify cable make-up and conductor wire size - These drawings shall be known as Cable Plans.
- F. Drawings showing the exact location of direct burial and surface cable trench runs, as applicable - These drawings shall be known as Trenching Plans.
- G. Drawings showing the various types of control, operating and indication circuits required - These drawings shall bear the title of the particular function(s) performed by the circuits illustrated, but shall all be classified as Circuit Drawings.
- H. Schematic drawings of various energy distribution systems or subsystems - These drawings shall be known as Energy Distribution Schematics.
- I. Drawings showing the details of electrical connections for various pieces of yard signaling equipment - These drawings shall bear the title of the particular piece of equipment, but shall all be classified as Wiring Diagrams. This category shall include "Back Panel Wiring Diagrams" for all control and indication panels provided under this Contract.
- J. Drawings showing the wiring and connection diagrams for individual systems and subsystems supplied on this Contract, for example, the separate drawings showing the TC Maintenance Telephone lines emanating from each TCR and showing all terminations of these lines within the Contract limits - These drawings shall be known as TC Maintenance Telephone System Drawings. Wiring diagrams of the connections between the various parts of a system shall be fully detailed with all terminals and wire numbers. They shall be complete and all on one page if possible. No connections shall be omitted. All interface connections shall show destinations, preferably graphically, but if not practical, through the use of adequate nomenclature. Reference may be made to drawings in the "Room Book-of-Plans," or the "Book of Typical Plans."
- K. Drawings showing complete Material Lists for all assemblies, subassemblies and components supplied on this Contract - These Material Lists shall include all information necessary for preparing an order to the supplier for replacement of such equipment. As an option, these

Material Lists may be provided on 8.5 x 11 inch paper, or may be included as part of related drawings. All items shown on these material lists shall be completely described, to include identifying sources, size, configuration, mating and attaching characteristics, functional characteristics and performance requirements, and "form, fit and function" data contained on specification control drawings, catalog sheets, and outline drawings. Items such as resistors, capacitors, nuts, bolts, and other general hardware, shall be described only once for this Contract provided they are adequately cross-referenced.

- L. Drawings entitled "List of Spare Parts" for all assemblies, subassemblies and components supplied on this Contract - These lists of spare parts shall include the recommended stock quantities for routine maintenance of the equipment for one year and shall include a sub-list of spare parts that are considered critical and for which extended amounts of time required for acquisition would create undesirable down-time for the equipment.
- M. Drawings entitled "List of Tools" for all assemblies, subassemblies and components requiring the use of tools - These drawings shall list all common and special tools required to perform inspection, adjustment, maintenance and repair. Special tools are those developed to perform a unique function related to a particular piece of equipment, which are not available from common commercial sources. Special tools shall be so identified on the list.
- N. Drawings showing complete circuits which, with minor modifications and details added, will be used repetitively throughout the Contract work - These shall drawings be known as Typical Circuit Drawings and shall have the word "Typical" included in the title along with the circuit or function name shown.
- O. Index sheets for each TCR Book of Plans.

1.05 QUALITY ASSURANCE

See Section 01113, Systems Integration

1.06 SUBMITTALS

See Section 16912, ATC Submittal Requirements

PART 2 - PRODUCTS

2.01 MATERIALS FOR TRACINGS

The final As-Built drawings shall be printed on four-mil-thick mylar in *AutoCAD 2000* format by automated techniques approved by the Designated Authority's Representative.

2.02 BOOKS OF DRAWINGS

The Design-Builder shall supply books of specific Yard Signaling drawings for submittal packages and plan books as required elsewhere in these Specifications. These books of drawings shall consist of the following components:

- A. A group of drawings assembled in a logical order.
- B. An index sheet of the same size as the drawings.

- C. Protective cover and backing sheets. The name of the submittal package or name and location of the plan book shall be printed on the cover sheet in two-inch-high letters.
- D. A device for binding the left-hand edges of the drawings firmly, but in such a manner that drawings may be easily added, removed, or replaced without damage to the drawings or the binding.

PART 3 - EXECUTION

3.01 BASIC FORMAT REQUIREMENTS FOR YARD SIGNALING DRAWINGS

- A. Each drawing (maximum size of sheet, 22 inches by 36 inches) shall have a blank area 3-1/2 inches by 3-1/2 inches, located adjacent to the title block in the lower right hand corner.
- B. The title block shall display the following:
 - 1. Number and type of drawing
 - 2. Date of drawing and all revisions
 - 3. Name of Yard and specific Train Control Room area
 - 4. Name of Design-Builder and SubDesign-Builder submitting drawing
 - 5. Clear identification of contents and location of the work
 - 6. Specification title and Contract number
- C. All lettering or printing shall be at least 0.10 inches high and shall be produced by automated means. Freehand printing or lettering will not be acceptable.
- D. Notes shall be located as far toward the right border of the drawing as possible.

3.02 SPECIAL REQUIREMENTS FOR YARD SIGNALING CIRCUIT DRAWINGS

- A. Circuitry shall be presented on the drawing with a minimum of crossed or offset lines.
- B. Circuits shall not be drawn as schematics, but shall be drawn to reflect the actual wiring of the circuits. A uniform method shall be used to indicate the actual location of double wire connections when it is not desirable to show both wires at the point of termination. If the final circuit is not wired as shown on the Design-Builder's drawing, the Design-Builder shall revise his tracings to indicate the actual wiring before final, As-Built prints are made.
- C. No more than two wires shall be shown connected to a single terminal or contact pin other than an AAR terminal unless specifically authorized by the designated Authority Representative. No more than three wires shall be shown connected to a single AAR terminal.
- D. Complete circuits shall be shown on each drawing insofar as possible. A minimum of continuations shall be used. When continuations must be used, they shall be clear and specific and shall include the identity of the continuation sheet and the unique identity of the specific continuation. Wherever practicable, these "continuations" shall "line up" from drawing to drawing.
- E. Circuits shall be drawn with relay coils, timers, motors or other operated devices shown near the right or left border of the drawing wherever practical. Where there is a choice, the right border shall be favored.

- F. Track relay contacts in Yard Signaling circuits shall be inserted successively in conformance with the geographical succession of the track circuits themselves insofar as possible and practical.

3.03 PLAN BOOKS

- A. The Design-Builder shall maintain two sets of plan books in each TCR in which Yard Signaling equipment is installed under this Contract. Each of these sets shall consist of two books of drawings:
1. One book shall consist of all the Yard Signaling drawings for the area controlled from that particular TCR and shall include applicable prints from adjacent TCRs to show the non-local portions of traffic circuits and other line circuits appearing in the local TCR. This book shall also include
 - a. A copy of the wiring diagram for each wayside Yard Signaling junction box and control case located within the area controlled from that TCR
 - b. Complete Yard Signaling cable plans for the entire area controlled from that TCR.
 2. The second book shall consist of typical circuits and typical arrangement or internal layout plans and wiring diagrams for the various pieces of ATC equipment common to the various TCRs.
- B. Both sets of these books shall be updated immediately to reflect any changes made in the circuits or equipment. Work shall not proceed within a TCR area of control until such updates are made. One set of these updated plan books for each TCR shall never leave the TCR, and shall be left in the TCR when the TCR is transferred to Authority control.
- C. The Design-Builder shall maintain a complete set of up-to-date plan books for all TCR locations included in this Contract at his on-site headquarters.
- D. Three additional copies of the typical books and three additional copies of each TCR book of drawings shall be furnished to the Authority at the time the Design-Builder begins work in the TCR.

3.04 AS-BUILT DRAWINGS

The completed As-Built drawings shall bear the signature of an officer of the Design-Builder's organization, certifying compliance with as-built conditions, as specified in Section 16912.

3.05 CD-ROMs

The individual formats required for the various CD-ROMs to be furnished by the Design-Builder shall be as directed by the Designated Authority Representative.

END OF SECTION

THIS PAGE NOT USED

Serial Number: RFP-FN5008/FMP
Date of Issue: December 3, 2004
Proposal Due Date: January 21, 2005

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 FIFTH STREET, N.W.
WASHINGTON, DC 20001

December 20, 2004

AMENDMENT NO. 1
TO

METRO MATTERS - Design/Build: Rail Yards Expansion Project
at Brentwood, Greenbelt, and Shady Grove Yards

Phase II - Request for Technical / Price Proposals

CONTRACT NO. FN5008

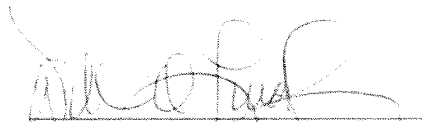
TO WHOM IT MAY CONCERN:

The proposal documents accompanying solicitation RFP-FN5008/FMP are hereby changed in part as follows:

1. The date established for Receipt of Proposals remains unchanged.
2. Proposers are hereby notified that all Questions pertaining to this solicitation and requests for Site Visits must be submitted by e-mail to fpohlmann@wmata.com with copies to wlinde@wmata.com and itriolo@wmata.com.
3. Proposers are notified that Questions received by WMATA after December 22, 2004 will not be responded to until January 3, 2005 at the earliest. In addition, no further Site Visits will be scheduled until January 3, 2005.
4. WMATA's responses to Proposer's Questions raised thru December 15, 2004 are attached.

ACKNOWLEDGMENT

Offerors are required to acknowledge receipt of this amendment in writing on the Proposal Form in the space provided or by separate letter or telegram prior to the date established for receipt of proposals.



William O. Linde, Jr.
Contracting Officer
Office of Procurement and Materiel

December 20, 2004

QUESTIONS AND ANSWERS

Question 1: In reviewing the Table of Contents for Division 0, it became apparent that page numbers are not accurate and that entire sections are not reflected. Can WMATA reissue a corrected Table of Contents?

Answer: Our review indicates that due to inconsistencies in printers and problems associated with bulk reproduction of documents, some of the copies provided for Book 1 (Division 0 and 1) were not in the correct format or order. For this reason we have reissued Book 1 (Division 0 and 1) in its entirety to all Phase II participants.

Question 2: Section 00102, Section 00434 - Notes to Proposers # 1: Since these Sections state that multiple contracts will be awarded, if a proposer submits a price and technical proposal for just one of the projects and not the other, is it WMATA's intent to reject the proposal?

Answer: WMATA intends to award one or more contracts for the RFP based on the best interests of the Authority. Since both contracts will be evaluated for award at the same time, it is necessary that all proposers submit price and technical proposals for both projects. Failure to do so may result in ineligibility for award with such determination to at the Authority's sole and absolute discretion.

Question 3: Section 0102 (K.2) states that the Design-Builder must coordinate with "Utility companies and jurisdictional agencies affected or having jurisdiction over the Project through the Authority Representative". Is it WMATA's intent that the successful Design-Builder submit all required submissions either to the separate County Permit Office, and the District of Columbia Permit Office and affected Utility companies to the Authority Representative and then WMATA will be responsible for submission to the agencies?

Answer: No. It is WMATA's intent that the Design-Builder prepare all submittals as required and forward same to the Authority Representative for review and comment. Forwarding of submittals to the agencies after WMATA review is the Design-Builder's responsibility.

Question 4: Section 00102(O.1.b.1) states that the Design-Builder shall coordinate delivery of the plantings to the worksite for installation by the Builder. The Builder will contract with a landscaping company who is usually responsible for coordinating the delivery of planting materials selected by the Designer and installation of such once they arrive at the jobsite. Is it WMATA's intent to have the Designer schedule the delivery of the planting material in lieu of the landscaping contractor? If so, this could prove to be a scheduling problem.

Answer: It is WMATA's intent to clearly state that the Design-Builder is responsible both for delivery and installation of the planting materials. Distribution of labor and coordination of work with the landscape contractor is also the Design-Builder's responsibility.

Question 5: Section 00102(O.1.a) states that the Builder is responsible for performing Quality Control for construction and the Designer for performing Quality Assurance during construction in accordance with Section 01470. Is it WMATA's intent that the Builder provide the normal Quality Control Procedures and the Designer provide on-site Quality Assurance functions? Or does the Quality Assurance referred to in Section 00102 deal mainly with the Quality Assurance that the Designer provides in the normal administrative functions relating to RFIs, submittals, reviewing non-conformance items identified by the Builder, etc.?

Answer: Quality Assurance by the Designer during construction refers to those actions necessary to ensure that the Project is constructed by the Builder in accordance with the approved Final Design Specifications and Drawings as provided by the Designer for construction of the Project. Quality Control refers to those actions normally performed by the Builder during the construction process to ensure compliance with WMATA specifications and the approved Quality Control Plan.

Question 6: Section 00201(P.1), Section 00792 - Section 00201(P.1) outlines the requirements for the Disadvantaged Business Enterprises. This section reads, "... and also of the Federal Transit Administration (FTA) and the U. S. Department of Transportation (USDOT) in receiving and participating in federally assisted contracts." In addition, Section 00792(F.1) states that the "... federal government is not a party to this contract and shall not be subject to any obligations or liabilities to the Authority, Design-Builder, or any other party ...". Do these Projects contain any funds from either the FTA or USDOT?

Answer: These projects are federally-funded, however, the intent of Section 00792 is simply to state that the federal government is not a party to any contract resulting from this solicitation. WMATA is partially funded from federal grants provided to FTA as a Third-Party Grantee under the requirements of FTA Circular FTA C 4220.1E, "Third Party Contracting Requirements" and therefore must comply with the requirements for participation by Disadvantaged Business Enterprises as stated as well as other federally-mandated requirements.

Question 7: Section 00201(V.2) refers to WMATA's tax exempt policy. Is it accurate to say the Proposers need to include taxes in their cost for the Brentwood project?

Answer: Proposers need to include all relevant sales taxes in their proposal for the Brentwood project.

Question 8: Section 00204.D.2.F indicates that "A detailed CPM schedule with narrative description of the construction methodology, including equipment, materials, and manpower to be employed to construct the project." is to be provided. Considering

the Design-Build nature of the project, the short RFP period, and the target price format, is it really necessary to provide a cost-loaded, equipment-loaded CPM schedule, or will a schedule which identifies the critical path and narrative be sufficient?

Answer: Due to the basis of award for these Projects being "Fixed Price / Best Design", it is necessary that Proposers provide a fully cost-loaded CPM schedule as described in order to make a determination as to what value is being provided within the target price. One of these factors is the value provided as far as construction methodology, value of equipment and materials provided and manpower, particularly as far as skilled versus semi-skilled or unskilled labor.

Question 9: Section 00204.D.3.B.2 indicates that the Project Manager must have a "professional engineering certification". Does the Project Manager for the Design-Builder need to be a Certified Professional Engineer?

Answer: Yes.

Question 10: Section 00341.A indicates that the "Authority anticipates Categorical Exclusions (CE) as a result of its own environmental investigations. Copies of the CE's are available upon request". Can WMATA provide copies of the CE's to the Proposers at this time?

Answer: Copies of the CE's will be provided to all proposers. Categorical Exclusions (CE's) are issued by FTA if it can be shown that there are no significant impacts to the environment as a result of a specific project. FTA's approval will void the need for a detailed environmental impact statement, which is a lengthy process.

Question 11: Section 00433 is included in the RFP for the Proposers to identify brand name or equal substitutions in the technical proposal. Since this Project is a Design-Build project and the design will take an extended period of time, it does not seem practical to provide "or equal" lists for products that are yet to be fully designed. Does this form need to be provided in the technical proposal?

Answer: Yes. One of the factors for technical evaluation is the major equipment to be provided. Division 11 includes Appendix A, "MAJOR SHOP EQUIPMENT LISTING" which clearly identifies which equipment will be evaluated. The Design-Builder must complete the Section 00433 to indicate what Major Equipment is being offered. As stated, brand names indicated in the Specifications are for descriptive purposes only, equals will be considered as shown under Section 00204.D.1.B., except where specifically stated otherwise.

Question 12: Section 00453 outlines the requirements of the Disadvantaged Business Enterprise (DBE) Program. Can WMATA provide a current 2004 DBE Program Directory?

Answer: For copies of the DBE Directory, please contact the Office of Civil Rights at (202) 962-2384.

Question 13: Section 00724.A. requires that the Design-Builder submit a schedule to the Authority 15 days after the award of the Contract. Based on the fact that the Proposers have to submit a detailed proposal schedule and that the project is a Design-Build project, the design will not have progressed far enough to provide another more detailed schedule within 15 days of Contract Award. Could this requirement be revised to require the Design-Builder to submit a baseline schedule within 15 days of the 60% design?

Answer: Yes. The updated detailed schedule can be submitted with the 60% design submittal.

Question 14: Section 00749 E. indicates that the "Authority will allow as an element of work accomplished, i.e., progress towards completion, only 50 percent of the invoiced cost of materials or equipment delivered to the site, or suitable location as described in paragraph D above, but not incorporated in the construction up to the time the materials or equipment are actually incorporated into the work." These projects have very large amounts of major equipment that have a long fabrication and delivery lead time. The manufacturers of these large equipment packages will not agree to only being paid 50% of the material price until installed. Can this requirement be relaxed to allow the manufacturers of the large packages of equipment to be paid for material actually fabricated, but not yet incorporated into the work, in full?

Answer: Authority regulations generally do not permit the use of "Advance Payments" for work not performed. In some cases, a request can be made by WMATA to the Federal Transit Administration (FTA) for an exception based on sound business reasons providing that adequate security for such advance payment is obtained. However, the granting of this exception by FTA cannot be guaranteed.

Question 15: Section 01110.1.04.a.3. indicates that the construction of the Brentwood shop main floor must be coordinated with WMATA so that disrupted maintenance functions at Brentwood can be accommodated at other WMATA facilities. It also states that this may result in delayed access to the main floor until other facilities, e.g., Greenbelt, are available. Section 00825 indicates that the Greenbelt Yard has an interim completion milestone of 765 calendar days after NTP and that the Greenbelt/Shady Grove Yards Project has a milestone of 825 calendar days after NTP. Is it the intent to have all of the work at the Greenbelt Project site complete within the 765 calendar days or only a portion complete so work at the Brentwood shop level can begin? Since the Brentwood project will be awarded separately and possibly to a separate Design-Builder from the Greenbelt/Shady Grove project, how will the scheduling and coordination of getting Greenbelt ready to accept the equipment from Brentwood be handled?

Answer: It is WMATA's intent to award one or more contracts from RFP FN5008/FMP. For this reason, it is possible that the two projects could be awarded to a single Design-Builder and/or to separate Design-Builders. WMATA's primary concern during construction of each of these projects is continuity of service at the affected

facilities. Brentwood Yard is being modified to allow it to be converted from a heavy truck and wheel maintenance facility to an inspection facility and Greenbelt is being modified to accept the heavy truck and wheel maintenance functions from Brentwood. In order to ensure that continuity of service is maintained, it will be necessary for certain areas at Greenbelt to be completed before work on the Brentwood main shop floor can proceed. Should a single contract be awarded, the Design-Builder will be responsible for coordinating all work with the Authority and developing a construction schedule that indicates compliance with this restriction. Should separate contracts be awarded, the Design-Builder for the Brentwood project is advised of these restrictions on work performance. It is recognized that the Design-Builder for the Brentwood project will have no direct responsibility for the Greenbelt project, however, they will be expected to coordinate their work efforts with the Greenbelt Design-Builder through the Authority so as to ensure that operations at these facilities are not adversely impacted.

The interim milestone shown in Section 00825 for Greenbelt Yard refers to work in the Yard only, not the entire Greenbelt Project. Currently there is no requirement for the Design-Builder to transfer equipment from Brentwood to Greenbelt. Should such be required, it would be treated as a change to the contract subject to equitable adjustment.

Question 16: Section 01112, Section 16900. In the past, WMATA has required that the Train Control Equipment Manufacturer be the Designer of Record for the system. Is it WMATA's intent on these projects to have the Train Control Equipment Manufacturer be the Designer of Record for the Train Control System?

Answer: Yes, the Train Control Equipment Manufacturer must be the Designer of Record for the Train Control System.

Question 17: Section 01330.1.03.A. requires that a preliminary submittal list be provided for Authority approval at the Pre-Design-Build Conference within 10 calendar days after the Award of the Contract. This requirement does not seem to be realistic for a Design-Build project since the actual design of the project will have just begun. In addition, Section 01330.A.1 requires that a Contract Documents Submittal Log be provided within 60 days of NTP. Can these requirements be relaxed to more accurately reflect these requirements for a Design-Build project?

Answer: The time requirements cited apply to submittal of design documents only and therefore will not be relaxed. The log of construction submittals should be submitted prior to the start of construction on a date to be determined by the Authority Representative and the Design-Builder.

Question 18: In reviewing the RFP, it became apparent that there were some copying problems that caused entire sections to be improperly copied. Can WMATA provide corrected copies?

Answer: Yes. Reissued RFP documents for Book 1 (Divisions 0 and 1) will be issued to all

Phase II participants as soon as possible.

Question 19: Section 00204.D.3.B. indicates the Key Personnel that must be included in the Technical Proposal. Section 01111.1.05 also provides a list of key personnel which is different from the list provided in Section 00204. Are the only personnel that need to be listed in the proposal the Key Personnel listed in Section 00204?

Answer: Section 00204 refers to Key Personnel whose qualifications will be evaluated as part of the Technical Proposal submitted by the Design-Builder. Section 01111 includes additional key personnel that must be included for the project and shown on the project-specific organizational chart but whose qualifications are not part of the technical evaluation with the following exceptions for which the descriptions are synonymous: Project Manager and Overall Program Manager; Design Manager and Design Engineering Manager; Superintendents and Construction General Superintendent; Quality Control Manager and Quality System Manager for QA/QC.

Question 20: Item B.2 of the Architectural Program Criteria for Shady Grove indicates that a new 15 ton overhead crane is to be installed at the truck repair hoist area. On sheet A16-A-02 this bridge crane is indicated as a 3 ton bridge crane. In addition, Section 1.06.D.8 indicates that a 3 ton bridge crane be provided at Shady Grove. Please confirm whether a 15 ton bridge crane or a 3 ton bridge crane is required?

Answer: A 15-ton bridge crane is desired at Shady Grove.

Question 21: Item B.3 and B.4 of the Architectural Program Criteria for Shady Grove indicates that we need to provide adequate bathroom facilities on the ground floor to accommodate the maximum number of men and women working on the day shift. Item C.1 and C.2 of the Architectural Program Criteria for Shady Grove indicates that we provide adequate lockers and benches in the locker rooms for the maximum number of men and women working in one shift. Please provide an approximate maximum amount of the men and women who work on the day shift so these areas be adequately sized and accommodated.

Answer: Currently there are approximately 110 employees at Shady Grove. Expect number of employees to increase by 70 to a total of 180 when the shop addition is operational. Woman's locker room has excess capacity now and will not have to be modified. Men's locker room has approximately 70 permanent lockers and 40 temporary lockers. Based on current gender mix and type of work to be performed, great majority of new employees will be male. Therefore, the full compliment of 70 new employees should be accommodated in the men's locker room. In addition the approximate 40 temporary lockers shall be removed and replaced with permanent lockers.

Question 22: Section 01110.1.04.A.4.a.(2) and b.(1) indicate that the heavy truck and wheel maintenance functions are to be relocated from Brentwood to Greenbelt as directed by the Authority. Is the Design-Builder responsible for relocation of equipment currently being utilized at Brentwood to the Greenbelt location?

RFP FN5008/FMP - Amendment 001

METRO MATTERS

Design/Build: Rail Yards Expansion Project at Brentwood, Greenbelt, and Shady Grove Yards

Answer: No. This is provided for information purposes only to indicate the intent of the Authority. Should any equipment need to be moved from Brentwood to Greenbelt it will be accomplished by the Authority.

Question 23: Section 01113.1.06.C.3.b. indicates that the Final 100% Systems Integration Design shall include "written disposition of the 90% design review comments", however, there is no reference to a 90% submittal requirement. Please clarify.

Answer: Revise Section 01113.1.06.C.3.b to read "60%" in place of "90%" as shown.

Question 24: Section 01115.1.02.B. and C. indicate that these documents are "To be provided prior to award". Are these documents to be provided by the Design-Builder as part of the Technical Proposal or by the Authority?

Answer: These documents will be provided to the Design-Builder by the Authority prior to award.

* * * * END QUESTIONS AND ANSWERS * * * *

SECTION 10600

STORAGE RETRIEVAL SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. The general extent and scope of work to be performed under this Section consist of the furnishing and installation of a storage and retrieval system in the new Component Parts Storage rooms at the Greenbelt Annex and the Shady Grove Shop. The existing storage and retrieval system in the Greenbelt Shop may be dismantled and reused in the Shady Grove Shop with modifications as necessary to generally conform to the requirements of this specification.
- B. The provisions of Section 11001, Equipment General Requirements, apply to work of this Section.

1.02 QUALITY ASSURANCE:

- A. Experience: Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified
- B. Reference Standards:
 - a. ANSI - American National Standards Institute.
 - b. OSHA - Occupational Safety & Health.

1.03 SUBMITTALS:

- A. Submit the following for approval in accordance with the requirements set forth in General Conditions and with the additional requirements as specified for each:
 - 1. Certificates: Fourteen days prior to shipment, submit four copies of certification that equipment to be delivered is in compliance with applicable codes.
 - 2. Shop Drawings: In accordance with the requirements of Section 01330; Design Construction Submittal Procedures, submit six copies of complete shop drawings to the Authority for approval, including but not limited to:
 - a. Equipment arrangement
 - b. Equipment outline dimensions
 - c. Assembly and subassemblies
 - d. Air systems
 - e. Wiring diagrams and schematics
 - f. Installation
 - 3. Operations and Maintenance Manual: Submit in accordance with the requirements of General Conditions, Section 001780; Closeout Submittals.
 - 4. Operations and Maintenance Training: Submit in accordance with requirements of General Conditions, Section 01820; Demonstration and Training, and Section 11001; Equipment General Requirements.

5. Contract Record Drawings: Submit in accordance with the requirements of General Conditions, Section 01330; Design Construction Submittal Procedures, and Section 01780, Closeout Submittals.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Ship equipment upon notification by the Engineer.
- B. Package, handle and store to prevent damage.

1.05 WARRANTY:

- A. Furnish warranty for the work in this Section in accordance with the General Conditions.

1.06 TRAINING PROGRAM:

- A. Design Builder is responsible for training as outlined in General Conditions, Section 01820; Demonstration and Training, and Section 11001; Equipment General Requirements.
- B. Number of Personnel to be Trained and class size:

Level of Training	Approximate Number of Individuals to be Trained	Maximum Class Size	Minimum Number of classes
Level I	8	8	1
Level II	4	4	1

PART 2 - PRODUCTS

2.01 STORAGE RETRIEVAL SYSTEM:

- A. General: This specification covers a storage retrieval system employing 1) integral lifting forks mounted on top of 2) variable location racks which accept 3) removable steel pallets. It includes the physical and mechanical requirements of that equipment, as well as the engineering assistance to be supplied by the vendor.
- B. Features and Construction
 - 1. Storage racks
 - a. The storage rack shall have a maximum capacity of 25,000 pounds per section and 50,000 pounds per bay.
 - b. The overall height of the storage rack shall be 13'-0".
 - c. The clear opening between columns shall be 1 ½" greater than the pallet width.

- d. The overall depth of each rack shall be 1 ½" greater than the pallet depth.
2. Columns
- a. Columns shall be accurate and straight.
 - b. Columns shall be 13'-0" long.
 - c. Roll formed front columns shall be a minimum of 3 ½" wide (left to right) by a minimum 2 ½" deep by a minimum 12 gauge thick steel and shall rest on a 5 ½" by 8" (minimum of 44 sq. in.) Bearing pad.
 - d. Formed rear columns shall be a minimum 7-7/8" wide (left to right) by a minimum 2-5/8" deep by a minimum 10 gauge steel and shall rest on a 5 ½" by 8" (minimum of 44 sq. in.) Bearing pad.
 - e. Each bearing pad shall be anchored to the floor with a minimum of two ½" diameter expansion anchors.
 - f. Each bearing pad shall have a minimum ½" diameter leveling screw, independent of the anchors, with a vertical adjustment of 5/16" minimum.
 - g. Each column shall have pallet retainer notches spaced a maximum of 3-7/8" on center.
 - h. The notches on the front columns shall be hooked for positive pallet engagement, while the notches on the rear columns shall be designed to facilitate loading and unloading without resistance or snagging.
 - i. Column spacing shall be a maximum of 5" on center greater than the pallet width.
3. Bridge Assembly
- a. The bridge assembly shall run on rails mounted lengthwise on the top of the storage rack and shall support the trolley and mast assemblies free and clear above the floor.
 - b. The bridge shall be constructed of rectangular welded box construction using 6" x 12 pound/ft wide flange beam construction and shall be capable of supporting 2,000 pounds live load.
 - c. The bridge wheels shall be 9" diameter double flange type with needle roller bearings with pressure grease fittings.
 - d. A rail sweep shall be mounted in front of each wheel for derailment protection.
 - e. Bridge shall have a cantilevered extension at one end.
4. Trolley Assembly
- a. The trolley assembly shall run on four wheels inside the flanges of the bridge beam and shall support the mast assembly.
 - b. The wheels shall be a minimum 5" diameter flange-less wheel with permanently lubricated ball bearings.

- c. The trolley must be capable of supporting 2,000 pounds live load and shall be constructed of integral flanged steel plate to prevent binding of the turntables.
 - d. In addition to the load bearing wheels, four stabilizing bearings shall be used to keep the trolley aligned within the bridge.
 - e. Multiple trolleys shall be provided to serve all aisles.
5. Rails
- a. The rails shall be constructed of a minimum 20 pound per yard ASCE steel.
 - b. The rails shall be mounted with sufficient accuracy to provide a smooth riding runway and must be capable of supporting the weight of the bridge, trolley, mast assemblies, and a 2,000 pound load.
 - c. Rails shall terminate with stops capable of restraining a fully loaded bridge/mast assembly.
6. Mast Assembly
- a. The mast shall be constructed of two 6" minimum steel channels connected by ladder type truss members and shall be mounted to the trolley with a 360 degree continuous rotation turntable.
 - b. The turntable shall be a ball bearing type and capable of free rotation when carrying a 2,000 pound load.
 - c. The rollers supporting the fork mounting plate assembly must operate inside the channels on high strength machined rails.
 - d. There shall be sufficient rollers to keep the fork assembly square and stable as it is raised and lowered by the chain hoist.
 - e. The mast shall be provided with a positive stop lock mechanism to prevent free-fall of the fork assembly in case of hoist chain breakage. The mechanism must restrain the free falling load in 3/4" travel or less.
 - f. Mast operating handles shall be mounted outboard of the mast for ease of rotation and shall be shrouded to prevent operator injury.
 - g. A minimum of 1/4" thick Plexiglass viewing window that is a minimum of 17" square shall be located in the mast at eye level.
 - h. A protective canopy and a trolley stop shall be provided over the operator for operator safety.
7. Forks
- a. The forks shall be mounted, adjustable for pitch and width, and have a 2,000 pound capacity measured 21" from the root.
 - b. The forks shall be minimum 4" wide by 1 1/4" thick by a minimum of 1" less than the depth of the pallet.

8. Pallets
 - a. Steel pallets shall be capable of holding 2,000 pound uniformly distributed load.
 - b. The pallets shall mate with the racks and be adjustable using the forks of the mast assembly described above.
 - c. The pallets shall be a minimum of No. 16 gauge steel and shall be reinforced with three to five "v" supports running left to right or perpendicular to the forks.
 - d. The pallets shall have two-way (front to back) entry with enclosed fork guides on the front and shall have hooks at the front to provide self-centering engagement on the front columns.
 - e. Provide 5 pallets per individual storage section. Design Builder to verify total number of pallets prior to shipping. Pallets shall each have a back lip 1 ½" high and a magnetic label holder.
9. Tub Kits
 - a. A tub kit shall consist of four sidewalls which can be attached to a pallet to form a tub.
 - b. Each tub shall be designed such that it can be divided into four equal size compartments using one partition (running back to front) and two dividers (running left to right).
 - c. Sidewalls, partitions, and dividers shall be a minimum No. 14 gauge steel.
 - d. Provide six tub kits, each with a wall height of 8 3/4".
10. Electrical Operation
 - a. Each mast and trolley/bridge system shall be provided with an electrically operated hoist capable of raising and lowering a 2,000 pound load at a speed of 16 feet per minute.
 - b. The hoist shall have a 1 HP motor and shall be dual voltage with electrical characteristics: 208 volt, 3 phase, 60 hertz, or 460 volt, 3 phase, 60 hertz. The hoist shall be wired for 208 volt, 3 phase, 60 hertz for this project. All 115V power requirements for controls and lights shall be provided through a step-down transformer.
 - c. The hoist shall be provided with a mechanical load brake (positive-stop type) connected to the load sheave, a solenoid-operated springset multiple disc-type motor brake, and an overload limiting clutch (wet cone type) located in the hoist transmission.
 - d. An insulated four bar power system and sliding power collector with replaceable shoes shall be provided to supply the electrical power to the trolley/bridge as specified above. Three of the bars shall supply power and the fourth bar shall be ground.

- e. Up/down controls operating with 115V control circuit shall be by push-button and located on the mast assembly convenient to a standing operator.
 - f. The system shall have a key-lock power on/off switch. The key shall not be removable in the ON position. All key-lock power switches shall be keyed alike.
 - g. Two 150 watt minimum reflector type flood lights shall be mounted on the trolley/bridge to provide in-use illumination. The lights shall operate on 115 VAC.
 - h. The light control shall be integral with the on/off switch such that the lights are on when the system is on.
 - i. Electrical components of the system shall conform to the applicable standards of UL and NEMA. All items of the same type and rating shall be identical.
 - j. All electrical wiring shall conform to the standards of the National Electric Code and applicable UL standards.
 - k. Protective insulated bushings shall be provided at all places where wiring passes through openings in metal panels and frames.
 - l. All electrical connections shall be suitably supported to prevent breakage and other damage.
 - m. Wiring shall be coded so that each wire can be easily identified from maintenance manuals, wiring schematics, and other documentation.
11. Safety Mesh
- a. Safety Mesh shall be provided to cover the rear of the individual storage bays and the open ends.
12. Finish
- a. Color shall be manufacturer's standard blue for the storage support structure; green for the pallets and safety yellow for the mast.
 - b. All painted surfaces shall be cleaned and iron phosphated and shall be coated with enamel and backed in accordance with supplier's directions.
 - c. The finish shall level out to produce a smooth, uniform surface without runs, wrinkles, grit areas of thin film, and separation of color.
13. Manufacturer
- a. Specifications are based on equipment identified herein by Manufacturer's name and model, and shall serve as the basis for determining acceptable standards of quality, performance, workmanship, construction and minimum features. Storage and retrieval System as manufactured by:

Stanley Vidmar
 11 Grammess Road
 Allentown, Pennsylvania 18103
 Telephone: (215) 797-6600;

or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install equipment specified herein in strict accordance with the approved shop drawings and manufacturer's installation instructions.
- B. Install material storage units at locations indicated on the approved Design and Shop Drawing following installation procedures recommended by the manufacturer. Provide mounting hardware as required.

3.02 FIELD QUALITY CONTROL:

- A. Provide the services of a qualified manufacturer's representative to perform the following:
 - 1. Supervise installation.
 - 2. Supervise testing, in the presence of the Engineer to ensure proper operation of the equipment.
 - 3. Provide instruction to the Authority's personnel in the proper operation and maintenance of the equipment.

END OF SECTION

THIS PAGE NOT USED

Serial Number:
Date of Issue:
Proposal Due Date:

RFP-FN5008/FMP
December 3, 2004
January 21, 2005

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 FIFTH STREET, N.W.
WASHINGTON, DC 20001

January 13, 2005

AMENDMENT NO. 2

TO

METRO MATTERS - Design/Build: Rail Yards Expansion Project
at Brentwood, Greenbelt, and Shady Grove Yards

Phase II - Request for Technical / Price Proposals

CONTRACT NO. FN5008

TO WHOM IT MAY CONCERN:

The proposal documents accompanying solicitation RFP-FN5008/FMP are hereby changed in part as follows:

1. The date established for Receipt of Proposals is hereby extended to **February 18, 2005**.
2. Proposers are hereby notified that an Amendment is to be issued shortly which will add an Option for the Expansion of the Alexandria S & I Rail Yard and Shops located at 3201 Eisenhower Avenue, Alexandria, VA 22314-4548. The scope of the Option will add 12 inspection and maintenance bays, extend two existing blow-down pits to support married pairs, trackwork, and expansion of the Shop area consistent with those to be performed at Shady Grove. This Amendment will include an Appendix to the Project Manual incorporating all relevant information, such as: specific evaluation criteria, conceptual design, geotechnical information, contract drawings, etc.. The Alexandria Rail Yard Project will be evaluated in conjunction with the Greenbelt / Shady Grove Project on a "Best Design / Fixed Price" basis. The exercise of the Option is predicated on receipt of funding, Board approval, and environmental clearances. The Option may be exercised at any time by the Authority within 365 calendar days of the Contract Award for the Greenbelt / Shady Grove Project.
3. Proposers should send e-mails to fpohlmann@wmata.com with copies to jtriole@wmata.com and wlinde@wmata.com should they desire to schedule Site Visits for Alexandria.
4. WMATA's responses to some of the Proposer's Questions raised since December 15, 2004 are attached. Additional responses will follow by separate Amendment.


5. The following additional companies have expressed an interest in providing their services for this Project:

Company	Rochester Signal, Inc.	Dynatran, Div. of Dynalectric Co.
Address	3505 Butler Street Pittsburgh, PA 15201	22930 Shaw Road, Suite 100 Dulles, VA 20166-9448
Contact Person	Jay Viraq, Director of Engineering	Bill Smith, Project Manager
Phone No.	(412) 687-6820	(703) 742-3796
Fax No.	(412) 687-6821	(703) 742-3592
E-mail	jviraq@rochestersignal.com	wsmith@dynalectric-dc.com
Specialty	Signal circuit design and detail; manufacturing and wiring management; systems testing and integration	Communications

6. Attached please find a separate Listing showing the additional information provided with this Amendment.

ACKNOWLEDGMENT

Offerors are required to acknowledge receipt of this amendment in writing on the Proposal Form in the space provided or by separate letter or telegram prior to the date established for receipt of proposals.



William O. Linde, Jr.
 Contracting Officer
 Office of Procurement and Materiel

January 13, 2005

QUESTIONS AND ANSWERS

Note: For ease of reference, WMATA has indicated the Question Number as received from the Design-Builder in parentheses at the end of each question (ex. DB Ref. 22).

Question 1: Section 00204.D.1.A requires that the Proposers address certain situations at each of the sites. Item #5 of the Shady Grove site indicates that the construction of the blow down pit must occur between the months of March and September. Item #7 suggests that it is WMATA's intent to have the construction of the blow pit completed in the least amount of time. Section 00103 indicates that the Projected Award Date is March 21, 2005. Considering the award date, the anticipated design timeframe, permitting process timeframe, and construction time for the blow pit, it appears that the blow pit construction would not occur until Calendar year 2006. Will WMATA relax the constraint of only working on the blow pit during the months of March through September so the construction of the blow pit can be completed as expeditiously as possible? (DB Ref. 22)

Answer: The constraint of only working on the blow pit during the months of March through September is hereby removed. Primary focus is to get the blow pit work completed in the shortest time frame possible.

Question 2: During our site visit to the Shady Grove site, we identified that water was infiltrating into the Switchgear Room through the electrical conduits feeding the panels from the bottom. It appeared that the water had been infiltrating through the conduit for an extended period of time. Is it WMATA's intent for the Design-Builder on this project to correct the water infiltration? (DB Ref. 23)

Answer: Yes it is WMATA's intent for the Design-Builder to correct the water infiltration problem in the Shady Grove AC Switchgear Room. Refer to Electrical Program Criteria 1.04.B.3.b.(4).

Question 3: During our site visit to the Brentwood and Greenbelt sites, we had discussion concerning the equipment that is identified in the RFP at Greenbelt. Several areas of the Architectural Program Criteria at Greenbelt states "Install existing Brentwood and/or Greenbelt equipment and/or procure and install new equipment ...". The Fixed Equipment list for the Greenbelt Site on sheets M1210-054 through M1210-058 of the RFP drawings indicates that all equipment will either be new or existing from the existing Greenbelt S & I shop. During our site visits, we were informed that we will not be required to relocate any of the equipment from the Brentwood Shop to the Greenbelt shop.

Please verify that all equipment to be provided at the Greenbelt shop will be either new or relocated from the existing Greenbelt shop as identified in the Fixed Equipment list and that all references in the Greenbelt Program criteria to existing equipment from the Brentwood shop will be removed. (DB Ref. 24)

Answer: For purposes of this contract, all Greenbelt equipment will either be new or relocated from the existing Greenbelt Shop. Major Shop Equipment items are identified in Item 3 of Schedule A in the Price Schedule. All other new Greenbelt equipment is considered Minor Shop Equipment. A \$1.5 M allowance is provided for the Minor Shop Equipment in Schedule C of the Price Schedule. WMATA will select those items of Minor Equipment to be furnished and installed by the Design-Builder.

Question 4: Section 00825.A.2.b indicates that the Final Completion of the Brentwood Yard Project shall be NTP + 910 Calendar days. Sheet M1210-157 of the Brentwood RFP Drawings lays out the suggested staging sequence for this site. Items 1 – 4 of this staging plan generally details what work can be accomplished at this shop prior to getting the Greenbelt Shop work completed. Is it WMATA's intent to issue the NTP for the Brentwood project at the same time the NTP for the Greenbelt and Shady Grove project, or is it the intent to award the NTP for the Brentwood project at a later date based on the progress of the Greenbelt shop? If it is the intent to award the Brentwood project at the same time as the other project, than the milestone schedule only allows for either 85 calendar days after the completion of the Shady Grove/Brentwood Project or 145 days after the completion of the Greenbelt Yard project. This timeframe is unrealistic for the renovation of this facility. Please clarify the intent. (DB Ref. 25)

Answer: On reviewing construction schedule developed by WMATA, interim completion for Greenbelt Yard should be 599 cd's not 765 cd's.

Question 5: The attached list of equipment is shown on the Fixed Equipment List on sheets M1210-054 through M1210 – 058 of the Greenbelt site as being removed from the existing Greenbelt facility, but the final location is indicated as "To Be Determined". Is it the intent for this equipment to be relocated in the existing Greenbelt Shop, New Greenbelt Annex, Other location within the WMATA system or be demolished? (DB Ref.26)

Answer: All such equipment will be relocated within the Greenbelt site.

Question 6: During our site visits to the three shops, we were informed that all other equipment and/ or materials in the shops not identified on the equipment lists to be removed would be removed by WMATA personnel prior to work beginning at the sites. Please confirm that the Proposers are not responsible for removing any equipment and/or materials not identified to be removed on the equipment list. (DB Ref. 27)

Answer: It is confirmed that the Proposers are not responsible for removing any equipment and/or materials not identified to be removed on the equipment list.

Question 7: During our site visit to the Brentwood shop, we were informed that all of the existing coaxial cable running throughout the shop basement could be demolished

and not replaced as it was no longer being used. Please confirm that the Proposers are not responsible for rerouting and replacing existing coaxial cable in the Brentwood shop basement. (DB Ref. 29)

Answer: Proposers are not responsible for rerouting and replacing existing coaxial cable in the Brentwood shop basement.

Question 8: The site drawings for the Greenbelt shop show the new forklift aisle outside of the existing Greenbelt shop turning the corner at the existing Loading Dock adjacent to the existing Component Parts Storage Room. During our site visit to the Greenbelt shop, we were informed that the forklift aisle should only extend to the existing curb, where a curb cut will be installed and not around the corner to the existing loading dock. Please confirm that the above indicates the actual direction for the forklift aisle. (DB Ref. 30)

Answer: Forklift aisle should extend to existing curb only and not around corner to existing loading dock. Curb cut shall be installed at curb.

Question 9: Note 6 on sheet M1210-324 directs the contractor to remove the existing below grade fuel tank (in front of the Shop at Shady Grove Yard). During the walk-through on December 16, 2004, the concrete pad above the fuel tank appeared to be relatively new. Can WMATA provide the size and capacity of the existing fuel tank, and the as-built drawings of the installation? In addition, please clarify who will be responsible for removing the heating oil stored in the tank? (DB Ref. 34)

Answer: Design-Builder will be responsible for removing the heating oil from the tank. Capacity of fuel tank is 20,000 gallons. PDF file of as-builts for the Heating Oil tank replacement Contract FM6207, as well as available design drawings for the Day Tank Installation Contract is attached in CD format.

Question 10: The contractor has been directed to "relocate" two above ground glycol tanks at Shady Grove Yard. Please confirm that all components of the glycol tanks including all related piping is to be above ground. In addition, please confirm that the glycol tanks in their current location do not have any underground piping that needs to be abandoned and removed. (DB Ref. 35)

Answer: Regarding the existing tanks the only underground component is the electrical feed. The new tanks will similarly not have any underground piping except for the electrical feed.

Question 11: Please clarify whether the new salt dome must be in place and operational prior to dismantling the salt dome in its current location? In addition, please clarify who will be responsible for physically relocating the salt from the existing salt dome into the salt dome in its new location? (DB Ref. 38)

Answer: Whether the new salt dome has to be in place and operational prior to dismantling

the existing salt dome depends on the time of year. If between April and September can get by without salt dome. During other months of the year a salt dome must be operational. Design-Builder will be responsible for physically relocating the salt from the existing salt dome to the relocated salt dome.

Question 12: At Shady Grove Yard, the RFP requires that we relocate one diesel pump and one gasoline pump. It appears that the pumps are fed from underground fuel tanks located adjacent to the current location of the pumps. The utility drawings do not indicate any underground fuel lines leading from the tanks to the pumps. Does WMATA have an as-built drawing showing these underground fuel lines? In addition, the location of the existing underground fuel tanks is under where the new concrete service road. We cannot locate any requirement to relocate the fuel tanks in the RFP. Is it the intent to leave the fuel tanks in their current location and install new piping to the new pump locations? (DB Ref. 40)

Answer: PDF files for the as-built drawings for A-16a Shady Grove Service and Inspection Yard Contract 1A0161 showing tank and piping is attached in CD format. Refer to Drawings A16a-P-8, E-30, and M-12, 13 and 14. Possibility that piping has been modified. WMATA is checking on this. As far as relocating the fuel tanks, that will be determined by final design. Also included are the electronic files for as-built drawings from the A-16d Shady Grove General maintenance Field Base Contract 1A0164, B-5b Brentwood Major Repair Yard Contract 1B0051, and E-11a Greenbelt Service and Inspection Yard Contract 1E0111 for use and information.

Question 13: RFP Section 00100 Paragraph C (page 00100-4) states that WMATA will provide the complete approved design of track work for all 3 sites. Will WMATA also provide complete design for the Contact Rail, Contact Rail Gaps, and Contact Rail End Approaches? (DB Ref. 41)

Answer: Complete design does not include final designs for the Contact Rail, Contact Rail Gaps, and Contact Rail End Approaches. Design-Builder to provide

Question 14: RFP Section 00321.C indicates that the Authority has copies of previous Geotechnical information other than that provided in the RFP. Will WMATA please provide copies of the information listed in 00321.C? (DB Ref. 43)

Answer: Yes. Copies are included with this Amendment.

Question 15: Our copy of Figure 1 of the Phase II ESA Subsurface Soil Investigation (for Brentwood) performed by EEE Consulting dated September 29, 2004 does not include the entire site. It appears that it was an 11" X 17" page that was folded during copying. Can WMATA please provide a clean copy of Figure #1. (DB Ref. 44)

Answer: Yes. Copy is included in this Amendment.

Question 16: Please reference the new exit access aisle as shown on drawing M1210-226. Are these aisles to be painted and/or accented with perimeter painted lines? Is there a WMATA standard for Exit Access Aisles? Please clarify? (DB Ref. 45)

Answer: Markings for new exit access aisle to match existing aisle's markings.

Question 17: Please reference demolition general note 14 on sheet M1210-216. This note instructs the Design Builder to clean existing dust and debris from the building and work areas. Being that this machine shop has been well used, dust and debris exist at all levels. Our concern is that the Design Builder will be forced to clean the entire facility of dust and debris regardless of where the dust and debris originated from. Please clarify that the intent of this requirement only relate to the dust and debris generated by the operation of the Design-Builder and not the dust and debris created by the past and ongoing shop operations. (DB Ref. 53)

Answer: The Design-Builder is responsible to clean dust and debris that he generates.

Question 18: Please reference "New Work General" Note 6 on sheet M1210-216. This note instructs the Design Builder to level, fill and patch all existing floors. There are no limits or defined areas on the plans in conjunction to this general note. Is the intent to level, fill and patch the floor at all floor locations including basement, ground floor and mezzanine? Please provide more information and/or limitations to the extent of this work. (DB Ref. 54)

Answer: Design Builder is to fill and patch all existing floors within his work area and any other areas that are damaged by his operations.

Question 19: In Drawing Book 4, Drawing Number ST-S-021 (M1210-503), "Typical Bonding for Retaining Wall Detail", Note 5 states "Epoxy coated rebar and wire mesh shall not be electrically bonded". Can this stray current control philosophy apply to other structural elements, particularly new shop building foundations and floor slabs? If epoxy coated rebar is an acceptable means of isolation and is utilized, please confirm that collector bars, welded longitudinal rebar, and test stations are not required. (DB Ref. 55)

Answer: Refer to Specification Section 03200, Concrete Reinforcement, Article 3.05 Electrical Bonding. Paragraph B. states "No electrical bonding is required for epoxy coated rebars.

* * * * END QUESTIONS AND ANSWERS * * * *

Attachments/Enclosures:

Question 14: One (1) copy each of Previous Geotechnical Reports regarding soils in the vicinity of the proposed work. (Reference Specification Section 00321.C.)

1. Greenbelt Yard Consolidated Heavy Repairs
 - a. MRCE Report No. 228 - Contract 3Z7256- Greenbelt S & I Yard- Section E011a/c, Greenbelt Route Supplementary Subsurface Investigation, March 25, 1991.
 - b. MRCE Report No. 229 - Contract 3Z7256- Greenbelt S & I Yard- Section E011a/c, Greenbelt Route Supplementary Subsurface Investigation, July 30, 1991.
2. Brentwood Shop Expansion
 - a. MRCE Second Supplementary Report - Modification No. 5 - Contract No. TAC 20-68-E - East Coach Yard Buildings - Subsurface Investigation, April 9, 1969.
 - b. MRCE Supplementary Report - Modification No. 6 - Contract No. TAC 20-68-E - B & O Route, East Coach Yard Buildings - Subsurface Investigation, May 13, 1969.
3. Shady Grove Shop Expansion
 - a. MRCE Report No. 147 - Contract Mod. No. 3Z725M-012- Section A016a - Rockville Route - Subsurface Investigation, May 24, 1976.
 - b. MRCE Report No. 120 - Contract Mod. No. 3Z725K-022- Section A016a & A017 - Rockville Route - Subsurface Investigation, December 23, 1974.
 - c. MRCE Report No. 152 - Contract No. 3Z725N- Section A016b - Rockville Route - Subsurface Investigation, July 29, 1977.

Question 15: One (1) copy Figure 1 from the Brentwood Phase II ESA Subsurface Soil Investigation by EEE dated September 29, 2004.

Questions 9 and 12:

One (1) CD containing the following PDF files:

1. As-Built drawings for the Shady Grove Yard Heating Oil Tank Replacement Contract FM6207.
2. Design drawings for the Shady Grove Yard Day Tank Installation Contract.
3. As-built drawings for the A-16a Shady Grove Service and Inspection Yard Contract 1A0161.
4. As-built drawings for the A-16d Shady grove General maintenance Field Base Contract 1A0164.
5. A-built drawings for the B-5b Brentwood Major Repair Yard Contract 1B0051.
6. As-built drawings for the E-11a Greenbelt Service and Inspection Yard Contract 1E0111.

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
CONSTRUCTION CONTRACT RFP-FN5008/FMP

Serial Number: RFP-FN5008/FMP
Date of Issue: December 3, 2004
Proposal Due Date: February 18, 2005

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 FIFTH STREET, N.W.
WASHINGTON, DC 20001

January 27, 2005

AMENDMENT NO. 3

TO

METRO MATTERS - Design/Build: Rail Yards Expansion Project
at Brentwood, Greenbelt, and Shady Grove Yards

Phase II - Request for Technical / Price Proposals

CONTRACT NO. FN5008

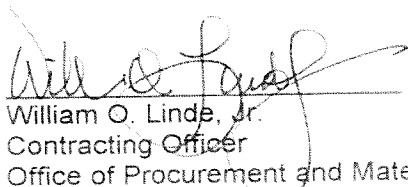
TO WHOM IT MAY CONCERN:

The proposal documents accompanying solicitation RFP-FN5008/FMP are hereby changed in part as follows:

1. The date established for Receipt of Proposals remains unchanged.
2. Update on issuance of Option for the Expansion of the Alexandria S & I Rail Yard and Shops: Amendment 4 should be issued next week. It will include a separate Proposal Submittal Date for the Option work.
3. WMATA's responses to some of the Proposer's Questions are attached. Additional responses will follow by separate Amendment.
4. Attached please find a separate Listing showing the additional information provided with this Amendment.

ACKNOWLEDGMENT

Offerors are required to acknowledge receipt of this amendment in writing on the Proposal Form in the space provided or by separate letter or telegram prior to the date established for receipt of proposals.


William O. Linde, Jr.
Contracting Officer
Office of Procurement and Materiel

January 27, 2005

QUESTIONS AND ANSWERS

Note: For ease of reference, WMATA has indicated the Question Number as received from the Design-Builder in parentheses at the end of each question (ex. DB Ref. 22).

Question 1: In the drawings for the Brentwood facility, we are unable to locate the new rooms B036 and B037, though they are discussed in the Architectural Program Criteria. Please clarify if these new rooms are required and direct us to more information on the proposed locations and design of these rooms. (DB Ref. 1)

Answer: Rooms B036 and B037 are identified in the Project Drawings, Book 2, Drawing B5-A09 (M210-224).

Question 2: On page 1 of the Architectural Program Criteria, paragraph 1.01.A.4 directs us to provide signage as shown on the "signage drawings". We have been unable to locate any signage drawings with our set of documents. Please provide us with the signage drawings described in this paragraph. The same paragraph also mentions a building identification sign (type 5). What is identification sign (type 5) as mentioned in this note? Are there signs required by code that are not mentioned in the specifications? Please verify that we are to provide signage as it relates to the new additions and that the Design/Builder is not responsible for any signage requirements in the existing facilities. (DB Ref. 2)

Answer: Design-Builder is responsible for signage as it relates to the new additions only. Informational signage drawings from the Branch Avenue Yard contract are provided in this amendment for guidance on signage criteria and types. Design-Builder is responsible for furnishing and installing all signs required by both WMATA and code.

Question 3: Paragraph 1.07.A.11 of the Architectural Program Criteria requires the design-builder to provide an inspection report, as well as patching of existing waterproofing system in the existing building basement. Does this requirement apply to the entire basement areas of each project location? Please clarify the intent and further define the scope of this requirement. (DB Ref. 3)

Answer: The intent is to provide protection from water infiltration where new work is to be performed. This includes foundations, pits, underground chases, etc.

Question 4: Is the latest WMATA approved method of stray current protection now being employed for elevators acceptable for the new elevators anticipated at each of the three (3) yards? (DB Ref. 4)

Answer: Yes. See Book 4, Drawing ST-ELEV-001 (M1210-501), and referenced DD drawings.

Question 5: At the Shady Grove shop, are drawings available showing the plan and profile of both the existing 78" and the existing 90" storm water sewer piping systems? If so, please provide. (DB Ref. 6)

Answer: Reference the A-16a Contract 1A0161 as-builts provided in Amendment No. 2

Question 6: What are the heaviest anticipated loads for the proposed elevated platforms adjacent to the Inspection Pit and Blow Pit areas? (DB Ref. 7)

Answer: Structural Program Criteria, Article 1.02.A.3.f. states the load to be used as the basis for structural design of the platform and pits is 250 psf.

Question 7: Can the elevator pits provided by the expansion program(s) be constructed with the standard WMATA grated pit for the use of a portable sump pump, or are permanent dedicated elevator pit sump pumps required as indicated in Mechanical Program Criteria 1.11.H.1? (DB Ref. 9)

Answer: Permanent dedicated elevator pit sump pumps are the local code requirements. The elevator pits are unattended structures and in the case of hydraulic elevators, the discharge from the sump must be routed through an oil separator before being finally discharged into the city storm drain system.

Question 8: In the Architectural Program Criteria, paragraph 1.02., Codes, Regulation, Reference Standards and Specifications, paragraph L, three locations refer to code review agencies and requirements. Specification section 00102.3.J notes that code related discussions have been conducted with the three jurisdictional agencies. Are the notes/minutes/results of meetings/contacted persons and other design criteria agreed upon available to the Design-Build teams? (DB Ref. 11)

Answer: Attached to this Amendment are:

- a. Minutes of November 22, 2004 meeting with PG County DPW&T and DER regarding Greenbelt,
- b. PB letters to District of Columbia Fire Department and Department of Consumer and Regulatory Affairs, both dated January 21, 2005 summarizing phone conversations regarding code compliance at Brentwood.
- c. MDE letter dated January 10, 2005 approving SWM concept at Greenbelt.
- d. Environmental Categorical Exclusions from signed January 11, 2005 by FTA with FTA cover letter dated January 14, 2005, for all three sites (Brentwood, Shady Grove, Greenbelt).

Additional meetings with Montgomery County and DC officials planned.

The Forest Stand Delineation and Forest Conservation Exemption Review

has been submitted to Maryland National Capital park and Planning Commission. Approved plans will be provided when received.

- Question 9: In specification section 00102.3.J, the proposer is required to submit for a building permit to the three jurisdictional agencies. Our contacts to date indicate that:
- a. there is a master agreement with Montgomery County Department of Permitting for WMATA to be their own permitting agent;
 - b. Prince Georges County asks for a "courtesy review", with no use & occupancy permit or fees required;
 - c. some Utilities require review and permitting;
 - d. MDE has site development authority at Shady Grove and Greenbelt, as stated in the RFP;
 - e. Question #3 of addenda #1 is noted; and
 - f. the requirement that the projects are to be built to the listed codes is acknowledged.

Please clarify in what areas WMATA has permitting authority, as some of the above information is inconsistent with the RFP and the ultimate permitting procedure can become a time component of the construction schedule. (DB Ref. 12)

Answer: Design-Builder should note that the Master Agreements with the local jurisdictions are over 30 years old and were based on the design-bid-build approach. Since this construction will take place by WMATA solely on WMATA property, building permits and use and occupancy permits are not required. However, County approvals for the fire protection systems and haul route are required. Refer to the November 22, 2004 minutes of meeting with Prince George's County, provided in the response to Question 8 above, for its requirements. An existing Use and Occupancy Permit does exist for the Brentwood Shop, so it can be assumed that, for now, a new or revised one will be required from DC. WMATA is attempting to clarify this. All affected utilities will require review and approval/permit from the utility's owner.

The Maryland Department of the Environment (MDE) has approval authority for erosion and sediment control measures and storm water management designs at both Shady Grove and Greenbelt. Overall site development authority lies more with the Maryland National Capital Park and Planning Commission (MNCPPC).

- Question 10: The following drawings are missing from Book 3 (Shady Grove) YA99-G-102 through 110 (9 sheets). Will the complete Train Control book of plans be issued for each of the locations? (DB Ref. 13)

Answer: Drawings YA99-G-102 through YA99-G-102 are attached as part of this amendment. Note that the information drawings are not intended to show all existing conditions; reference Specification Section 16911, Paragraph 1.03A. Complete set of Train Control Book of Plans will be furnished by the Authority to the successful proposer upon request.

Question 11: On all three (3) sites, please confirm that WMATA will remove the loose rails, small equipment, crates, trailers, etc from the scope of work limits. Please verify that the Design/Build Contractor will only remove/relocate the items noted on the drawings to be moved. If this is not the case, please provide us with detailed list(or drawing) denoting all of the materials/structures that are required to be relocated by the Design /Build Contractor. (DB Ref. 14)

Answer: It is assumed this question concerns areas outside the Shops, within the Design-Builder's limits of work. The Design-Builder will relocate the container and storage boxes within his limits of work to an accessible location within each Yard. Location to be acceptable to WMATA. WMATA will relocate loose materials such as rails, ties, third rail insulators. As this is still being coordinated within WMATA, additional information will follow on this issue.

Question 12: On all three (3) sites, please provide us with additional information pertaining to the movement/relocation plans for the current WMATA personnel. Which areas of the facilities are to remain fully operational at all times? (DB Ref. 15)

Answer: Refer to other responses. All areas not designated for turn over to the Design-Builder to remain operational. Design-Builder needs to be more specific.

Question 13: On all three (3) sites, please provide us with additional information (ie "as-builts") pertaining to any existing support of excavation systems that were installed (and possibly remained) during the construction of the facilities. (DB Ref. 16)

Answer: With the as-builts provided in Amendment No. 2, all available as-builts have been provided. Working or shop drawings that might show additional information are not available.

Shady Grove Shop Expansion

Question 14: At Shady Grove, drawing A16-A-09, note 13 references a "knock-out-panel". Has an existing masonry header beam and brick relief angle been provided at this knock-out panel? (DB Ref. 17)

Answer: This is an existing knockout panel with existing header support.

Question 15: Southwest of the proposed Blow Pit Expansion there is a slab with several manhole covers and monitoring wells. Please clarify what this is and provide us with "as-builts" as required? (DB Ref. 18)

Status: This was the location of the original fuel oil storage tank which was abandoned in place. Refer to Drawing A16b-M-61 (M369-204) in the as-built files previously provided. WMATA is currently scheduling to have the four monitoring wells grouted in February 2005.

Question 16: Are there any available documents that detail the existing drainage system in the Blow Pits? (DB Ref. 19)

Answer: Reference the A-16b (1A0161) as-built files provided. See Drawing A16b-M-10 (M369-153).

Question 17: Please provide us with "as-built" drawings for the installation of all of the existing underground storage tanks. (DB Ref. 20)

Answer: This information has been provided with the additional as-built drawings provided in Amendment No. 2. If there are other tanks in question, please be specific.

Greenbelt Yard Consolidated Heavy Repairs

Question 18: Reference drawing E11-A-14 on the Greenbelt project. Due to conflicts with the existing water main and existing sprinkler assembly piping, can the proposed new track and turntable at the Steam and Degreasing Room G108 be modified or deleted? (DB Ref. 21)

Answer: Yes. An amendment to the reference drawing will be issued modifying the current layout.

Question 19: Reference drawing E11-A-14 on the Greenbelt project. Can the limits of the proposed 5-ton bridge crane be modified to avoid mechanical, electrical, and plumbing conflicts North of column line 14? (DBE Ref. 22)

Answer: Yes, the limits of the 5-ton bridge crane can be modified. An Amendment modifying the referenced drawing will be issued.

Question 20: Reference drawing E11-A-11 on the Greenbelt project. Can the proposed track and turntable near column line F15 be relocated or deleted to avoid conflicts with the existing train controls, existing electric, and existing motor control centers? If not, where should these existing items be relocated? (DB Ref. 23)

Answer: Items cannot be relocated to the extent that would be beneficial. Suggest that the existing panels be located in a grouping with the new panels required for the new truck hoists.

Question 21: Please provide details for the existing site slabs at the South end of the yard, Area "K", where the storage tracks are being relocated. (DB Ref. 24)

Answer: Details provided in E-11a (1E0111) as-built drawing files provided in Amendment No. 2.

Question 22: At the Greenbelt project, can the grass area North of the existing salt dome be made available for the Design/Build Contractor's laydown/parking/office complexes? (DB Ref. 25)

Answer: No. The area adjacent to the storm water management pond bordered by the loop track and access road is an environmentally sensitive area and cannot be used.

Question 23: Please provide civil drawings of Area "N", if available. (DB Ref. 26)

Answer: Reference the E-11a as-built files provided in Amendment No. 2.

Question 24: For the duration of work inside the existing Greenbelt shop, does the Design/Build Contractor have complete unfettered access to all areas of work? Will all WMATA employees and equipment be completely vacated from Areas 4, 5, 6, 7, 8, 9, 10? Are there functions/equipment in Areas 4, 5, 6, 7, 8, 9, and 10 that must remain operational while the Design/Build Contractor is working in the existing Greenbelt shop? (DB Ref. 27)

Answer: Design-Builder will not have complete unfettered access to all areas of work at any time. Phasing will be required to ensure no disruption in critical activities. A detailed work plan will be required. Areas 8, 9 and 10 must be to a point of functionality before equipment can be moved from 5 and 6. An alternate lift area must be functional prior to working in Sections 5 and 6.

Question 25: Does the completion of the work in the existing Greenbelt facility have to be phased for WMATA use and occupancy? Please provide us with additional information pertaining to the movement/relocation plans for all of the current WMATA personnel who are currently occupying areas which are to be renovated. (DB Ref. 28)

Answer: Yes, work will have to be phased to ensure critical operations are maintained. See response to above Question 24. Proposer needs to be more specific.

Question 26: At the existing waste oil area, please define what equipment must be moved by the Design Build Contractor. (DB Ref. 29)

Answer: All equipment must be moved by the Design-Build Contractor.

Brentwood Shop Expansion

Question 27: Regarding the Brentwood Shop Expansion, please confirm that there will be no interim/phased occupancy of the project by WMATA. (DB Ref. 30)

Answer: As far as the shop area no interim/phased occupancy is contemplated. However, beneficial occupancy of the new/renovated office areas, lunch room and locker

rooms/restrooms shall be provided as soon as possible, prior to final completion of the Brentwood construction.

Question 28: Please confirm that all WMATA employees will vacate the entire Mezzanine level before the Design/Build Contractor commences work on the Mezzanine. (DB Ref. 31)

Answer: No, employees will not vacate the Mezzanine level. See response to Question No. 76.

Question 29: Regarding the Brentwood Shop Expansion, please define the existing equipment, services, functions, and areas that need to remain in operation to support the daily functions associated with the continuous operation of tracks 7, 8, and 9. (DB Ref. 32)

Answer: Tracks 7, 8 and 9 must be kept functional. All hoists and turntables along these tracks, the hoist equipment room in the basement, shop power, fire suppression, sprinklers, compressed air. Design-Builder should note that the air compressor cooling tower is located on the loading dock roof. Before this can be removed a replacement cooling tower must be in operation.

Question 30: Please confirm that all WMATA employees will vacate the entire Basement Area "1" level before the Design/Build Contractor commences work in this Area. For example rooms B011 to B023 are not modified by the Design/Build Contractor, but it is unclear if we are to maintain services and access to these areas or if they will be vacant. In addition, noisy and heavy structural demolition nearby would impact these rooms and could create a safety issue. (DB Ref. 33)

Answer: No, WMATA will not vacate the entire Basement Area "1". Services and access to the rooms not being modified should be maintained. See response to Question No. 75.

Question 31: Regarding the Brentwood Shop Expansion, the new freight elevator machine room is currently located in the footprint of the existing loading dock and ramp. Does the freight elevator need to be operational before the existing ramp is taken out of service? Can the proposed freight elevator machine room be relocated? (DB Ref. 34)

Answer: Yes, the new freight elevator needs to be operational before the existing ramp is taken out of service. Yes, the proposed freight elevator machine room can be relocated.

Question 32: Regarding the Brentwood Shop Expansion, since the train control tower remains operational during the entire shop expansion, how will the WMATA employees

access the control tower when stair #1 is out of service and the mezzanine structural modifications are being performed? (DB Ref. 35)

Answer: Reference to Stair #1 above should be existing stair #2. See Drawing B5-A-30 (M1210-245). In response to the question, access through the mezzanine offices will not be permitted for the temporary construction period or for the final configuration. Another means of access will be necessary. A permanent covered metal staircase outside the west wall of the building between column lines 1 and 3 is suggested with the upper landing and door at the location of the existing window between columns lines 2 and 3.

Question 33: Regarding the Brentwood Shop Expansion, will parking for construction workers be allowed on-site? (DB Ref. 36)

Answer: No.

Question 34: Regarding the Brentwood Shop Expansion, during the structural renovation of the mezzanine level, please confirm that the equipment in Train Control Room B204 must remain functional and accessible. (DB Ref. 37)

Answer: All train control equipment must remain functional and accessible.

Question 35: Please verify if there are any time restrictions on the removal of the existing wheel truing machine. (DB Ref. 38)

Answer: See response to Question 74.

Question 36: Are there any restrictions on duration of outage on track 11 to allow for the installation of the new pit/wheel truing machine? (DB Ref. 39)

Answer: Work should be accessed from the south end of the shop, leaving the north end of Track 11 available to WMATA. WMATA will give up use of the one truck lift on Track 11 between column lines 11 and 12 to facilitate construction for and installation of the new pit/wheel truing machine. Work must be done in as short a time frame as possible. A detailed work plan will be needed.

Question 37: Please provide a copy of the existing occupancy permit for the (Brentwood) S&I shop and clarification on which part of shop it covers. (DB Ref. 40)

Answer: Copy attached.

Question 38: Please confirm that all storage/equipment at the basement level will be removed by WMATA for the full length of building between column lines D & F at the start of construction. (DB Ref. 41)

Answer: Storage shelves and their contents in the Storage Room area will be removed by WMATA between column lines D&F. Design-Builder can begin removing wheel truing machine, elevator and two truck hoists at start of construction. See response to Question 74. For locker room/rest rooms and lunch room see Response to Question 75. Also see answer to Question 62. Other loose materials and equipment not identified on the fixed equipment list will be removed by WMATA.

Question 39: Please confirm that all equipment, in the areas of the Design/Build Contractor's scope, at the Ground level will be removed by WMATA. If not, please provide a comprehensive list of all equipment that the Design Build Contractor must remove/relocate. (DB Ref. 42)

Answer: Design-Builder is responsible for removing equipment items listed in Fixed Equipment Schedule.

Question 40: Please confirm that the traction power/train control/COMM are not isolated from the WMATA main line. (DB Ref. 43)

Answer: Confirmed.

Question 41: Will the existing hazardous storage shed in area "D" be relocated by WMATA? (DB Ref. 44)

Answer: Yes, WMATA will relocate the existing hazardous storage shed in area "D".

Question 42: Please note that the existing "Component Shop" will not fit in the designated double-wide trailer. Is the Design Build/Contractor to provide the equivalent square footage of the existing "Component Shop"? (DB Ref. 45)

Answer: Comparable area is required to house an arrangement where the component shop functions can be efficiently and effectively performed. Design-Builder shall determine minimum requirements for this and provide an area large enough to accommodate it, which may be larger than a double-wide trailer. Arrangement subject to the approval of WMATA

General Questions

Question 43: Please confirm that submittal approval for a typical item will apply for all three sites, if properly noted. (DB Ref. 46)

Answer: Submittal approval for a typical item will apply for all three sites, if properly noted. Details for "properly noted" to be approved by WMATA.

Question 44: Please confirm that all existing COMM that must be relocated or modified is currently sufficient and suitable for modifications/relocations. (DB Ref. 48)

Answer: Communications Systems at some of the Yards have no further expansion capabilities and will require new or supplemental systems. These issues are addressed in the specific yard requirements in Specification Section 16700, Scope of Work - Communications.

Question 45: Please verify that the Design/Build Contractor will not be required to refinish/repaint the existing construction (ie overhead framing, roof deck, columns, walls, utilities, etc) except where we tie in new work. (DB Ref. 49)

Answer: Verified.

Question 46: At Greenbelt, the existing Component Parts Storage (GE117, reference drawing E11-A-30) is full of existing shelving and other storage materials. The Fixed Equipment Schedule does not indicate that the GC is to remove any material from this area. Please verify that this material be removed by WMATA. (DB Ref. 50)

Answer: WMATA will move the parts and materials from the shelves in the existing storage room when the new storage room in the Greenbelt Annex is ready. Design-Builder to dismantle and remove shelving and other components of the Storage Retrieval System. Existing System may be salvaged and reinstalled in the new Shady Grove storage room.

Question 47: Please provide us with a sketch of the exterior loading dock area at the Greenbelt Annex that better defines the final layout of this area? Reference the Architectural Program Criteria, page 13 and drawing E11-A-17. (DB Ref. 51)

Answer: The concept for the exterior loading dock is illustrated in the Project Drawings, Book 1, Drawings E11-A-09 and E11-A-25.

Revise in its entirety project Manual, Book 2, Architectural Program Criteria, 1.03.C.2.R to read as follows:

"Component Parts Storage - 7200 S.F.; G128: Procure and install a component parts storage system comprising a combination of pallet rack shelving, cantilever rack systems, bin type shelving, secure shelving systems and vertical carousel shelving systems, as defined by WMATA. Secure the room with concrete masonry unit walls.

Ceiling finish is to be open to structure above. The wall finish is to be epoxy paint full height of CMU. The floor finish is to be epoxy paint on concrete substrate. Provide 6-inch diameter concrete filled steel bollards at both side of all overhead coiling doors and at room side of freight elevator. Provide adjacencies with direct access to freight elevator, clerk's office, supervisor's office, interior central corridor,

and covered receiving area. Provide exterior forklift access at the south exterior wall into the adjacent central corridor via a 12 FT. high x 12 FT. wide insulated coiling door with indirect connection to components parts storage area. Provide two (2) 12 FT. high x 12 FT. wide overhead coiling doors with adjacent man doors leading into adjacent internal central corridor. Provide a 12 FT. high x 12 FT. wide insulated overhead coiling door and adjacent man door at the northeastern exterior wall of the components parts storage room with direct access to the covered receiving area. The receiving area is a covered open elevated dock with protection on three sides. The dock area consists of 500 S.F. with one (1) pit type dock leveler with exterior dock bumpers at each side. Provide direct access from receiving dock area to grade."

Specification Section 10600, Storage Retrieval System, is being issued with this amendment.

Question 48: Does the leveler need any special requirements in order to interface with the rails at the Shady Grove loading dock? (reference drawing A16-A-09) Or, will a crane be required? (DB Ref. 52)

Answer: There are no special requirements and no crane is required.

Question 49: At Shady Grove, the rails from the new addition run through the knockout panel to the rails for track #6. Are any special provisions required to transfer items between the two sets of rails (i.e., turntable, or jib crane)? (DB Ref. 53)

Answer: There are no special requirements.

Question 50: At Greenbelt, we are to install three (3) 15-ton bridge cranes on the same set of rails in Areas 5-6 over G101 and G102. What is the span and travel of these cranes? How do these cranes interface with the existing crane in that area? (DB Ref. 54)

Answer: Both existing cranes to be removed. All new cranes to access the entire area (4, 5 and 6) and shall have perimeter sensors.

Question 51: At Greenbelt, we are to install two (2) 5-ton bridge cranes on the same set of rails in Areas 8-9 over G105. The Architectural Program Criteria (pages 8 & 9) says they should run from A-C and from 10-16. But drawing E11-A-14 shows the cranes stopping short of 16, at the edge of area G107. Please clarify. (DB Ref. 55)

Answer: The crane's limit will be prior to column line 15. Amendment drawings will be issued showing revision.

Question 52: At Greenbelt, the Architectural Program Criteria states that we are to retain and refurbish the bridge crane system currently in place over G107. Please verify that this refers to the two (2) 2-Ton bridge cranes by Virginia Crane. (DB Ref. 56)

Answer: This referenced criteria refers to the two (2) 2-Ton bridge cranes by Virginia Crane.

Question 53: At Greenbelt, the Architectural Program Criteria, page 12 when describing Area G125, it calls out for a 3-Ton bridge crane, but it references column lines 33-34, already covered by the crane mentioned for area G120. Area G125 is between lines 36-37, and no crane is indicated on the drawings above this area. Also, APC-32 and the Fixed Equipment Schedule both indicate there are four (4) total 3-Ton cranes in the Annex. Please confirm there is no crane required for area G125 between column lines 36 and 37. (DB Ref. 57)

Answer: No crane is required for area G125 between column lines 36 and 37.

Question 54: At Greenbelt, Item 1020 on the Equipment List (drawing E11-A-06) indicates 6 new Jib Cranes to be installed at the Annex, and to see the plans for locations. Only 5 cranes appear to be on the drawings with that label (rooms G117, G120 (x2), G125, G217). Please clarify. (DB Ref. 58)

Answer: The remaining cranes are located in G107 in the existing Greenbelt Shop. The Equipment List will be revised to reflect a total of seven (7) jib cranes.

Question 55: There are a number of equipment items shown on the "existing" plans that are neither shown on the new plans, nor listed on the Fixed Equipment Schedules. Are these items to be removed and "scrapped" by WMATA? Some of the items include the following:

@ Greenbelt: Items 507, 597

@ Brentwood: Items 8, 59, 60, 94, 116, 249, 289, 314 (DB Ref. 59)

Answer: All items referenced above are representations of space between equipment or not actual fixed equipment and should be deleted.

Question 56: Equipment Item 605 at Greenbelt is shown on the new drawings, but not listed in the Fixed Equipment Schedule. Please clarify what this item is. (DB Ref. 60)

Answer: Item was found to be an open space and was deleted.

Question 57: A number of items are listed in the Fixed Equipment Schedule as being installed in particular areas, but not shown on the drawings. Please provide us with a layout of these rooms with the following items:

Greenbelt Area G102: Items 231 through 278, and 515 to 517

Greenbelt Area G105: Items 279 through 284, and 524 to 525

Greenbelt Area G107: Item 542

Greenbelt Area G227: Item 353 (DB Ref. 61)

Answer: All layouts were intended to be visual aids with final location determined between

the Design-Builder and WMATA.

Question 58: Greenbelt drawing E11-A-18 shows the passenger elevator with two doors at the second level of the Annex. The drawing also indicates steps right beside the elevator going down to the elevated walkway to the main building. This would imply that the two doors from the elevator are actually at different elevations. Please clarify the stops and elevations of this elevator. (DB Ref. 62)

Answer: The passenger elevator in question is a three-stop elevator. The first stop is a front entrance door only at the elevation of the basement level. The second stop is a front entrance door on at the elevation of the elevated walkway. The third stop is a rear entrance door only at the elevation of the new shop second floor.

Question 59: At Brentwood, page 22 of the Architectural Program Criteria indicates to provide a three-stop freight elevator. We found the Basement and Ground Floor stops on the drawings. However, where is the third stop? (Passenger elevator on other side of building also has three stops, but that's because it services the mezzanine.) (DB Ref. 63)

Answer: The freight elevator in question is a three-stop elevator. The first stop is a front entrance door only at the elevation of the basement level. The second stop is a front entrance door on at the elevation of the existing ground floor level of the open shop area. The third stop is a rear entrance door only at the elevation of the new elevated receiving area.

Question 60: The Fixed Equipment Lists for all three sites depict many items (primarily at the Brentwood facility) which are indicated to be moved to "TBD". Please verify that the movement of these items will be by WMATA. (DB Ref. 64)

Answer: No. Movement of these items is to be by the Design-Builder. See response to Question 73.

Question 61: The Greenbelt Annex drawings show a large number of items which are labeled with text only, but no equipment labels. Are we responsible for providing these items? If so, please provide additional information. (DB Ref. 65)

Answer: Reference Drawings E11-A-16 thru 19. Drawings provide conceptual layouts showing functionality of shop only and may change as a result of final design. The "text only" equipment you refer to will be covered by the \$1.5M minor equipment allowance.

Question 62: The Brentwood existing drawing B5-A-24 shows a number of items in areas B029 and B030. The Fixed Equipment List indicates these items (as well as Item 377, not shown) to be relocated from these areas to a location "TBD". During the site walk it was stated that WMATA would clean out the basement prior to GC work at

Brentwood. Will WMATA be moving these items or not? If so, to where? (DB Ref. 66)

Answer: At the beginning of construction WMATA will have the basement area between column lines D and F cleared and other others areas as agreed upon for work to progress, except for the items on the fixed equipment list. Design-Builder responsible for moving items on fixed equipment list. Note that items in the Pneudraulics Shop B030 between column lines F and H will not be relocated at the beginning of construction. Pneudraulics Shop to remain operational until a replacement shop is provided and operational at Greenbelt or some other location. WMATA will direct the Design-Builder where to move the items in Corridor B029 at the beginning of construction.

Question 63: Note #6 on drawing M1210-386, states that "all existing floors shall be leveled, filled and patched". Please verify that this note only applies to floor areas within our scope of work limits, or areas which we disturb. (DB Ref. 67)

Answer: See response to Question No. 18 in Amendment No.2.

Question 64: Please clarify the security requirements inside the shop yards. In particular, what are the requirements for construction vehicles crossing the tracks. Are flagmen required? Who will provide the flagmen? Do they need special training? Do they need radios, or any other special equipment? (DB Ref. 68)

Answer: See response to Question No. 77. They will need whatever equipment a roadway flag person would normally use. As they WILL NOT be flagging trains, they will have no need for radios.

Question 65: We assume that the Design/Build contractor is not responsible to bring the entire existing facilities up to current code requirements (ie ADA, fire alarm, sprinkler, etc). Please verify that the Design/Builder's scope of work is limited to the immediate area of disturbance only. (DB Ref. 69)

Answer: It is not the intent to bring the entire existing facilities up to current code requirements. However, the Design-Builder shall ensure that the final product complies with code; and this may require some work outside his immediate area of disturbance. Design-Builder should refer to the Architectural Program Criteria Section 1.02, Codes, Regulations, Reference Standards and Specifications; and Code Analysis Drawings A16-A-01, B5-A-01 and E11-A-01. Design-Builder's code review and analysis are required before final determination can be made.

Question 66: In the specifications, book 1 - Section 00200-17 Article D.1.A.1.a - Shady Grove Site - Relocation of underground utilities. Considering the footprint of the building, new roadways, and new track construction, are other / additional manholes and/or ductbanks impacted? (DB Ref. 70)

Answer: The list of underground utilities provided in Specification Section 00204, Article D.1.A.1 is not intended as a complete list of underground utilities that will be impacted by program construction, but, as stated, identifies some design and construction challenges for the purpose of evaluating the Proposer's design solutions as part of the Phase II Technical Proposal Evaluation. There are other manholes and ductbanks which will likely be impacted, but how and to what extent will depend on the proposer's approach to design and construction. It is suggested that the Proposers thoroughly review project and as-built drawings provided and conduct site inspections as necessary to evaluate existing utility conditions.

Question 67: Please clarify the meaning of paragraph 1.01.C in Section 14100. The second sentence in the paragraph is confusing. Confirm the intent that all body supports (at both Shady Grove and Brentwood) shall have the capacity to raise and lower married pairs of cars. (DB Ref. 71)

Answer: Confirmed. Intent is that all body supports (at both Shady Grove and Brentwood) shall have the capacity to raise and lower married pairs of cars.

Question 68: During our site visit to the Brentwood shop, we noticed that the paint on the existing roof decking was separating from the roof decking through out the shop. Please confirm that the Proposers are not responsible for repainting the existing roof decking. (DB Ref. 28)

Answer: Proposers are not responsible for painting the existing roof decking.

Question 69: The Mechanical Program Criteria for heating the new shop expansion at Shady Grove (PROJECT MANUAL BOOK 2, page 9, Part 1.04A.3.b(2) states that the existing fuel oil fired boilers in the basement mechanical room shall be used to furnish the heating hot water supply and return for the new 16 bay maintenance shop. Please confirm that the existing boilers have sufficient spare capacity to provide the hot water required for space heating and for preheating the ventilation air in the new shop expansion area. PROJECT DRAWING BOOK 3 (Drawing A16-A-09) shows new architectural space identified for a new boiler room in the proposed new shop expansion area. This seems to conflict with the requirement to utilize the existing boiler plant for building heat in the expanded shop space. Please clarify WMATA's intent for heating the space in the new shop expansion. (DB Ref. 32)

Answer: The existing boiler has sufficient capacity for the existing facility plus the new blow pit expansion. The Boiler Room located in the Inspection/Repair Area is to be used to locate a new boiler that will heat the new expansion.

Question 70: Will there be any time constraints (i.e. hours of the day) on when demolition activities within the three shops can occur. This will apply to all operations using equipment such as air-hammers and concrete saws that produce excessive noise and potential vibration? (DB Ref. 39)

Answer: Shops operate 24 hours a day, seven days a week. Bulk of the people work day shift from 6:00 am to 3:00 pm., so most advantageous times for demolition are the off-shifts after 3:00 pm and before 6:00 am. However, work may be permitted any time of day. Noise, vibration fumes and dust from the Design-Builder's operations are all concerns and must be taken into account in a detailed work plan with abatement measures identified where needed. Any disruptive type activities shall be coordinated with Safety and Operations through the Authority Representative. The Design-Builder's operations must comply with the most stringent provisions of the occupational safety and health statutes and regulations of OSHA and the local jurisdictions and meet WMATA specified requirements.

Question 71: *Response provided in Amendment No. 2, Question No. 12. Have further information to be provided in Amendment No. 3.*

At Shady Grove Yard, the RFP requires that we relocate one diesel pump and one gasoline pump. It appears that the pumps are fed from underground fuel tanks located adjacent to the current location of the pumps. The utility drawings do not indicate any underground fuel lines leading from the tanks to the pumps. Does WMATA have an as-built drawing showing these underground fuel lines?

In addition, the location of the existing underground fuel tanks is under where the new concrete service road. We cannot locate any requirement to relocate the fuel tanks in the RFP. Is it the intent to leave the fuel tanks in their current location and install new piping to the new pump locations? (DB Ref. 40)

AM 2 Response: PDF files for the as-built drawings for A-16a Shady Grove Service and Inspection Yard Contract 1A0161 showing tank and piping will be provided on a CD. Refer to Drawings A16a-P-8, E-30, and M-12, 13 and 14. Possibility that piping has been modified. WMATA is checking on this. As far as relocating the fuel tanks, that will be determined by final design. (AM2, #12)

AM3 Addendum: Addendum to Response given for Question 12 in Amendment No. 2: Approximately ten years ago single wall fiberglass piping was replaced with double-wall fiberglass piping. Diesel lines should be in same location; gasoline lines may be somewhat different than what is shown in A-16a as-builts. As-builts for this new work could not be found. Will provide electronic files of design drawings.

Question 72: At the Shady Grove site, a portion of the existing Train Control and Communications duct bank runs in the footprint of the addition. It is likely that a large portion of the duct bank will need to be relocated. In reviewing sheets M292-270 through M292-278, it is apparent that the as-built drawings indicate the manhole locations and duct bank characteristics. However, the drawings do not indicate the direct burial path of the ATC cables from the manholes to the wayside equipment junction boxes. Can WMATA provide the as-built locations of these direct bury cable runs?

Section 00204.D.1.A.1.a indicates that the 24 way ATC and communication duct bank needs to be relocated. This section does not address the 60 way duct bank running between the existing building and Manhole TC/C-A. Is it the intent to relocate this duct bank in addition to the 24 way identified?

In reviewing the as-built information, it appears that the following duct banks and manholes may need to be relocated:

- a. Manhole TC/C-A and 60 way duct bank TC/C5 running from the building to this manhole.
- b. Manhole TC/C-B and duct bank 24 way TC/C1 running between manhole TC/C-A and TC/C-B.
- c. Manhole TC/C-E and duct bank 36 way TC/C6 running from manholes TC/C-A to manhole TC/C-E.
- d. Manhole TC/C-H and duct bank 12 way TC/C18 running from manhole TC-C-B to manhole TC/C-H.

Please address the following issues related to the potential relocation of these existing items:

1. Is it WMATA's intent to relocate all of the existing work listed above?
2. Will WMATA accept cable splices for this relocated work or will all new cables runs be required?
3. Will WMATA provide as-built drawings showing the path of the existing direct burial runs and a detailed inventory of the cables in the affected areas?
4. Will WMATA require system/ safety testing for all of the relocated work?
5. If system/ safety testing is required, will WMATA provide the full requirements of the system/ safety re-certification process for the cable relocation/ replacement? (DB Ref. 42)

Answer: Reference: Drawings M292-270 through M292-278 Shady Grove Yard

1. It is WMATA's intent to relocate/replace only the ductbank between Manholes TC/C-A and TC\C-B which conflicts with pits in the shop floor for vehicle hoists. It is anticipated that other parts of the ductbank system can be protected and retained through innovative design and construction techniques. Relocation/replacement of other sections of the ductbank is not prohibited if that proves to be the most cost efficient way to resolve potential conflicts with shop building and track construction. It should be noted that the final ductbank provisions must accommodate both the existing and new cables. Surface trench, as described in the specifications and shown on drawings, is considered an acceptable alternative to underground ductbank.
2. Cable splices are not allowed per Specification Section 16949 3.08A.5.

Cables required to be relocated should be considered for replacement between existing termination points unless an acceptable alternative is proposed.

3. Respective as-built Signal and Communications drawings identify the cables by number of conductors (or pairs) and wire size that are routed through the ductbank system; however, the drawings do not indicate the path or depth of direct burial portions of the cable runs.
4. Relocated/replaced cables should be tested the same as new cables.
5. WMATA will perform certification testing of the relocated/replaced cabling as necessary for re-certification based upon the Design-Builder's performance and documentation of required conductor continuity and insulation resistance tests.

Question 73: The Fixed Equipment List on the above mentioned drawings of the Brentwood shop are detailed as being removed from the existing Brentwood location, but the final location is indicated as "To Be Determined". Please provide more information on final location. Will the existing equipment need to be stored before being transported to its final destination? Please clarify. (DB Ref. 46)

Answer: Can not provide any additional information at this time. Some of the equipment may be moved to Greenbelt, some may be relocated within Brentwood. This will be determined during final design. DB should state in their proposal what assumptions were made on this issue. Should something else be directed by WMATA, it could be eligible for an equitable adjustment under the contract.

Question 74: Equipment Item 383 Wheel Truing Machine- Underfloor is identified as to be "scrap". Is it the intent for the Design Builder to scrap this machine? The Miscellaneous column for this item list "S/N 10272". Is this the Serial Number for this equipment or another designation? Please verify that WMATA will allow immediate removal of this piece of equipment upon start of Construction. (DB Ref. 47)

Answer: Upon review of this question, WMATA has decided that it does not want the Item 383 Wheel Truing Machine to be scrapped. If the machine cannot be modified and used for the in-line wheel truing machine to be installed on track 11, then it should be turned over to WMATA in good condition to be stored at a site to be determined. The S/N 10272 designation is the Serial Number for this particular piece of equipment. WMATA will allow immediate removal of this machine, along with the elevator at Column Lines D and 11, the truck hoist at Column line D between Column lines 11 and 12 and the truck hoist at Column Line D between Column Lines 14 and 15, with certain conditions. Refer to Drawing B5-A-28 (M1210-243). These conditions include:

1. Wheel truing machine must be removed in such a way that it can be reused

- at another location.
2. Access to the freight elevator between column lines G and H and column lines 11 and 12 is maintained.
 3. After removal of the wheel truing machine and truck hoist between column lines 11 and 12, the tracks shall be restored so that a truck can be moved from Track 9 through the vacated hoist and wheel truing machine areas to the Truck Drop Table/Freight Elevator between column line G and H. These tracks can be taken out of service when the main shop floor between column lines D and F is turned over to the Design-Builder.
 4. The removed truck hoists shall be turned over to WMATA in good condition at a location to be determined.
 5. Any openings in the ground floor slab due to removal of equipment shall be immediately protected to avoid personnel or equipment from falling through.

Question 75: Sheet M1210-225 BRENTWOOD details the complete renovation and replacement of the men's and women's locker/shower rooms, locker rooms, and office areas. Who, if anyone, is responsible to provide temporary facilities for these displaced areas? If these accommodations are required to be done by the Design Builder, please clearly identify location and criteria to meet. The anticipated construction time for the complete demolition of the existing facilities and the reconstruction of the new facilities will be approximately 3-6 months. Please provide more information. (DB Ref. 48)

Answer: Specification Section 01110, Summary of Work, Article 1.04.A.2.a.(4) currently restricts early access to this area. If early access is desired, then temporary replacement facilities must be provided by the Design-Builder for the lunch room and locker room/rest rooms. Referring to Drawing B5-A-23 (M1210-238) which shows existing conditions, areas available for temporary facilities include Room B010 Office No.#2 and the adjacent area between its north wall and column line 3a; the area between column lines G and H and column lines 4 and 9. WMATA would clear these areas. Temporary facilities should include, for men's room: two (2) showers, three (3) toilets, three (3) urinals, three (3) lavatories and lockers same in number as existing; for women's room: two (2) showers, two (2) toilets, one (2) lavatories and lockers same in numbers as existing. Temporary facilities could possibly be placed on a raised platform with drainage to the existing sewage ejection pump.

Question 76: Sheet M1210-232 BRENTWOOD outlines the renovation work in the existing mezzanine offices, see note 4 on B5-A-17. Please detail how this work can be accomplished as well as the work hour constraints that may be placed on the work. Will the office continue to be occupied? Can the work be done during regular day time? Will the Design Builder be required to work only at night? Will temporary dust partitions need to be used? Also please provide information on how to accomplish the installation of the new Stair # 2 B212 if these are will remain occupied. Please provide additional information. (DB Ref. 49)

Answer: Mezzanine offices will continue to be occupied during construction. Offices are manned from 5:00 am to 5:00 pm, so construction work shall be conducted from 5:00 pm to 5:00 am. and performed in stages so as to minimize disruption to the occupants. Adequate dust partitions will be required. A sufficient area around new stair no. 2 will be provided to facilitate construction of the new stairs; more specifically approximate area from column line G to half-way between column lines E and F, and from column line 1 to near column line 3 at the north wall of Office B216. Access will have to be maintained from one end of the mezzanine to the other while this work is going on. A detailed work plan will be required. Note that new stair no 2 comes down in the existing LAN Server office and therefore cannot be constructed until access to the main shop floor is given and some of its offices are relocated.

Question 77: Please reference note 4 on sheet M1210-157. This note instructs the Design Builder to be responsible for crossing the tracks in a safe manner. Access to the Brentwood project requires the crossing of WMATA tracks and AMTRAK tracks. Will crossing guards be required at all WMATA and AMTRAK track crossings? Who will provide and pay for the the cost of crossing guards? Please provide additional information. (DB Ref. 50)

Answer: The Amtrak tracks at entrance to Brentwood are protected by road crossing equipment. The problem is that when entering the yard two stops are required, one for security and the other prior to crossing an unprotected interior yard track. Both of these stops will leave the rear of a truck fouling the Amtrak right-of-way. There are also several additional unprotected interior yard track crossings. A procedure needs to be established wherein all deliveries are scheduled and the contractor provides WMATA qualified flagman at the appropriate crossings to flag the trucks, not the trains. The procedure should also address the need for the truck driver to stop prior to entering the Amtrak road crossing, get out of the truck and walk to the security check point to obtain permission to enter the yard. That way we don't block Amtrak's right-of-way during the security screening process. A similar process needs to be established at all yards where it will be necessary to cross at interior unprotected road crossings with equipment and personnel. WMATA qualification of flag persons would require an additional element of instruction during the ROW training course and would be given only to proposed flag persons.

Question 78: Please reference note 3 on sheet M1210-157. This note allows the Design Builder to have office space and storage in the BRENTWOOD basement. How much space would be available? Would the space be available for the entire construction duration? Who would be responsible for clearing the space of loose and fixed equipment or materials? How much space would be available for office and storage? Please provide additional information. (DB Ref. 51)

Answer: Intent of note is to permit Design-Builder to use available space in work area between column lines D & F for office and storage. Nothing outside this area.

Space would be available for contract duration.

Question 79: Please reference demolition general note 13 on sheet M1210-216. This note limits the use of equipment unless approved by the Owner. Please provide additional information. Will construction equipment ordinarily used in the pursuit of the project construction be limited by the Owner? What are the parameters for approval by the Owner? Are the parameters noise-related? Please provide additional information. (DB Ref. 52)

Answer: Equipment will be evaluated based upon the hazards associated with using the equipment in the shop/yard environment and the extent to which the hazards can be mitigated. Main concerns are noise, vibration fumes and dust. A detailed work plan will be required.

Question 80: Sheet M1210-228 illustrates a new wheel truing (Equipment ID # 1011) pit being installed on track #11 at the Brentwood Shop. Item 1.04.46 of the Architectural Program Criteria for Brentwood discusses the requirements for the Wheel Truing Pit. Neither the drawings nor the Program Criteria discuss any requirement for a car progression system for this new wheel truing pit. Is a car progression system required for this new wheel truing pit? If a car progression system is required, is it the intent for the car progression system to be installed in the slab? If it is required to be placed in the slab, we do not feel that the existing slab is thick enough to install the chain channel that would run the length of the track. In addition, four 2 foot deep pits will need to be installed for the drive motors and idler sprockets. A detailed plan view of this area is not included in the RFP documents, but during our site visit we believe that track #11 runs over an existing electrical room, so thickening the floor slab may have an adverse effect on the electrical service. Please advise. (DB Ref. 56)

Answer: It is not the intent of the Authority to install an "in slab" car progression system. The intent is for the Design Builder to provide a cable wench progression system as supplied by Wheel Truing Machine vendor.

* * * * * END QUESTIONS AND ANSWERS * * * * *

RFP FN5008/FMP
METRO MATTERS
Design/Build: Rail Yards Expansion Project at Brentwood, Greenbelt, and Shady Grove Yards
Amendment 003

Attachments/Enclosures:

Question 41: One (1) CD containing following design drawings for Shady Grove Service and Inspection Yard Underground Fuel Storage Tank Modifications:

9408-160
9408-161
9409-191
9409-192
9511-466
9511-467

Question 2: One (1) half-size each of Informational Branch Avenue Storage Yard Graphics Drawings:

OF-YD-AS-2, Site Key Plan
OF-YD-AS-4, Building - Key Plans
OF-YD-AS-6, Signage Types
OF-YD-AS-7, Signage Types
OF-YD-AS-8, Signage Types
OF-YD-AS-9, Signage Types
OF-YD-AS-10, Signage Types
OF-YD-AS-11, Templates & Fonts
OF-YD-AS-12, Details
OF-YD-AS-13, Details

Question 8: One (1) copy each of :

- WMATA Memo of Minutes of November 22, 2004 meeting with PG County DPW&T and DER regarding Greenbelt,
- PB letters to District of Columbia Fire Department and Department of Consumer and Regulatory Affairs, both dated January 21, 2005 summarizing phone conversations regarding code compliance at Brentwood.
- MDE letter dated January 10, 2005 approving SWM concept at Greenbelt.
- Environmental Categorical Exclusions from signed January 11, 2005 by FTA with FTA cover letter dated January 14, 2005, for all three sites (Brentwood, Shady Grove, Greenbelt).

Question 10: One (1) half-size each of Informational Train Control Drawings for Shady Grove Yard, Train Control Wayside Cable Plans: YA99-G-102 through YA99-G-110 (nine drawings)

Question 37: One (1) copy of Certificate of Occupancy for the Brentwood Shop

Question 47: Specification Section 10600, Storage Retrieval System, new pages 10600-1 through 10600-8.

Serial Number: RFP-FN5008/FMP
Date of Issue: December 3, 2004
Proposal Due Date: February 18, 2005

**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 FIFTH STREET, N.W.
WASHINGTON, DC 20001**

February 17, 2005

**AMENDMENT NO. 4
TO**

**METRO MATTERS - Design/Build: Rail Yards Expansion Project
at Brentwood, Greenbelt, and Shady Grove Yards**

Phase II - Request for Technical / Price Proposals

CONTRACT NO. FN5008

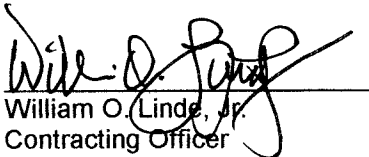
TO WHOM IT MAY CONCERN:

The proposal documents accompanying solicitation RFP-FN5008/FMP are hereby changed in part as follows:

1. The date established for Receipt of Proposals is hereby extended to February 25, 2005 at 2:00 pm.
2. Appendix A - Project Manual for the Alexandria Shop Expansion Option, Books 1, 2, and Project Drawings Book 5 are attached. Separate Price and Technical Proposals are due on the Alexandria Option on April 8, 2005.
3. WMATA's responses to Proposer's Questions are attached. No further questions on anything other than the Alexandria Option will be accepted.
4. Attached please find a separate Listing showing the additional information provided with this Amendment.
5. Replace the following Pages with those attached and revised as follows:
Pgs. 00800-19 to 00800-47, Appendix D, Wage Rates

ACKNOWLEDGMENT

Offerors are required to acknowledge receipt of this amendment in writing on the Proposal Form in the space provided or by separate letter or telegram prior to the date established for receipt of proposals.


William O. Linde, Jr.
Contracting Officer
Office of Procurement and Materiel

February 17, 2005

Note: For ease of reference, WMATA has indicated the Question Number as received from the Design-Builder in parentheses at the end of each question (ex. DB ref. 22).

I. Revisions to Amendment No. 3 Answers:

Answers to several questions provided in Amendment No 3 are being revised. Delete the Amendment No. 3 Answers to Questions 38, 39, 60, 62, 73 and 75 and replace with the following Answers:

AM3 Question 38: Please confirm that all storage/equipment at the basement level will be removed by WMATA for the full length of building between column lines D & F at the start of construction. (DB Ref. 41)

Revised Answer: Storage shelves and their contents in the Storage Room area will be removed by WMATA between column lines D&F. Design-Builder can begin removing wheel truing machine, elevator and two truck hoists at start of construction. See response to AM3 Question 74. For locker room/rest rooms and lunch room see Response to AM3 Question 75. Also see answer to AM3 Question 62.

AM3 Question 39: Please confirm that all equipment, in the areas of the Design/Build Contractor's scope, at the Ground level will be removed by WMATA. If not, please provide a comprehensive list of all equipment that the Design Build Contractor must remove/relocate. (DB Ref. 42)

Revised Answer: See Answer to AM3 Question 73.

AM3 Question 60: The Fixed Equipment Lists for all three sites depict many items (primarily at the Brentwood facility) which are indicated to be moved to "TBD". Please verify that the movement of these items will be by WMATA. (DB Ref. 64)

Revised Answer: See response to Am3 Question 73.

AM3 Question 62: The Brentwood existing drawing B5-A-24 shows a number of items in areas B029 and B030. The Fixed Equipment List indicates these items (as well as Item 377, not shown) to be relocated from these areas to a location "TBD". During the site walk it was stated that WMATA would clean out the basement prior to GC work at Brentwood. Will WMATA be moving these items or not? If so, to where? (DB Ref. 66)

Revised Answer: At the beginning of construction WMATA will have the basement area between column lines D and F cleared and other others areas

Design/Build: Rail Yards Expansion project at Brentwood, Greenbelt and Shady Grove Yards

as agreed upon for work to progress. Note that items in the Pneudraulics Shop B030 between column lines F and H will not be relocated at the beginning of construction. Pneudraulics Shop to remain operational until a replacement shop is provided and operational at Greenbelt or some other location.

AM3 Question 73: The Fixed Equipment List on the above mentioned drawings of the Brentwood shop are detailed as being removed from the existing Brentwood location , but the final location is indicated as "To Be Determined". Please provide more information on final location. Will the existing equipment need to be stored before being transported to its final destination? Please clarify. (DB Ref. 46)

Revised Answer : Reference the Answer to Question No. 15 in Amendment No. 1. There is no requirement for the Design-Builder to relocate Brentwood equipment whose location is noted "To Be Determined", unless specifically noted in answers to other questions.

AM3 Question 75: Sheet M1210-225 BRENTWOOD details the complete renovation and replacment of the men's and women's locker/shower rooms, locker rooms, and office areas. Who, if anyone, is responsible to provide temporary facilities for these displaced areas? If these accommodations are required to be done by the Design Builder, please clearly identify location and criteria to meet. The anticipated construction time for the complete demolition of the existing facilities and the reconstruction of the new facilities will be approximately 3-6 months. Please provide more information.(DB Ref. 48)

Revised Answer: Specification Section 01110, Summary of Work, Article 1.04.A.2.a.(4) currently restricts early access to this area. If early access is desired, then temporary replacement facilities must be provided by the Design-Builder for the lunch room and locker room/rest rooms. Referring to Drawing B5-A-23 (M1210-238) which shows existing conditions and B5-A-09 (M1210-224) which shows proposed conditions, areas available for temporary facilities include Room B010 Office No.#2 and the adjacent area between its north wall and column line 3a; the fenced area between column lines H and L and column lines 4 and 6. WMATA would clear these areas. Temporary facilities should include, for men's room: three (3) showers, three (3) toilets, three (3) urinals, two (2) lavatories and 260 lockers; for women's room: one (1) shower, two (2) toilets, two (2) lavatories and 20 lockers. Temporary facilities could possibly be placed on a raised platform with drainage to the existing sewage ejection pump. Construction of Electrical Room B036 in this area would have to be deferred until completion of the new locker rooms rest rooms.

II. New Answers

Question 1: At Shady Grove Yard, with regards to “removing and relocating” the underground fuel tank, the fuel pump, the diesel pump and the two glycol tanks, has a contaminated soil remediation plan been developed? Does WMATA currently have a program or process in place for handling contaminated soils should they be encountered? If so, please provide documentation and /or instructions for handling “dirty’ soil. (DB Ref. 36)

Answer: There is no past history of leakage from the underground gasoline or diesel tanks and piping or the glycol tanks. WMATA is not anticipating any contaminated soils in this area.

Question 2: Sheet M1210-323 indicates that there is a “HAZMAT Locker” located near the existing Salt Storage Building in Shady Grove Yard. Is this locker currently being utilized? If so, where should this locker be relocated?

In addition, please clarify that this locker is intended to allow WMATA personnel respond to a Hazardous Material spill and does not currently contain any hazardous materials. (DB Ref. 37)

Answer: Locker is currently being used to store ice melting chemicals and cement mix. It is not for a response to a hazardous material spill and does not contain any hazardous materials. Locker to be relocated within Shady Grove Yard to a location approved by WMATA.

Question 3: On past projects WMATA has provided the direct fixation fasteners for the track sections within the shop buildings. We could not find mention of who is to provide these in the RFP. Please clarify who is to provide the Direct Fixation Fasteners? (DB Ref. 57)

Answer: WMATA will provide direct fixation fasteners.

Question 4: Section 1.06 of the Architectural Program Criteria provides a list of certain equipment. This section provides the names of the WMATA Preferred Vendors for several of the items of equipment; however several equipment items did not have preferred vendors listed. Please provide the WMATA preferred providers for the attached list of equipment.

In addition, please provide the requirements for the items on the attached spreadsheet where specifications are not provided (i.e. forklift, prefabricated storage buildings, etc.) (DB Ref 58)

Answer: For Greenbelt: Reference Drawing E11-A-06, M1210-058.

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Storage Equipment Specification, Section 10600, entitled "Storage Retrieval System", was provided in Amendment No. 3. Reference Answer to Amendment 3 Question 47.

Delete Dock Lift, Item 1045, Shop Work Station, Item 1046, and Forklift, Item 1048, from the "Major Shop Equipment List" given in Specification Article 00434, Price Schedule, Schedule A, Item 3. These items will be included in the \$1.5M allowance for Minor Shop Equipment, Item 3, Schedule C of the Price Schedule.

The Car Component repair and Test Equipment, Item 1047, is already included in the \$1.5M allowance for Minor Shop Equipment .

For Brentwood:

Reference Drawing B5-A-05 (M1210-220).

Delete Storage Equipment System, Item 1034. Reference response to Question 78b in Amendment 4.

Also delete the following equipment:

Item 1043	Forklift
Item 1036	Shop Work Station
Item 1039	Car Component Repair & Test Equip
Item 1037	Cleaning Equipment System
Item 1038	Steam Pressure Washing
Item 1040	Prefab Storage Bldg System
Item 1041	Material Lift System
Item 1042	Jacking Carriage

For Shady Grove:

Reference Drawing A16-A-02 (M1210-387)

Storage Equipment Specification, Section 10600, entitled "Storage Retrieval System", was provided in Amendment No. 3. Reference Answer to Amendment 3 Question 47.

Delete the following equipment:

Item 1031 Fork Lift
Item 1033 Shop Work Station
Item 1027 Car Component Repair & Test Equip
Item 1028 Jacking Carriage

Item 1025 Steam Cleaner Pressure Washer

Specification is provided for Bridge Cranes and Jib Cranes. Provider must meet requirements in specification.

Question 5: Section 00101.C.1 states that WMATA will provide the track alignment and trackwork designs for the three sites. Please verify that WMATA will provide all re-design of the trackwork as needed based on the field surveys performed as the design process progresses. In addition, please verify that WMATA will design all of the track work details required. (DB Ref. 59)

Answer: Refer to Answer to Question 13 in Amendment No, 2. Design-Builder to provide any re-design needed as a result of final design process. Trackwork details not provided in project Drawings are to be provided by the Design-Builder.

Question 6: In reviewing the trackwork design for the Shady Grove site as illustrated on sheet M1210-339 it does not appear that the trackwork geometry as it enters the shop conforms to the WMATA standards, as the tracks appear to enter the shop on a curve. Please verify that the tracks leading into the shop on the curve is acceptable. (DB Ref. 60)

Answer: The curve enters the building as noted. WMATA has waived the criteria in this instance. Final building design should set the vehicle door width to accommodate any vehicle overhang caused by the curve.

Question 7: Who is responsible for paying the PEPCO fees associated with the new/replacement 13.8 kV PEPCO feeders. (DB Ref. 61)

Answer: Design-Builder.

Question 8: Does the asbestos concrete piping used for the existing PEPCO 5 inch ducts need to be disposed of as ACM hazardous waste? (DB Ref. 62)

Answer: If it has asbestos in it, pipe should be considered ACM hazardous waste, but not RCRA hazardous waste, unless there are other considerations.

Question 9: The existing fire alarm panel at Brentwood is on a wall that will have to be demolished. The panel will have to be relocated or replaced. If we remove and relocate the existing panel will we have to upgrade the shop system to current codes? If we replace the existing panel with a more modern panel will we have to upgrade the shop system to current codes? (DB Ref. 63)

Answer: Any and all replacements will have to be done to meet current code.

Question 10: The AC duct bank and PEPCO duct bank at Shady Grove will have to be demolished. This will require new AC cubicles for both PEPCO feeders to the substation. Does WMATA have a contact at PEPCO to identify the route and our options. (DB Ref. 64)

Answer: Contact is Mike Bell at 301-548-4352 or Bob Brown at 202-388-2602.

Question 11: The Shady Grove tower view will be obstructed by the new building. In order to provide the tower with visual observation of the yard, it is anticipated that PTZ

CCTV cameras will provide adequate viewing of the yard. Please confirm that the tower needs to have visual observation of the yard, and that WMATA does not have a problem with the camera approach with monitors in the tower. (DB Ref. 65)

Answer: Yes, the control tower will need to have visual observation of the operational yard. The camera approach is acceptable.

Question 12: Please provide as-built information about the communication conduits running to the Shady Grove Gate House. How many conduits are there? Where do they go? What size are they? Which ones are empty? Which ones have dead cable that can be removed? (DB Ref. 66)

Answer: See Drawing SGSIY-FSS-30-1 and -2 provided as an attachment.

Question 13: While on our site visits we noted that each shop apparently had an intrusion and detection systems installed which was not shown in the as-built drawings. Is it the intent for the Design-Builder to maintain these existing systems and then extend them into the new work, or is it the intent for the Design-Builder to install a new intrusion system for the new work? (DB Ref. 67)

Answer: Yes, the intent is for the Design-Builder to maintain these existing yard security systems and extend them into the new work.

Question 14: Item 46 of the Architectural Criteria on page 29 and Item 3 on page 33 requires, in general terms only, that the Contractor is to provide equipment and manpower to "assist" the manufacturer with installation of the Wheel Truing Machine. Please provide a specific scope of work that the Design-Builder will be responsible for. (DB Ref. 68)

Answer: It is the intent of the Authority that the Design Builder coordinate with the equipment manufacturer to provide a seamless installation of the Wheel Truing Machine. A specific scope of work must be developed by the Design Builder in conjunction with the WTM manufacturer.

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Question 15: The attached list of New Equipment for the Greenbelt Shop does not have sufficient information to provide pricing for. Please provide the appropriate Manufacturer, model number, and any other specifics for the following list of equipment:

1. Item # 1044 Storage Equipment System
- Item # 1045 Dock Lift
- Item # 1046 Shop Work Station
- Item # 1048 Fork Lift (DB Ref. 69)

Answer: See response to Question 4.

Question 16: The response to Question #9 included in Addendum #1 indicated that the Construction Project Manager needed to be a Certified Professional Engineer. In subsequent conversations since this addendum was issued, it is our understanding that this requirement may be waived by WMATA. Please clarify if the Project Manager for the Design-Builder needs to be a Certified Professional Engineer? (DB Ref. 70)

Answer: The Project Manager for the Design-Builder does not have to be a Professional Engineer (PE), although it would be considered favorably in the Technical Evaluation if he or she were a PE.

Question 17: During a recent site visit to the Greenbelt Shop, it became apparent that the existing car hoist equipment on the track West of F line is not equipped with body hoisting capabilities. Since the trucks cannot be removed from the car on this track, it does not appear that the turntables and associated new bar rail shown to be installed in this area would be functional.

Can the two turntables be deleted?

Can the rail heading East from the turntable located adjacent to Column line #11 be deleted between the new turntable and two adjacent truck tracks?

Can the rail heading East from the new turntable adjacent to Column Line #14 be deleted all the way to the other new turntable adjacent to Column Line D. In addition, can the other turntable adjacent to Column Line D be deleted? (DB Ref. 71)

Answer: Refer to Drawing E11-A-11 (M1210-063). Delete the two proposed turntables shown on Track 5a South, delete the rail heading east from each deleted turntable in its entirety, including the proposed turntable adjacent to column lines D and 14. Drawing E11-A-11 and the Fixed Equipment List Drawing E11-A-06 have been amended to reflect these changes.

Question 18: During a recent site visit to Greenbelt we discussed the limits of the new

Design/Build: Rail Yards Expansion project at Brentwood, Greenbelt and Shady Grove Yards

bridge crane between Column Lines A and C as shown on sheets M1210-065 and M1210-066. As we discussed, the last steel column in the area is adjacent to Column Line #15. In addition, the existing services (water, fire line, gas) in this area will not allow the crane to pass beyond Column Line #15.

Please confirm our discussion that the limits of this bridge crane will be between Column Line #10 and Column Line #15. (DB Ref. 72)

Answer: Confirmed. Revised drawing is being issued.

Question 19: Sheet M1210-064 show a fence enclosure around the new lift equipment, turntable, and truck track between Column Line D and F and adjacent to Column Line 18. It appears that this fence line was left over on the drawing from the existing conditions plan.

Please confirm that this fence does not need to be installed. (DB Ref. 73)

Answer: Confirmed. Fence does not need to be installed.

Question 20: Item 1.03.C.1.a of the Greenbelt Architectural Program Criteria identifies that three new 15 ton bridge cranes are to be installed between Column Lines D and F. However the limits of the Bridge Crane are not identified. Please confirm that the limits of the new bridge cranes will be from Column Line #1 to Column Line #19.

In addition, the RFP documents do not include a drawing for Area #4 of the Greenbelt Shop. Please provide a drawing for this area. (DB Ref. 74)

Answer: Confirmed, limits of new bridge cranes shall be from Column Line 1 to Column Line 19. A new Drawing for Area #4 will not be issued.

Question 21: The response to Question #3 issued with Addendum #2 indicates that all equipment not included in Item #3 of Schedule A in the Price Schedule shall be included in the Equipment Allowance. Please verify that this Allowance is to include the Equipment, Installation of the Equipment, Services to the Equipment, and Hookup of the Equipment. (DB Ref. 75)

Answer: Yes, this Allowance includes the Equipment, Installation of the Equipment, Services to the Equipment, Hookup of the Equipment and Testing.

Question 22: The Response to Question #4 included in Addendum #2 indicates that the Interim Completion for the Greenbelt Yard should be 599 calendar days after NTP in lieu of the 765 calendar days specified in the RFP. In reading the RFP, we cannot locate a definition of what is entailed in the Interim Milestone. Please provide clarification on what is included in the Interim

Milestone for Greenbelt? (DB Ref. 76)

Answer: The intent is to complete all work at Greenbelt in 599 calendar days. It is noted as an Interim Completion Date because completion of Greenbelt is required before final contract completion, which will include Shady Grove and possibly Brentwood. Interim contract completion for Greenbelt includes completion of all work to provide a complete, functional, certifiable Annex Building and Main Shop.

Question 23: The Brentwood, existing shop Drawing B5-M-42 (M1210-292) shows an existing Lube Oil Tank and Waste Oil Tank. Proposed Drawing B5-A-16 (M1210-231) shows a new Waste Oil Storage Room B134. Please provide information on WMATA's intent for this new Room. Will this room be used for waste oil storage only or is there a requirement for a Lube Oil Tank as well? If waste oil only, will shop personnel bring the waste oil to this room in portable carts for local discharge into the tank, or is process piping and pumps required throughout the shop, and if so, where? If a Lube Oil Tank is required, provide information regarding the product, and distribution requirements to outlying shop points, if any. (DB Ref. 77)

Answer: Room will be used for waste oil only. Shop personnel will bring oil to room. Design-Builder will need to provide a removal or suction point to remove waste oil from the tank. An overflow alarm on tank, locally alarmed, should be provided.

Question 24: At Brentwood, proposed Drawing B5-A-10 shows a new Carwash Equipment Room B014, and existing shop Drawing B5-M-37 shows an existing Carwash Equipment Room, but we can find no information that identifies what equipment is to be relocated, if any. Please provide the requirements for these rooms and a statement regarding temporary provisions, if any, since both these rooms are within the work zone. (DB Ref. 78)

Answer: All existing equipment to be relocated to proposed location. There is no requirement for temporary provisions during construction.

Question 25: At the Shady Grove shop, are drawings available locating the existing 2,000 gallon used oil tank located near the existing loading dock? If so, please provide. (DB Ref. 5)

Answer: All available as-built drawings have been provided.

Question 26: In the Architectural Program Criteria, paragraph 1.07.A. lists numerous specification sections that have not been included in the issued RFP Specifications. They are as follows:

Design/Build: Rail Yards Expansion project at Brentwood, Greenbelt and Shady Grove Yards

1. 08331-Overhead Coiling Doors
2. 09971-Epoxy Mastic Flooring
3. 10265-Impact-Resistant Wall Protection
4. 10520-Fire Protection Specialties
5. 14215-Freight Elevators

Please clarify if these components are to be included in the building program(s) and provide specifications as appropriate. (DB Ref. 8)

Answer: The above referenced specification sections shall be provided by the Design-Builder upon completion of final design as appropriate.

Question 27: Are there any roofing/flashing warranties in effect at the three (3) sites? If so, please provide copies of these warranties. What are the ages of the existing roofing systems? Please provide us with the names of the manufacturers and installers of each system. (DB Ref. 10)

Answer: Attached are the following warranties:

- | | |
|------------------------|---|
| Shady Grove S&I Shop - | 20-year warranty dated 06/09/2000 from GAF and a 15-year warranty dated 02/20/98 from Johns Manville. Roofers, Inc. to perform additional repairs on this roof. |
| Brentwood S&I Shop - | 15-year warranty dated 06/11/96 from red Shield. |
| Greenbelt S&I Shop - | Warranty not found as of issuance of this amendment. |

Question 28: Please confirm that a COMM splice handhole can be incorporated whenever the COMM must be relocated. (DB Ref. 47)

Answer: Handholes should be used exclusively to route cables between conduits. No general permission is given to splice cables in any handhole. If no other option exists and that fact can be documented, Design-Builder must request a variance for each such particular case.

Question 29: At the Brentwood facility, what are the limits of the VCT floor finish in room B015? No wall is shown on the East side. (DB Ref. 72)

Answer: Room B015 is identified as General Storage Area. The Architectural Program Criteria, under section 1.04.A.16 does not identify VCT in this area.

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Question 30: At the Brentwood facility, on drawing B5-A-10 at General Storage Area B015, the existing concrete aisles are coated with a material not listed in the **original** documents. 1) Do we recoat the areas under the racks that have not received a coating? 2) Do we remove the existing coating? 3) Do we recoat the uncoated areas? 4) What is this existing material? (DB Ref. 73)

Answer: At Brentwood it is intended that WMATA will relocate and consolidate storage shelves to the area between column lines F and H, freeing up the area between column lines D and F for the Design-Builder. This consolidation will occur before the Design-Builder has access to the basement. This area will further be consolidated by WMATA near the completion of work. Therefore, the Design-Builder is not required to recoat the area identified in the question above.

Question 31: Specification section 11200 – mentions an “optional transfer crane”. Is such a crane required? If so, please provide us with the capacity requirements for this crane. (DB Ref. 74)

Answer: Transfer Crane is an OPTION which can be exercised by the Authority. Design Builder shall provide a price as an OPTION for this piece of equipment. Section 11200 goes on to indicate that the “transfer crane bridge shall be electrically driven with two 2 1/2 ton hoists and one 1/2 ton hoist on a second bridge attached to the main bridge to facilitate gearbox handling.”

Question 32: In the Shady Grove “as-built” drawings, section 1 on drawing A16b-S-35 shows the foundation designed for a “future platform” between shop tracks 2 & 3. Are there any such requirements at any of the three sites for our present design and construction to take into account “future construction” considerations. Please clarify. (DB Ref. 75)

Answer: A platform in the area mentioned above is not in this scope of work.

Question 33: Specification section 11160-Loading Dock Equipment, lists Truck Levelers under the summary of work, but no details have been given for the levelers anywhere in the section. Please confirm that Truck Levelers are not required for this project. (DB Ref. 76)

Answer: Truck leveler is not required.

Question 34: Specification section 11160-Loading Dock Equipment, calls out Truck Restraints, but none are called for on the drawings or in the Program Criteria. Should we provide one truck restraint at each Dock Leveler? Or, verify that truck restraints are not required for this project. (DB Ref. 77)

Answer: Truck restraints are required at each dock leveler.

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Question 35: Brentwood drawing B5-A-05 lists equipment item 1034 "Storage Equipment System". What is this, and where is it located? (DB Ref. 78)

Answer: Reference response to Question 30. Storage Equipment System is not required for Brentwood. Delete Item 1034.

Question 36: At the Brentwood Shop, can the location of the existing Wheel Truing Machine be adjusted, if possible, to avoid the removal, relocation, and/or replacement of adjacent structures and/or equipment? Please describe the constraints/limitations associated with the existing Wheel Truing Machine. (DB Ref. 79)

Answer: Wheel Truing Machine (WTM) location must allow for a married pair to fit in the building on both sides of the WTM. Clearances to equipment using track 12 must also be acceptable. Any adjustments to the WTM location must be approved by the Authority.

Question 37: Specification Section 00102, J indicates "WMATA will obtain conceptual storm water management approvals from MDE for the Greenbelt Site only". Please provide a copy of the conceptual plan and MDE approvals. (DB Ref. 80)

Answer: Reference Answer to Question 8 in Amendment No. 3. Copy of MDE letter dated January 10, 2005 approving storm water management concept provided. January 7, 2005 referenced drawings in MDE's letter are included in Amendment 4. SWM report dated December 31, 2004 is also included.

Question 38: For the new and revised foundation work in the existing Greenbelt Main shop area, can we install sheet piling to manage the existing ground water? (DB Ref. 81)

Answer: Design Builder shall submit water intrusion mitigation measures during final design.

Question 39: In reviewing the CADD drawings provided by WMATA it was noted that both the existing and proposed track alignment drawings (SG-exist ctr trk.dwg & SG-alignment.dwg) don't align with either the existing site (SHADYGROVE.dwg) or the proposed Architectural drawings (a-flr-01.dwg). The existing building as-built drawings show the centerline distance between Tracks 5 and 6 to be 20 feet. The existing alignment files measures 21'-10". The distance between the center lines of existing Track 6 and proposed Track 7 is 82'-9" in the architectural plans and is 88'-0" in the alignment files. The proposed building files shows proposed Track 7 to be 15 feet from the outside edge of the train control room wall to the center line of the track. The distance between Tracks 7, 8, 9, and 10 is shown as

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20 feet center to center. The Proposed alignment file measures 19 feet center to center and 20 feet to the outside wall of the train control room. We first thought it was a scaling issue with the alignment files but the stationing ticks on the alignments measure 50 feet between ticks. This is causing a great deal of confusion.

- Since the Architectural plans align with the site topo, are we to assume that the Architectural plans are correct to cost out the building construction? But if we hold the building plans the Track alignment layout has an impact on the rest of the site layout (roads, utilities, storm sewers, etc). Which is correct? Please clarify. (DB Ref. 82)

Answer: Track alignment will be adjusted to match the Architectural plans. New track drawings will be issued when completed.

Question 40: What are the lightning protection requirements for all three sites? (DB Ref. 83)

Answer: WMATA does not have any specific Lightning Protection requirements. It is the intent of the Authority that all building grounding meet the Authorities Design Criteria, however, Lightning Protection shall be determined by local codes and requirements.

Question 41: Specification Section 01520-1.07 addresses the equipment to be provided by the Design/Build Contractor for the Authority Representative's Facility. Paragraph 1.07 C, item 14 indicates that the field office shall be furnished with new equipment. However subparagraph "c" indicates that the Authority will provide the computers and printers. Please confirm. (DB Ref. 84)

Answer: Confirmed. WMATA will provide computers and printers.

Question 42: Appendix D to section 00800 Wage Determination Rates, are rates for "heavy" construction. Please verify that all workers at all three (soon to be 4) sites are to be paid in accordance with the heavy rates set out in appendix D, not general building rates. (DB Ref. 85)

Answer: Yes. Appendix 'D' Davis-Bacon rates apply to all three sites

Question 43: Is a submersible hydraulic pump allowed for the elevators? (DB Ref. 86)

Answer: No. WMATA does not allow submersible hydraulic pumps for elevators.

Question 44: Are freight elevator doors to be side slide, or bi-parting? (DB Ref. 87)

Answer: The doors are to be bi-parting, that is, center opening.

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Question 45: Please provide the size of the freight elevator doors. The Architectural Program Criteria says that the car needs to fit a forklift with a 4x4 pallet. (DB Ref. 88)

Answer: A standard Class "A" freight elevator with bi-parting doord is designed to accommodate the loading of materials using a forklift with a 4x4 pallet

Question 46: Please provide the class of elevator for the freight car. (DB Ref. 89)

Answer: Class "A" 6000 lbs. Is recommended.

Question 47: The Greenbelt Main shop has both an existing 15-Ton and a 2-Ton bridge crane in Areas 5 and 6. It appears that the intent is to leave the existing 15-Ton crane, but to scrap the 2-Ton crane. Please confirm if this is correct, and if so, whether WMATA or the D/B contractor should remove the 2-Ton crane. In addition, there is a short "spur line" going into Area 2 which appears to allow the trolley from the 15-Ton crane to access that area. Will the new 15-Ton cranes need to be compatible with this spur? (DB Ref. 90)

Answer: Reference response to Question 50 in Amendment No. 3. Both 15T and 2T cranes to be removed by the Design-Builder. New 15T crane should be compatible with spur or spur modified to be compatible with new crane.

Question 48: Will service catwalks be required for double-girder crane? (DB Ref. 91)

Answer: Service catwalks are required.

Question 49: Page 9 of the Architectural Program Criteria states that at the Greenbelt shop, "the existing bridge crane system in the area (G 107) shall be retained and refurbished." During our recent job walk, the two 2-Ton cranes in that area appear to be in good shape. Please define and further clarify the scope that is required to "refurbish" these cranes. (DB Ref. 92)

Answer: Cranes shall be professionally inspected and brought to a certifiable "state of good repair".

Question 50: In Amendment #2, question #3 stated that the minor shop equipment is included in the \$1,500,000 allowance described on the price proposal form. Please provide us with a list that defines all equipment (by equipment number and description) that is to be included in this allowance. (DB Ref. 93)

Answer: This is for Greenbelt. Reference Answer to Question 3 in Amendment 2. Minor Shop Equipment is defined as all equipment listed in the Fixed Equipment List on Drawings E11-A-02 through E11-A-06, except for those items identified in Item 3 of Schedule 'A' in the Price Schedule. Minor shop

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equipment will be selected by WMATA from the Fixed Equipment List. The \$1.5M allowance will cover these purchases. The amount of the allowance will be adjusted up or down depending on the equipment WMATA selects from the list.

Question 51: On the Greenbelt project, should equipment item #1047 (shown on drawing E11-A-06) be included under the "Major Equipment" section on the Price Schedule? On the Price Schedule, Item 3 "Major Shop Equipment" does not include item #1047 in its description. Please clarify if we are to include this item, and if so, where are we to include the pricing? (DB Ref. 94)

Answer: Item #1047, Car Component Repair and Test Equipment System, is not included in the Major Shop Equipment. It will be covered in the \$1.5M allowance for Minor Shop Equipment described in the previous question.

Question 52: On the Greenbelt & Brentwood projects, there are numerous pieces of equipment that are described as being "relocated". Please clarify whether this "relocation" is to be provided by WMATA or the Design/Builder. If this work is to be performed by the Design/Builder, where are we include the costs on the price proposal form? Please clarify. (DB Ref. 95)

Answer: Reference response to Question No. 15 in Amendment no 1. For Brentwood, there is no requirement for the Design-Builder to relocate Brentwood equipment whose location is noted as "TBD" on the Fixed Equipment Lists, unless specifically noted in other answers to Design-Builder's questions. Design-Builder is responsible for relocating all other listed equipment at Brentwood. For Greenbelt, Design-Builder is responsible for relocating all equipment noted to be relocated on the Fixed equipment Lists. Costs for relocation of equipment shall be included in Item 2-E of Price Schedule, Interior Construction and Finishes, for each site.

Question 53: On drawing A16-A-09 at Shady Grove, there is a note that directs us to provide a center platform at the Blow Pit extension. We have been unable to determine the extent of this new platform. Please provide us with additional details that locate the extent of this new Center platform. (DB Ref. 96)

Answer: Platform shall run the entire length of the existing and proposed extension on the blow pit. Platform shall be located between the two married pairs and provide a positive seal between the edge of the platform and the rail cars. Platforms, both right side and left side, to be at a height to provide access to the interior of the vehicle and to provide a positive seal (to avoid particles from migrating above platform during blow pit operations).

Question 54: At the Greenbelt shop walk-thru, there appeared to be four (4) rail storage tracks located south of column line 8 at the existing wheel truck storage

area. The current set of as-built drawings for the Greenbelt shop does not show four tracks. The drawings do not show the "fourth track" (i.e. closest to column line F). Was this "fourth track" added to the Greenbelt shop at a later time? What is the centerline dimension of the "fourth track"? Does this "fourth track" centerline match the centerline of the track closest to column line F? Please verify that the current layout of this "fourth track" aligns with the final track layout. Please provide us with as-built drawings of this "fourth track". (DB Ref. 97)

Answer: As-built drawings for the fourth track could not be found. From field measurements taken it appears the tracks do line up as shown on Drawing E11-A-11 (M1210-063). It is the desire of the Authority that the stated existing track centers align with the proposed location of the new truck shop tracks to provide for transition and movement of trucks from the storage area to the truck repair area.

Question 55: On page 8 of the Architectural Program Criteria, paragraph 1.03.C.1.a; directs us to connect the new trackwork at the Truck Repair & Rebuild Shop to the "three (3) tracks within the Truck Storage area located south of column line 8". (see question above concerning 3 vs. 4 tracks) It goes on to say that the existing "tracks within the Truck Storage area shall be reconfigured as required to align with the Truck Shop tracks". The existing set of tracks (second set) that are centered approximately 20'-4" from column line D are located 1'-2" to the east of where they should be. Is it WMATA's intent that the existing tracks be removed entirely from this area? Or, would it be possible to abandon the existing track in place and simply "cut-in" new track to align with the proposed Truck Shop tracks? Please verify. (DB Ref. 98)

Answer: See Answer to Question 54 above. WMATA does not intend to remove the existing tracks. If one of the existing tracks does not line up with the new truck shop track, a crane will be utilized to move the truck assemblies.

Question 56: On page 5 of the Architectural Program Criteria, paragraph 1.02.L.1.c states that the Greenbelt Annex must be located a minimum of 60' from the existing paint shop in order to maintain its status as an "unlimited area building" for code requirements. Does this 60' dimension include what appears to be a loading dock structure located from column line AA-32 to AA-33? The loading dock appears to be approximately 20' wide coming off of column line AA. This would provide only 40' of clearance to the existing paint shop. Please clarify. (DB Ref. 99)

Answer: WMATA's consultant is currently coordinating with the Prince George's County Fire Department to obtain a variance for or approval of the existing design. WMATA has no intention of adjusting the location of the Annex. If a variance cannot be obtained with the current design, walls and roof will be

removed from loading dock.

Question 57: At the Greenbelt Shop, what is the required capacity for equipment item #286, the Jib Crane for the Wheel Boring Mill? (DB Ref. 100)

Answer: Crane is offered as an option with the wheel bore machine and has a 1 ton capacity. Note Item #286 is included in the \$1.5M allowance for Greenbelt "Minor Shop Equipment". See Answer to Question No. 3 in Amendment No. 2.

Question 58: In specification section 14401, paragraph 1.02.A.5.d requires the crane and hoist manufacturers to be both ISO-9001 and QS-9000:98TE supplement certified and registered. Many of the crane manufacturers do not meet both of these requirements, including companies with numerous units in operation at existing WMATA facilities. Please consider removing this requirement, or revising to simply ISO-9001 and no-load testing by CMAA member. (DB Ref. 102)

Answer: Crane and hoist manufacturers to be ISO-9001 certified and registered. Delete the requirement to be QS-9000:98TE certified and registered.

Question 59: There appear to be two different uses for the term "Major Equipment". Specification section 00200 and 11001 refer to a list of equipment in the Appendix A in section 11001. Item 3 under Schedule A in the Price Schedule refers to a number of items on the Fixed Equipment lists. However, these two lists are different, and cause confusion, whereby a 2-Ton Jib crane is considered Major Equipment as item 1020, but Minor Equipment as item 229, in the same facility. Please consider revising the equipment pieces listed under Item 3, Schedule A to reflect the list shown in Appendix A in Section 11001. (DB Ref. 103)

Answer: Reference Answer to Question 4 in Amendment 4 for changes to Item 3 under Schedule A in the Price Schedule. Other than the changes noted in the Referenced Answer, no other changes to listings will be made.

Question 60: Specification section 14401 – Cranes calls for class "D" service for bridge cranes and built-up type hoists with horizontally split gear cases. From our job walks, it appears that the existing cranes do not have these designs, but instead standard type wire rope package hoists. Furthermore, it is not possible to provide such a hoist design on single girder bridge cranes and jib cranes. Please advise. (DB Ref. 104)

Answer: Where appropriate underhanging wire rope type cranes can be substituted.

Question 61: Please verify that the four (4) 15-Ton bridge cranes (Shady Grove / Greenbelt) and the two (2) 5-Ton bridge cranes (Greenbelt) are of a double

girder design, and that the rest of the bridge cranes are single girder. (DB Ref. 105)

Answer: Verified as stated.

Question 62: Please verify that the three(3) 15-Ton bridge cranes at Greenbelt are the only ones required to be under-running (due to existing conditions), and the rest can be top-running. (DB Ref. 106)

Answer: Verified as stated.

Question 63: At Shady Grove, drawing A16-A-13 (M1210-398) has a Keyed Note #12 which reads "Drains and material cart rails full length of pit). Will the Design/Build contractor be responsible for providing the material cart rails? If so, please provide more information. (DB Ref. 107)

Answer: Intent was to provide rails in the pit for the material carts to travel on, but this is not compatible with operations at other WMATA shops. Delete requirement for material cart rails.

Question 64: In the Mechanical Program Criteria, page 11, paragraph 1.05.A.1 states "All existing, retrofitted and new office and shop areas shall be evaluated for use and shall be modified or designed to meet all current codes, standards, and/or the Program Criteria for ventilation rates." However, on page 3, paragraph 1.04.1.a lists a site specific scope of work for existing Greenbelt Shop; page 5, paragraph 1.04.2a lists a site specific scope of work for existing Brentwood Shop; and page 8 paragraph 1.04.3a list a site specific scope of work for Shady Grove Shop. Please verify that our scope of work is limited to the site specific scope and does not apply to the "All existing" areas. (DB Ref. 108)

Answer: Any existing areas not specifically mentioned in the site specific scope of work that may be affected by the Design-Builder's final design and construction, requires an evaluation by the Design-Builder for use and shall be modified or designed to meet all current codes, standards, and/or the Program Criteria for ventilation rates.

Question 65: Shady Grove Drawing A16-TC-03 does not show signals 92 & 94 positioned between Turnout (TO) 149 and TO 171. However, on drawing A16-TC-06 the signal is shown. Please advise us as to the correct location and orientation of the signals.(i.e. Signal 92 permits a movement from ___ to ___.) (DB Ref. 109)

Answer: For proposal pricing purposes, Signals 92 and 94 should be included at the locations shown on drawing A16-TC-06. The final number and locations of all signals associated with the track changes must be determined by the

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Design-Builder, as a design function, to satisfy the yard operational flexibility and safety requirements addressed in the Program Criteria.

Question 66: Shady Grove Drawing A16-TC-02 depicts Signal 158 (existing), and Signal 160, 162, 164, 166, & 168. Specifications section 16911-5, 1.03.C.5.b identifies 162, 164, 166, & 168 as NEW. What about Signal 160? (DB Ref. 110)

Answer: Signal 160 is presently located in an area where Shop Lead Track 6 is required to be realigned or replaced and Signal 160 will therefore have to be relocated. It is expected that all signals that require relocation to be replaced with complete new layouts and cabling.

Question 67: Shady Grove Drawing A16-TC-03 – Signals 62 and 74 are depicted as being across the track from each other while drawings A16-TC-07 show them with a track circuit between them. Please advise as to the proper layout and orientation. (DB Ref. 111)

Answer: Signals 62 and 74 are presently located across the track from each other in reference to the same set of insulated joints. It is not considered likely that the program track changes will require any change in the location of Signals 62 and 74. The separation of the two signals on Control Machine Drawing A16-TC-07 does not indicate a track circuit between them but provides space behind the panel for lamp sockets and pushbutton mechanisms.

Question 68: Section 16911 gives no information concerning Train Control work required at Greenbelt and the remaining RFP documentation does not provide sufficient information to determine if it is required. No Train Control modifications would be required if tracks FY-1, FY-2, and FY-3 have no track circuits, no related signals, and the turnouts are operated by manual switch machines with no indications. Please verify that this is the case. (DB Ref. 112)

Answer: The track changes at Greenbelt Yard are not expected to require any changes to the Yard Signal Control and Interlocking System due to the changes and additions to only involve non-signaled tracks with hand throw switch stands.

Question 69: Please clarify the conflict in Section 16700 Scope of Work – Communications.
In section 3.01 and 3.02 there is no major interface listed. If there is no major interface, the Design-Builder should not be responsible for surveying this equipment, as indicated in section 2.02 and 2.03. (DB Ref. 113)

Answer: The Communications Scope of Work (Section 16700) includes a general description of all yard communications systems and then provides a

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preliminary assessment of the changes and additions at each of the three yards in this program. As required in the Scope of Work, the Design-Builder is expected to survey the existing conditions and become familiar with all the Yard Communications Systems and their interfaces in order to perform a fully integrated design. Although no Major interfaces to the Carrier and Fiber Optic Systems are anticipated, the actual requirements will be determined by the Design-Builder. The Design-Builder is responsible to avoid interference and damage to existing systems, therefore a knowledge of these systems not requiring changes is considered essential.

Question 70: Please clarify the conflict in Section 16700 Scope of Work – Communications. It is the Design-Builder’s responsibility to expand on the existing communication equipment and not to replace or provide new systems that are currently in use. That may or may not be required for the Telephone, Fire Alarm and Public Address Systems as indicated in 2.04-A-7, 2.06-B-2&3, and 2.11 A-1. (DB Ref. 114)

Answer: It is incorrect to assume, “It is the Design-Builder’s responsibility to expand on the existing communication equipment and not to replace or provide new systems that are currently in use.” Although it is preferable f o r systems to be expanded to cover the additional requirements associated with the shop expansions, this is not possible in some locations, for some systems. The Communications Scope of Work includes a preliminary assessment of the existing systems, however, the proposers are strongly encouraged to make their own assessment with a site inspection. The actual communications requirements for the new and expanded shop facilities are to be determined during the design by the Design-Builder, and the existing systems may not be suitable for use in these areas due to system components no longer being available or control units already used to capacity.

Question 71: In the Shady Grove expanded shop building, do the columns need to be sized for a future overhead crane spanning the four new tracks? (DB Ref. 115)

Answer: Columns do not have to be sized for a future crane.

Question 72: Item #1046 in the Greenbelt shop and item #1036 in the Brentwood shop and item #1033 in the Shady Grove shop is called out to be a Shop Work Station? Please provide us with more information describing this piece of equipment. (DB Ref. 116)

Answer: Reference response to Question 4 in Amendment No. 4..

Question 73: Item #1037 in the Brentwood shop is called out to be “Cleaning Equipment for Additional Bays”. Please provide us with more information describing this

piece of equipment and it's intended purpose. (DB Ref. 117)

Answer: Reference response to Question 4 in Amendment No. 4.

Question 74: What is a Car Component Repair & Test System? (Greenbelt item 1047, Brentwood item 1039, Shady Grove item 1027) What components of the car are to be repaired/tested? Please provide us with more information describing this piece of equipment and it's intended purpose. (DB Ref. 118)

Answer: Reference response to Question 4 in Amendment No. 4.

Question 75: What is desired for the Pre-Fab Storage Buildings? (Brentwood item 1040) What sizes are required? Please provide us with more information describing this piece of equipment and it's intended purpose. (DB Ref. 119)

Answer: Reference response to Question 4 in Amendment No. 4.

Question 76: What is a Jacking Carriage? (Brentwood item 1042, Shady Grove item 1028) What is it lifting, and what capacity is required? Please provide us with more information describing this piece of equipment and it's intended purpose. (DB Ref. 120)

Answer: Reference response to Question 4 in Amendment No. 4.

Question 77: Please clarify the requirements for the Shady Grove new/existing blow pit D.C. stinger system requirements. The traction power program criteria appears to conflict with the RFP drawings A16-A-09(M1210-394) and A16-A-13(M1210-398) regarding the number of stingers and stinger locations. Should we provide a fifth and sixth D.C. stinger to serve tracks #2 & #3 as indicated on drawings A16-A-09 and A16-A-13? Is there an existing blow pit in any of the other yards where the stinger bus and control bus are installed under the pit platforms and mounted on the pit walls? Please clarify. (DB Ref. 121)

Answer: In Book 2 Traction Power and Lighting Program Criteria, Section 1.03 System Description, paragraph 13. Sentence that reads: "A fifth new stinger/trolley assembly is to be provided to serve the new construction (blow pit) area for tracks 2 and 3; this stinger assembly shall be located between tracks 2 and 3, to serve either track, and shall provide power not only to the new blow pit construction area (approximately 85 feet in length) but also the existing blow pit area at tracks 2 and 3.", will be edited to read: "A fifth and sixth new stinger/trolley assembly is to be provided to serve the new construction (blow pit) area for tracks 2 and 3; this stinger assembly shall be located alongside (wall mounted) tracks 2 and 3 to serve the respective track, and shall provide power not only to the new blow pit construction area (approximately 85 feet in length) but also the existing

blow pit area at tracks 2 and 3.”

This type system is used in the SEPTA system in Philadelphia at the Fern Rock maintenance facility blowdown, and other major transit facilities.

Question 78: Specification section 02270-page 1, paragraph 1.01.C says that the gas company will do it's own work as it relates to gas distribution and services. The Architectural Program Criteria directs the Design/Build contractor to provide “natural gas supply” to numerous rooms in the project. Please clarify the gas company's scope of work for this project. Also, please provide us with the location(s) of the gas meters for the Greenbelt site. (DB Ref. 122)

Answer: Contact was made with Ms. Jennifer Eugene of Washington Gas Light (WGL) Engineering Sales Staff (703-750-4844). Ms. Eugene advised that the Yard is supplied off of a main provided with up to 50 lbs. pressure. Also the service size pipe is four inches. The yard has three meters which are probably located at the Paint shop, S&I shop and the O&M Building. WGL could not confirm at this time if that was the actual location of the meters. WGL will provide the engineering, construction and materials for any piping up to and including the meter. WGL would need the anticipated load, additional load and connected load figures to determine if any additional work/materials on its part are required. A Service Information Request containing this information will be required by WGL from the Design/Builder. Ms. Eugene advised that she may be contacted with questions concerning this matter.

Question 79: In the Project Manual – Book 1; specification section 00200-page 11- references an electronic copy of the proposal “as required”. Please verify that we are to submit only paper documents with this proposal submission. If this is not the case, then we suggest that the proposer's be given adequate time (ie one or two weeks) after the submission date to submit this information electronically. (DB Ref. 123)

Answer: Electronic copy can follow paper document submittal by one week.

Question 80: Specification section 02468-page 1: paragraph 1.01.D- references unit prices for caissons. Please verify that these unit prices are not required for this project. (DB Ref. 124)

Answer: Unit prices for caissons are not required. It is suggested that cost for caisson drilling be included in Price Schedule Item 1-B, Earthwork, and concrete in Item 2-B, Concrete and Masonry.

Question 81: Specification section 03200 references epoxy reinforcing steel. We have been unable to locate where this project would need epoxy coated

reinforcing steel. Please verify that this project does not require epoxy coated reinforcing steel. (DB Ref. 125)

Answer: There is no requirement for epoxy coated reinforcement or epoxy coated WWF.

Question 82: Specification section 03300-page 10; paragraph 2.01.Q references elastomeric concrete. We have been unable to locate where this project would need elastomeric concrete. Please verify that this project does not require elastomeric concrete. (DB Ref. 126)

Answer: It is anticipated elastomeric concrete may be used to repair damaged or spalled concrete within the limits of work.

Question 83: Specification section 03300-page 11; paragraph 2.01.T references corrosion-inhibitor in concrete. This is typically used in precast concrete garages for WMATA. Please verify that this project does not require corrosion-inhibitor in the concrete. (DB Ref. 127)

Answer: There is no requirement for corrosion inhibitor in the concrete.

Question 84: In the Architectural Program Criteria on page 18, room G222 (Greenbelt Annex) – Component Parts Storage Room calls for us to provide a component parts storage system “as defined by WMATA”. Please provide us with additional inform clarifying this WMATA “definition” of the component parts storage system. (DB Ref. 128)

Answer: Specification 10600, Storage Retrieval System issued in Amendment No. 3. Reference answer to Question 47 in Amendment No. 3.

Question 85: At the Shady Grove project, is the start of the remodeling of the existing Men’s and Women’s locker/toilet areas constrained by the completion of the new Mezzanine lunchroom? (DB Ref. 129)

Answer: Yes. Existing Men’s and Women’s locker/toilet area must remain in service until replacement facilities are available.

Question 86: At the Shady Grove project, the existing stinger line is below the header height at the future knock-out panel. Do you require that the stinger be raised or modified, or is the current vertical clearance at the existing stinger sufficient? (DB Ref. 130)

Answer: Current vertical clearance sufficient.

Question 87: The response to Question No. 15 in Amendment No. 1 regarding the Interim Completion in Section 00825 states that “Greenbelt Yard refers to work in

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the yard only, not the entire Greenbelt project". Please clarify what portion is to be complete for Interim Completion and Final Completion. In addition, confirm that the New Greenbelt Annex and Main Greenbelt Shop Reconfiguration must be complete before the start of construction on the Brentwood main floor level. (DB Ref. 131)

Answer: Reference Answer to Amendment 4 Question 22. Except for any exceptions noted in previous answers, Greenbelt Annex and Main Shop must be operational before start of construction on the Brentwood main floor level, so that there can be a continuous flow of maintenance functions.

Question 88: The response to Question No. 32 in Amendment No. 3 indicates that a permanent covered metal staircase is to be constructed outside of the west wall of the building between column lines 1 and 3 for permanent access to the control tower. Since an existing six foot wide surface cable trench crosses this same area, is it your intent to build over this existing surface cable trench or relocate it, if possible? (DB Ref. 132)

Answer: The intent is to build over the surface cable trench, while maintaining access to it.

Question 89: With regard to Question 74 in Addendum No. 3; If the existing Hegenscheidt Model 104 wheel truer cannot be modified for installation on Track 11, does WMATA have a preference for manufacturer and/or model of a new machine? Does WMATA require either milling or lathe reprofiling? (DB Ref. 133)

Answer: Reference Architectural Program Criteria for Brentwood, Section 1.04, Article B.46 for new machine. Modification of existing machine or procurement of new machine will be at the expense of WMATA.

Question 90: This contract requires a new dust collector for the Shady Grove blow pit extension. Is a screenwall required around the new dust collector? (ie-similar to the current configuration at the Greenbelt Shop?) Please verify. (DB Ref. 134)

Answer: Provide screenwall around the new dust collector at Shady Grove.

Question 91: What flooring is required for the new Freight Elevators? (DB Ref. 136)

Answer: Steel plate flooring would be compatible with the type of elevator this is. Reference Answers to Amendment 4 Questions 45 and 46.

Question 92: What training is required for the Elevators? Does specification section 11001 apply? If so, what level of training is required (I, II, III)? (DB Ref.

137)

Answer: The Contractor shall develop and provide operation and maintenance training in accordance with the General Requirements and as follows:

1. Three days of classroom plus two days of at-the-site training to be repeated five times with 15 students per class.
2. Time and place of training will be determined by WMATA, but must be completed no later than 30 days before Final Completion.
3. Training shall be organized to make optimum use of the required maintenance and operation manuals including training for replacement of all parts contained in the Parts Inventory list.
4. Provide one additional copy of all required submittals to the Engineer for forwarding to WMATA RAIL/ELES.
5. Provide two copies of training materials along with visuals and handouts to the Engineer for forwarding to WMATA/TRNG.

Question 93: Please provide more information on the gate type for the freight elevators. Manual vs automatic, bi-parting vs side sliding vs center opening, etc..? (DB Ref. 138)

Action: "Gates" are not intended for the freight elevators. Doors to be bi-parting and center opening per answer to Amendment 4 Question 44. Doors to be automatic.

Question 94: Montgomery County DPS has indicated that all redevelopment of the Shady Grove site will be treated as 100% impervious and a 100 year flood plain analysis must be performed on the existing 78/90 inch pipe system. Are we responsible to perform this analysis? Is information available to perform this analysis? Are we responsible to increase the size of the existing storm piping or perform any modifications to the off-site regional storm water pond? If the existing 78/90 inch pipe system is inadequate, are we responsible to design/build a new on-site SWM pond? (DB Ref. 139)

Answer: Proposal should be based on information provided. A preliminary analysis has been conducted by WMATA's consultant and a preliminary Stormwater Management report prepared. The purpose of the SWM report was to investigate stormwater management requirements needed for the Shady Grove Yard improvements; to advance the understanding of the project with

Design/Build: Rail Yards Expansion project at Brentwood, Greenbelt and Shady Grove Yards

Maryland Department of the Environment (MDE); and to demonstrate that a workable SWM plan is achievable. A copy of the SWM Report dated February 16, 2005 is attached.

Question 95: The Answer, Item c, to Question #8 in Amendment No. 003 references the MDE letter dated January 10, 2005. Item No. 1 in this letter references "PI plans". Please clarify what these plans are and provide them to us. (DB Ref. 140)

Answer: Above referenced letter was from MDE, approving SWM concept at Greenbelt Yard. "PI plans" are preliminary investigation plans and are the same as those provided as an attachment to the Answer for Amendment 4 Question 37. See list of Attachments, Roman Numeral II.

Question 96: For mechanical equipment placed on the roof of the new Greenbelt Annex, will a screenwall be required? (DB Ref. 143)

Answer: WMATA does not have a roof top equipment screening requirement. Screening of roof top mechanical equipment shall be determined by local code and local zoning requirements.

Question 97: The Answer to Question 27 in Amendment No. 003 indicates "...beneficial occupancy of the new/renovated office areas, lunch room and locker rooms/rest shall be provided as soon as possible, prior to final completion of the Brentwood construction." It appears that the new ground office area from column line 1 to column line 5 must be constructed, and occupied before the removal of the existing office space from column line 1 to 4. Please confirm. (DB Ref. 144)

Answer: Confirmed. Or equivalent temporary office area must be provided subject to approval by WMATA.

Question 98: The Answer to Question 8 in Amendment No. 003 indicates that additional meetings with Montgomery County and DC officials are planned. Please provide any information or meeting minutes from these meetings. (DB Ref. 145)

Answer: No additional meetings to date. However, Brentwood Yard Improvements Stormwater Management Report dated November 30, 2004 is enclosed in response to above question. Greenbelt Yard Improvements Stormwater Management report provided in response to Amendment 4 Question 37; and Shady Grove Yard Improvements Stormwater Management Report provided in response to Amendment 4 Question 94.

Question 99: The Answer to Question 8 in Amendment No. 003 indicates that plans submitted to The Forest Stand Delineation and Forest Conservation

Design/Build: Rail Yards Expansion project at Brentwood, Greenbelt and Shady Grove Yards

Exemption Review will be provided when received. Can we get a copy of the plans and the subsequent approval? (DB Ref. 146)

Answer: WMATA's consultants are still coordinating with MDE and addressing comments. Approved plans will be provided when as soon as available.

Question 100: At the Greenbelt Shop, the answer to question #24 in Amendment No. 003 indicates that an alternate lift area must be functional prior to working in Sections 5 and 6. Please clarify. Since there is no new lift in Areas 8, 9, and 10, are we to provide a temporary lift? Are we required to attempt to phase the work in Areas 5 and 6 so that the existing lifts are available? (DB Ref. 141)

Answer: Work must be phased in such a way that two truck lifts will always be functional at Greenbelt for truck maintenance. Temporary lifts will not be allowed because of safety concerns. WMATA plans to temporarily divert some truck maintenance work normally handled at Greenbelt to the Branch Avenue Yard Shop during the period that only two lifts will be operating at Greenbelt.

Question 101: At the Greenbelt Shop, the Answer to question #25 in Amendment No. 003 indicates, "work will have to be phased to ensure critical operations are maintained." Please define critical operations, functions, durations, etc. (DB Ref. 142)

Answer: All maintenance activities are critical and must continue with minimal or no disruption. Except for the wheel press activities, it is understood that there may be some disruption when equipment is moved from one location to another within Greenbelt, but this time of disruption must be minimized. An example of this would be the time to relocate the wheel boring mill (item 528) within the Greenbelt Shop. Regarding wheel press operations, the new wheel press (item 1008) must be operating before the existing wheel press (item 523) is taken out of service and relocated.

Question 102: Can WMATA provide us with hardware maps of the existing Rolm 8000 Satellite PABX Equipment at the Greenbelt and Brentwood Yards? These would be needed to determine how to expand the existing Rolm equipment currently in use. (DB Ref. 135)

Answer: WMATA is checking on the availability of these hardware maps. Assume that WMATA will provide.

Question 103: The Mechanical Program Criteria for heating the new shop building at Greenbelt (PROJECT MANUAL BOOK 2, page 5, Part 1.04A.1.b(1) does not specify the type of heating system required. Given that the existing building utilizes natural gas for the energy source it seems reasonable that

Design/Build: Rail Yards Expansion project at Brentwood, Greenbelt and Shady Grove Yards

a natural gas system (as opposed to, say, fuel oil fired boilers) would be desired by WMATA. Please comment on WMATA's preference, if any, for heating the new building, and please confirm that adequate spare natural gas capacity is available on site to supply the new shop. (DB Ref. 33)

Answer: Natural gas is preferred. Reference Answer to Amendment 4 Question 78. It would appear that sufficient gas is available.

Question 104: At the Greenbelt shop, The RFP requires three (3) new 15 Ton bridge cranes (equipment Item 1019) for use in the existing shop, in Truck Storage, and in the existing and new Truck Repair Areas for the area (columns 1-19, D-F). The existing 10 Ton and 2 Ton cranes in that area are "underhung" cranes traveling on crane girders connected to both the building columns and suspended from the roof beams. Replacing those cranes with three 15 Ton cranes adds considerable load that must be accounted for by design modifications to the structure. Relying on crane anti-collision devices to prevent "crane bunching" is not a recommended design strategy for modifications to the structure. Can WMATA be more specific on their intent for crane use and requirements in this area? Can the crane capacity requirements be reduced to 10 Ton? Can permanent stops on the girder be utilized to maintain crane separation (which would also prevent "through traffic"). Can the new cranes be "underhung", to make use of, if possible, the existing crane girders? Would two (2) 10 ton cranes running end to end be sufficient? (DB Ref. 79)

Answer: In lieu of three (3) 15T cranes, two (2) 10T cranes and one (1) 15T crane may be provided with the 15T in the middle and a 10T crane on each side. All cranes need access to the entire area for multiple use options. Therefore, new cranes to have laser stops or perimeter sensors with hard stops only at extreme ends. New cranes may be the "underhung" type.

Question 105: What speeds are required for the bridge cranes? Please provide minimum speeds for bridge/trolley/hoist for each capacity of bridge crane (15, 5, and 3 Ton). (DB Ref. 101)

Answer: It is advised that the cranes utilize an infinitely variable flux vector control.

Attachments/Enclosures

- I. Reference Answers to Amendment 4 Questions 17 and 18; and Amendment 3, Questions 18, 19, and 54.

The following Drawings have been revised:

Drawing E11-A-06	(M1210-058)	Revised Turntable Quantities
Drawing E11-A-11	(M1210-063)	Deleted Turntables
Drawing E11-A-14	(M1210-066)	Deleted Turntable & Relocated Crane
Drawing E11-A-19	(M1210-071)	Revised Equip. ID No. For Jib Crane

- II. Reference Answer to Amendment 4 Question 37.

- a. The following drawings represent those drawings given SWM conceptual approval by MDE for Greenbelt and supersede current drawings of the same number:

Drawing E11-G-05	(M1210-014)
Drawing E11-G-06	(M1210-015)
Drawing E11-U-03	(M1210-018)
Drawing E11-U-04	(M1210-019)
Drawing E11-SW-1	(M1210-020)
Drawing E11-SW-2	(M1210-021)
Drawing E11-SW-3	(M1210-022)
Drawing E11-SW-4	(M1210-023)

- b. Greenbelt Yard Improvements, Stormwater Management report dated December 31, 2004

- III. Reference Answer to Amendment No 4 Question 12.

Shady Grove Service and Inspection Yard as-built Drawings SGSIY-FSS-30-1 and 30-2.

- IV. Reference Answer to Amendment 4 Question 27.

Roofing warranties for:

- a. Shady Grove S&I Shop - 20-year warranty dated 06/09/2000 from GAF and a 15-year warranty dated 02/20/98 from Johns Manville. Roofers, Inc. to perform additional repairs on this roof.
- b. Brentwood S&I Shop - 15-year warranty dated 06/11/96 from Red Shield.

- V. Reference Answer to Amendment 4 Question 94.

Attachments/Enclosures

Shady Grove Yard Stormwater Management report dated February 16, 2005.

VI. Reference Answer to Amendment 4 Question 98.

Brentwood Yard Improvements Stormwater Management report dated November 30, 2004.

VII. Alexandria Yard Expansion

- a. FN5008 Project Drawings Book 5, Alexandria Shop Expansion, February 3, 2005, Amendment 4.
- b. Appendix A to FN5008 Project Manual Book 2 for Alexandria Yard Expansion (Program Criteria), February 3, 2005, Amendment 4.
- c. CD Containing PDF files of as-built drawings for:
 - Contract 1C0111, Alexandria Service and Inspection Yard
 - Contract 1C0113, Alexandria Service and Inspection Yard Excavation and Grading
- d. Half-size set of design drawings for Section C-11b, Alexandria Service and Inspection Shop, Contract 1C0112, May, 1979. (These are design drawings. Search for as-builts continues.)



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authority

Appendix A
Project Manual
Book 1 (Div. 0 -1)

METRO MATTERS
DESIGN/BUILD: RAIL YARDS EXPANSION
PROJECT, ALEXANDRIA YARD OPTION

Amendment 4
Contract No. FN5008

February 2005

**DIVISION 0
PROCUREMENT AND CONTRACTING REQUIREMENTS**

END OF SECTION

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INTRODUCTORY INFORMATION

00001 PROJECT TITLE PAGE

APPENDIX A
PROJECT MANUAL

FOR

RFP-FN5008/FMP

DESIGN-BUILD

CONTRACT FN5008

METRO MATTERS: RAIL YARDS EXPANSION PROJECT, ALEXANDRIA YARD OPTION

February 17, 2005

END OF SECTION

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INTRODUCTORY INFORMATION

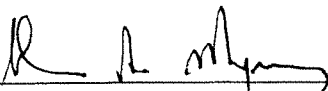
00005 SOLICITATION CERTIFICATIONS PAGE

METRO MATTERS: RAIL YARDS EXPANSION PROJECT, ALEXANDRIA YARD OPTION

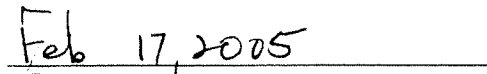
DESIGN-BUILD

CONTRACT No. FN5008

APPROVED FOR RELEASE



Colin A. Myers - CONS
Project Manager



Date

William O. Linde, Jr. - PRMT
Contracting Officer

Date

END OF SECTION

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INTRODUCTORY INFORMATION

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PROCUREMENT REQUIREMENTS

00100 SOLICITATION - REQUEST FOR PROPOSALS

This Section includes project information for proposers.

NOTICE TO OFFERORS

RFP-FN5008/FMP includes Project Manuals and Project Drawing Sets for:

PROJECT DESCRIPTION: RAIL YARDS EXPANSION PROJECT, APPENDIX A -
ALEXANDRIA YARD OPTION

PROPOSALS for the work described herein shall be submitted by the Proposers so as to be received at the Office of Procurement, Washington Metropolitan Area Transit Authority, Office of Procurement, **PRMT File Room 3C-02**, 600 Fifth Street, N.W., Washington, D.C. 20001 before the time and date listed in Section 00412 and 00413. Questions may be directed to the Contract Administrator.

DIRECTIONS FOR SUBMITTING OFFER: Read and comply with Section 00200, INSTRUCTIONS TO PROPOSERS. Proposal volumes shall be submitted in accordance with Section 00204. Proposal documents are contained in Section 00500, PROPOSAL FORMS AND SUPPLEMENTS.

The separate, sealed Proposal Volumes must be marked with offer under solicitation RFP NO. FN5008/FMP, Volume Number and Description. All amendments must be acknowledged on the Proposal Forms.

PROPOSALS MUST SET FORTH FULL, ACCURATE AND COMPLETE INFORMATION AS REQUIRED BY THIS REQUEST FOR PROPOSAL INCLUDING ANY AMENDMENTS.

NOTE TO PROPOSERS: THIS DOCUMENT IS NOT INTENDED TO BE A STAND-ALONE DOCUMENT AND IS TO BE CONSIDERED IN CONJUNCTION WITH THE PROJECT MANUAL: BOOK 1 - DESIGN/BUILD: RAIL YARDS EXPANSION PROJECT AT BRENTWOOD, GREENBELT, AND SHADY GROVE YARDS. ONLY THOSE AREAS OF REQUIREMENTS UNIQUE TO THE ALEXANDRIA OPTION ARE INCLUDED IN THIS APPENDIX A PROJECT MANUAL.

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00101 GENERAL STATEMENT OF WORK:

- A. This Appendix A to the Project Manual adds a separately-priced Option to the Shady Grove / Greenbelt Project for the Expansion of the Alexandria Yard. This work is to added as a priced Option to the Greenbelt /Shady Grove Project. The exercise of the Option is predicated on receipt of funding, Board approval, and environmental clearances. The scope of the Option will add 12 inspection and maintenance bays and extend the existing blow pit to support married pairs with necessary trackwork and expansion of Shop areas consistent with those to be performed at Shady Grove. The performance period is approximately 720 calendar days with work commencing upon exercise of the Option. The Option may be exercised at the sole discretion of the Authority within 270 calendar days of the award of the Greenbelt / Shady Grove Project. The target price established for the Alexandria Option is \$34 million.

END OF SECTION

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PROCUREMENT REQUIREMENTS

00200 INSTRUCTIONS FOR PROCUREMENT

- A. This solicitation is a competitive, "best value" selection process as described herein for the award of a Design-Build contract.
- B. This Section includes procedures with which proposers must comply and conditions affecting award of the Contract.

00201 GENERAL INSTRUCTIONS

- A. Method of Procurement:

This is a competitive, negotiated acquisition with a "best value" (Fixed Price / Best Design) selection process. Proposers shall submit separate proposal volumes in accordance with this Section, which the Authority will evaluate in accordance with the Authority's evaluation criteria as specified in this Section.

- B. Basis for Award:

The Alexandria Rail Yard Expansion Option will be evaluated separately for technical and price on a "fixed-price best design basis".

The Alexandria Rail Yard Expansion Option evaluations will be combined with those for the Greenbelt / Shady Grove Project to determine that Design-Builder who represents the best overall value to the Authority. The Brentwood Project will be evaluated and awarded separately, unless a combined award is determined to be in the best interests of the Authority. Proposers will be asked to provide a separate deduct amount to eliminate duplication of overhead and profit costs should the Brentwood Project be combined with the award of the Greenbelt / Shady Grove Project.

00204 PROPOSAL FORMAT, PROCEDURES AND EVALUATION FACTORS, AND INSTRUCTIONS

Volume 4: Technical Proposal, Alexandria Option				
Volume	Part	Title	Copies	Page Limits
4	A	Value of Design Solutions	6	N/A
4	B	WorkApproach/ScheduleCompliance	6	N/A
4	C	Management Resources	6	N/A

Volume 5: Price / Contract Proposal				
Volume	Part	Title	Copies	Page Limits
5	A	Alexandria Option Project Price w/ Detailed Narrative	6	N/A
5	B	Forms and Contractual Information	4	N/A

A. Since it is anticipated that multiple awards will result from this solicitation, Proposers must submit information requested under Phase Two separately as follows: Shady Grove and Greenbelt combined with Alexandria Option and Brentwood as a standalone project.

1. Value of Design Solutions

A. The RFP will describe several design and construction challenges or major activities that if not fully addressed would produce detrimental effects to the project. The proposers are required to address these and any other situations with detailed solutions that demonstrate that they understand the issues, have developed viable solutions and can implement these solutions in a timely manner to meet the schedule. These will include but are not limited to:

Alexandria Shop Expansion:

1. Contractor's approach to blow pit expansion:
 - Minimizing loss of blow pit service during the blow pit expansion.
 - Minimizing interference with track one operations.
 - Installing the raised grating in the existing and new blow pits.
2. Contractor's plans for expanding and extending various shop systems:
 - Replacement of compressed air plant while minimizing loss of service duration
 - Extension of electrical service without interrupting on going maintenance operations

- Expansion of heating, ventilation and plumbing into the new shop sections
- 3. Contractor's plans for modification of the yard signal control and interlocking system with minimal impact to ongoing operations and service reliability.
- 4. Contractor's plans for trackwork installation and realignment. Show phasing, staging and schedule to minimize impacts to the ongoing yard operations and service reliability.
- 5. Contractor's plans for construction of the west and east end sections with minimal interference with existing shop operations and work.
- 6. Contractor's approach to controlling dust, noise and particularly fume control when applying epoxy paint and while working in and/or adjacent to the active work areas of the shop and yard.

2. Work Approach / Schedule Compliance

No change.

3. Management Resources

No change.

B. Technical Proposal Instructions: The information provided should be complete and clearly presented. If the information requested under a factor is presented elsewhere in the proposal, the proposer should cross reference this information rather than duplicate it.

1. Complete, sign and submit the TECHNICAL PROPOSAL FORM (Section 00412)

C. Price Proposal Instructions: The information provided should be complete and clearly presented. If the information requested under a factor is presented elsewhere in the proposal, the proposer should cross reference this information that is provided elsewhere rather than duplicate it.

1. Instructions for Supplementary Items to Price Proposal

- a. Provide an estimated cash flow curve for the planned duration of the project showing the dollar values.
- b. Price proposals shall be supported by a detailed narrative which clearly explains the quality of design, construction, major equipment, etc. that is being offered in sufficient detail to permit a value analysis as well as cost information.

D. Oral Presentations:

1. The Authority reserves the right to schedule oral presentations. If oral presentations are scheduled, the oral presentations shall be requested only from proposers which have not been eliminated from the competition. The oral presentation shall address items and issues identified by the Authority. The oral presentation shall be provided by the proposed key members of the proposer's project team. Proposers' proposed major subcontractors/DBE representatives are also urged to attend. Total presentation time, including clarifications, shall be no longer than two hours with additional time allotted for technical discussions.
2. At its sole discretion, the Authority will schedule oral presentations at the Headquarters of the Washington Metropolitan Area Transit Authority at 600 Fifth Street, N.W., Washington, D.C. 20001. Requests from proposers to reschedule their oral presentations are discouraged. No rescheduling will be done unless determined necessary by the Authority.
3. If held at the Authority Headquarters, the presentations will be held in a conference room with conference room style seating. The Authority will provide only a projection screen.
4. Oral presentations shall be treated as a discussion.

END OF SECTION

PROCUREMENT REQUIREMENTS

00400 PROCUREMENT FORMS AND SUPPLEMENTS

This Section includes forms and supplements for submitting proposals.

00410 PROPOSAL FORMS

This Section includes Proposal Forms that are required to be submitted with the Offeror's Proposal.

00411 REQUEST FOR QUALIFICATIONS PROPOSAL FORM - NOT USED

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00412 TECHNICAL PROPOSAL FORM

DATE OF REQUEST: PHASE 2 - February 16, 2005

PROJECT: FN5008 METRO MATTERS: RAIL YARDS EXPANSION PROJECT, ALEXANDRIA
YARD OPTION

REQUEST FOR TECHNICAL PROPOSAL containing information requested herein shall be submitted by the Proposer so as to be received before: **2:00 p.m.** on **April 8, 2005** at the Washington Metropolitan Area Transit Authority, Office of Procurement, PRMT FILE Room 3C-02, 600 Fifth Street, N.W., Washington, D.C. 20001. Questions may be directed to the Contract Administrator, Fred M. Pohlmann at (202) 962-1529, FAX to (202) 962-6247.

In response to your Request For Technical Proposal for the above referenced Contract, the undersigned hereby proposes to furnish all labor, equipment and materials and perform all work to design and construct the Project in strict accordance with the Contract requirements for the consideration of the amount proposed on the Price Schedule under the Price Proposal. If awarded the Contract within the Proposal Acceptance Period, the undersigned agrees to execute the Design-Build Contract within 10 calendar days and to furnish, if required, performance and payment bonds on standard Authority forms with good and sufficient surety or sureties.

If the Contract is executed, the undersigned further agrees to commence the work within 10 calendar days after the receipt of Notice to Proceed and to complete the work within the time specified in the Contract.

The undersigned acknowledges receipt of the following amendments to the Request for Technical Proposal under RFP - FN5008/FMP (give number and date of each):

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Note: Failure to acknowledge receipt of all amendments may cause the Technical Proposal to be considered not responsive to the request, which would require rejection of the Technical Proposal as unacceptable.

00412 TECHNICAL PROPOSAL FORM (CONT.)

PROPOSER:

_____	By _____
Firm Name	
_____	_____
Address	Printed name
_____	_____
Zip Code	Title
_____	_____
Telephone	DUNS Number
_____	_____
Representative Authorized To Act on Proposer's Behalf	Alternate Authorized Representative

DIRECTIONS FOR SUBMITTING OFFER:

1. Read and comply with the Solicitation Instructions. This form is to be submitted with your Technical Proposal. The Price Proposal and Price Proposal Attachments shall be submitted separately from the Technical Proposal, and the Technical Proposal shall not contain any information relating to costs.
2. The Technical Proposal Form and related required documents must be sealed, marked, and addressed as follows:

WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY
PRMT FILE ROOM 3C-02
600 FIFTH STREET, N.W.
WASHINGTON, D.C. 20001

TECHNICAL OFFER UNDER FN5008/FMP

**TECHNICAL PROPOSALS SHALL BE TIMELY MAILED OR HAND DELIVERED TO REACH
WMATA BEFORE 2:00 p.m. (LOCAL TIME) ON DAY OF PROPOSAL CLOSING.**

00412 Technical Proposal Form
Page 2 of 2

00413 PRICE PROPOSAL FORM

DATE OF REQUEST: PHASE 2 - February 16, 2005

PROJECT: FN5008 METRO MATTERS: RAIL YARDS EXPANSION PROJECT, ALEXANDRIA
YARD OPTION

REQUEST FOR PRICE PROPOSAL containing information requested herein shall be submitted by the Proposer so as to be received before: **2:00 p.m.** on **April 8, 2005** at the Washington Metropolitan Area Transit Authority, Office of Procurement, PRMT FILE Room 3C-02, 600 Fifth Street, N.W., Washington, D.C. 20001. Questions may be directed to the Contract Administrator, Fred M. Pohlmann at (202) 962-1529, FAX to (202) 962-6247.

In response to your Request For Price Proposal for the above referenced Contract, the undersigned hereby proposes to furnish all labor, equipment and materials and perform all work to design and construct the Project in strict accordance with the Contract requirements for the consideration of the amount proposed on the Price Schedule. If awarded the Contract within the Proposal Acceptance Period, the undersigned agrees to execute the Design-Build Contract within 10 calendar days and to furnish, if required, performance and payment bonds on standard Authority forms with good and sufficient surety or sureties.

If the Contract is executed, the undersigned further agrees to commence the work within 10 calendar days after the receipt of Notice to Proceed and to complete the work within the time specified in the Contract.

The undersigned acknowledges receipt of the following amendments to the **Request for Price Proposal under FN5008/FMP** (give number and date of each):

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Amendment Number ____, dated _____.

Note: Failure to acknowledge receipt of all amendments may cause the Price Proposal to be considered not responsive to the request, which would require rejection of the Price Proposal as unacceptable.

00413 PRICE PROPOSAL FORM (CONT.)

PROPOSER:

_____	By _____
Firm Name	
_____	_____
Address	Printed name
_____	_____
Zip Code	Title
_____	_____
Telephone	DUNS Number
_____	_____
Representative Authorized To Act on Proposer's Behalf	Alternate Authorized Representative

DIRECTIONS FOR SUBMITTING OFFER:

1. Read and comply with the Solicitation Instructions. This form is to be submitted with your Price Proposal. The Price Proposal and Price Proposal Attachments shall be submitted separately from the Technical Proposal, and the Technical Proposal shall not contain any information relating to costs.
2. The Price Proposal Form and related required documents must be sealed, marked, and addressed as follows:

WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY
PRMT FILE ROOM 3C-02
600 FIFTH STREET, N.W.
WASHINGTON, D.C. 20001

PRICE OFFER UNDER FN5008/FMP

**PRICE PROPOSALS SHALL BE TIMELY MAILED OR HAND DELIVERED TO REACH WMATA
BEFORE 2:00 p.m. (LOCAL TIME) ON DAY OF PROPOSAL CLOSING.**

00413 Price Proposal Form
Page 2 of 2

00430 PROCUREMENT FORM SUPPLEMENTS

This Section includes the Supplementary Proposal Forms that are required to be submitted with either the Technical Proposal or with the Price Proposal.

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00432 COMPLIANCE / EXCEPTION INFORMATION - **Submit with Technical Proposal**

Indicate whether the proposal submitted is intended to fully comply with the Requirements of this Request for Proposals, or if certain exceptions are taken. If exceptions are taken, the proposer shall clearly identify any exception to the requirements, terms, or conditions of any part of this RFP. Each exception must be specifically related to the particular part of the RFP to which the exception is taken. The proposer must support and explain the reason for any exceptions taken and explain the impact, if any, on the RFP requirements and state the necessity for or advantage of the exception.

Check one statement below. If exceptions are taken, explain the exceptions per the following instructions.

- The proposer certifies that its proposal is intended to comply fully with all Requirements.
- The proposer certifies that its proposal is intended to comply fully with all Requirements, except as noted (add additional sheets to explain).

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00434 PRICE SCHEDULE - Submit with Price Proposal

A. DESCRIPTION OF WORK:

The Design-Builder shall Design and Build the Facilities satisfactorily completed for its intended use in the manner and at the locations set forth in the Requirements of the Project Manual and the Project Drawings of this solicitation, and in accordance with the Technical and Price Proposals as finally accepted by the Authority. The Design-Builder shall design the facility pursuant to the Authority's Design Criteria, and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities, and shall construct the facility in strict accordance with the Final Design Specifications and Final Design Drawings and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities.

Schedule F: ALEXANDRIA YARD OPTION

Item	Description	Unit	Amount
1	Sitework		
1-A	Demolition	LS	\$ _____
1-B	Earthwork	LS	\$ _____
1-C	Paving and Surfacing	LS	\$ _____
1-D	Piped Utilities	LS	\$ _____
1-E	Site Improvements	LS	\$ _____
1-F	Yard Electrical Work	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration		
2-A	Demolition and Earthworks	LS	\$ _____
2-B	Concrete and Masonry	LS	\$ _____
2-C	Metals	LS	\$ _____
2-D	Thermal and Moisture Protection	LS	\$ _____
2-E	Interior Construction and Finishes	LS	\$ _____
2-F	Conveying Systems	LS	\$ _____
2-G	Mechanical	LS	\$ _____

Item	Description	Unit	Amount
2-H	Electrical	LS	\$ _____
2-I	Building Communication and Electrical Specialties	LS	\$ _____
3	Major Shop Equipment (Drwg. E11a-A-06, Sections 1003 - 1009, 1012 - 1021, 1024, 1044-1046, 1048)	LS	\$ _____
4	Environmental Mitigation	LS	\$ _____
5	Systems	LS	\$ _____
5-A	Trackwork	LS	\$ _____
5-B	Traction Power	LS	\$ _____
5-C	Automatic Train Control	LS	\$ _____
5-D	Train Control Communications	LS	\$ _____
6	Design for Items 1 thru 5	LS	\$ _____
7	Project General Conditions	LS	\$ _____

SUBTOTAL Schedule F \$ 31,894,000

Schedule G: MISCELLANEOUS ALLOWANCES FOR ALEXANDRIA YARD OPTION

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ <u>20,000</u>
2	Disputes Review Board (Section 01260)	LS	\$ <u>86,000</u>
3	Minor Shop Equipment (Greenbelt Yard Only)	LS	\$ <u>1,500,000</u>
4	Spare Parts (Section 01780 1.07)	LS	\$ <u>500,000</u>

TOTAL Schedules F & G \$ 34,000,000

NOTES TO PROPOSERS:

1. The Contract(s) will be awarded to responsible contractor(s) on the basis of the proposal that provides the overall best value to the Authority in terms of design solutions, innovativeness, and technical factors based on an integrated assessment within the stated target price as shown in the Price Schedule for each Project. Multiple contracts will be awarded, however, it is required that proposals be submitted for both Projects and all items, therefore failure to submit an offer on all items may result in rejection of the proposal.
2. Unless otherwise specified, each LUMP SUM priced line item includes all labor, material, equipment, and other incidentals, ready for its intended use including, but not limited to, furnishing, installation and testing. The successful Offeror will be required to provide a detailed breakdown to the Authority Representative of all LUMP SUM items for payment purposes.
3. Schedule G of the Price Schedule is for items where a specific allowance is set-aside by the Authority for payment. This is an estimated amount subject to negotiation and is not guaranteed.

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CONTRACTING REQUIREMENTS

00800 SUPPLEMENTARY CONDITIONS

This Section includes Modifications to the Section 00700 General Conditions for requirements unique to a specific project and are hereby incorporated into the General Conditions by reference to. This Section 00800, which specifies any modifications to the General Conditions, shall be read in conjunction with Section 00700 and which will be cited in the 00700 Section using the same last 2 digits of the Section number; i.e., a mod to Section 00724 is indicated as Section 00824.

00811 WORK BY DESIGN-BUILDER PERCENTAGE REQUIREMENTS

Modify General Conditions Section 00711, WORK BY DESIGN-BUILDER to delete Paragraph A. and substitute the following Paragraph:

- A. The Design-Builder shall perform, with its own organization, work equivalent to at least 15% for the construction work.

00825 PERIOD OF PERFORMANCE AND PROJECT SCHEDULE REQUIREMENTS

Modify General Conditions Section 00725, PERIOD OF PERFORMANCE AND PROJECT SCHEDULE to delete Paragraph A. and substitute the following Paragraph and subparagraphs:

- A. The Design-Builder shall perform, complete and advance all Work under this Contract in accordance with the following:
1. Interim Completion(s)
 - a. None.
 2. Final Completion after Option Exercise
 - a. Alexandria Yard Option NTP+ 720 calendar days
 3. See Section 00888 LIQUIDATED DAMAGES for Liquidated Damages associated with the Milestone(s) listed above.

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APPENDIX D TO SECTION 00800 WAGE DETERMINATION RATES

APPENDIX D

WAGE RATES

CONTRACT NUMBER FN5008

All on-site work to be performed at the **HEAVY** Rates.

NOTICE: In accordance with 29 CFR, Part 1, the contractor will be required to pay wages which are not less than those established by the final Wage Determination Decision contained in the solicitation.

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General Decision Number: VA030092 01/21/2005 VA92

Superseded General Decision Number: VA020092

State: Virginia

Construction Type: Heavy

County: Alexandria* County in Virginia.

*INDEPENDENT CITY OF ALEXANDRIA

HEAVY CONSTRUCTION PROJECTS (Excluding Sewer and Water Lines)

Modification Number	Publication Date
0	06/13/2003
1	04/02/2004
2	05/14/2004
3	06/18/2004
4	06/25/2004
5	07/02/2004
6	07/16/2004
7	09/17/2004
8	09/24/2004
9	10/15/2004
10	10/29/2004
11	11/12/2004
12	01/21/2005

ASBE0024-001 10/01/2004

Rates Fringes

Asbestos Worker/Heat and
Frost Insulator

Includes application of
all insulating materials,
protective coverings,
coatings and finishes to
all types of mechanical
systems. Also the
application of
firestopping material for
wall openings and
penetrations in walls,

floors, ceilings and curtain walls.....	\$ 25.00	11.41
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 ASBE0024-002 03/01/2004

	Rates	Fringes
Hazardous Material Handler Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials, whether they contain asbestos or not,from mechanical systems.....	\$ 12.43	4.59

 * BOIL0193-001 10/01/2004

	Rates	Fringes
Boilermaker.....	\$ 32.17	14.29

 * BRDC0001-001 11/01/2004

	Rates	Fringes
Bricklayer.....	\$ 25.00	5.77

 CARP0132-001 05/01/2004

	Rates	Fringes
Carpenter/Lather.....	\$ 22.50	4.83
Piledriver.....	\$ 20.85	5.50

 CARP0132-003 05/01/2004

	Rates	Fringes
Diver Tender.....	\$ 20.85	5.50
Diver.....	\$ 29.63	5.50

 CARP1831-001 04/01/2003

	Rates	Fringes
Millwright.....	\$ 24.34	4.05

* ELEC0026-001 11/01/2004

	Rates	Fringes
Electrician.....	\$ 29.85	9.57+3%+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King Jr.'s Birthday, Inauguration Day, Memorial Day, Fourth of July, Labor Day, Veterans Day, Thanksgiving Day, the day after Thanksgiving and Christmas Day or days designated as legal holidays by the Federal Government.

ELEC0070-001 03/31/2002

	Rates	Fringes
Line Construction:		
Groundmen.....	\$ 14.00	2.45+17.5%
Linemen, Cable Splicers, Equipment Operators.....	\$ 24.48	2.45+17.5%
Truck with winch.....	\$ 14.00	2.45+17.5%

ENGI0077-007 05/01/2004

	Rates	Fringes
Power equipment operators:		
GROUP 1.....	\$ 24.74	5.62+a+b
GROUP 2.....	\$ 24.28	5.62+a+b
GROUP 3.....	\$ 23.57	5.62+a
GROUP 4.....	\$ 21.54	5.62+a
GROUP 5.....	\$ 17.00	5.62+a
GROUP 6.....	\$ 26.11	5.62+a

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: 35 ton cranes & above, tower & climbing cranes, derricks, concrete boom pump, drill rigs (equivalent to L & Double L), mole.

GROUP 2: Backhoes, cableways, cranes, cherry pickers, elevating graders, hoists, paving mixers, power shovels, tunnel shovels,

batch plants, shields, tunnel mining machines
 gradalls, front end loaders, 3 1/2 cu. yds. and above, power
 driven wheel scoops and scrapers (50 cu. yds. struck
 capacity or above), rail tamper, draglines, boomcat,
 mucking machines, graders in tunnels, pile driving engines.
 GROUP 3: Front end loaders below 3 1/2 cu. yds, boom trucks,
 hydraulic backhoes 1/2 yds. capacity or below rubber or
 track mounted, tug boats, power driven wheel scoops and
 scrapers, blade graders, motor graders, bulldozers,
 trenching machines, concrete mixer, speed swing pettibone,
 ballast regulator, concrete pump, mechanic, welder,
 mechanic welder, shotcrete machines, Hoeram, locomotive
 (standard, narrow gauge), tuggers.
 GROUP 4: High lifts above 10 feet, boilers skelton), asphalt
 spreaders, bullfloat finishing machines, concrete
 finishing machines, concrete spreaders, fine graders, air
 compressors, welding machines, pumps, generators, well
 points, deep wells, hydraulic pumps, elevators, freeze
 units, tunnel motorman or dinky operator, roller,
 conveyors, well drilling machines, grout pump, fireman.
 GROUP 5: Fork lifts, ditch witch, bobcat 1/3 cu. yd. and
 below, space heaters, sweepers, assistant engineers, oilers.
 GROUP 6: Master mechanic.

a. PAID HOLIDAYS: New Year's Day, Inaugural Day, Decoration
 Day, Independence Day, Labor Day, Martin Luther King's
 Birthday, Veterans' Day, Thanksgiving Day, Friday after
 Thanksgiving and Christmas Day.

b. PREMIUM PAY: Tower cranes and cranes 100-ton and over to
 receive \$1.00 per hour premium over Group One.

 IRON0005-001 06/01/2003

	Rates	Fringes
Ironworkers:		
Structural, Ornamental and Chain Link Fence.....	\$ 24.00	8.975

 * IRON0201-001 05/01/2004

	Rates	Fringes
Ironworkers:		
Reinforcing.....	\$ 23.45	9.73

LABO0074-002 06/01/2004

	Rates	Fringes
Laborers: (HAZARDOUS WASTE REMOVAL, (EXCEPT ON MECHANICAL SYSTEMS): Preparation for, removing & encapsulation of hazardous materials from non-mechanical systems)		
Skilled Asbestos Abatement Laborers.....	\$ 15.39	3.30
Skilled Toxic and Hazardous Waste Removal Laborers.....	\$ 18.17	3.30

LABO0456-003 06/01/2004

	Rates	Fringes
Laborers: (TUNNEL, RAISE & SHAFT (FREE AIR) (FOR HEAVY AND SEWER & WATER LINES CONSTRUCTION)		
GROUP 1.....	\$ 18.93	3.30
GROUP 2.....	\$ 19.46	3.30
GROUP 3.....	\$ 20.84	3.30
GROUP 4.....	\$ 21.39	3.30

LABORERS CLASSIFICATIONS

GROUP 1: Brakeman, Bull Gang, Dumper, Trackman, Concrete Man.

GROUP 2: Chuck Tender, Powdermen in Prime House, Form Setters and Movers, Nippers, Cableman, Houseman, Groutman, Bell or Signman, Top or Bottom Vibrator Operator.

GROUP 3: Miners, Re-Bar Underground, Concrete or Gunnite Nozzlemen, Powdermen, Timbermen and Re-Timbermen, Wood Steel Including Liner Plate or any Other Support, Material, Motorman, Caulkers, Diamond Drill Operators, Riggers, Cement Finishers - Underground, Welders and Burners, Shield Driver, Air Trac Operator, Shotcrete Nozzleman and Potman.

GROUP 4: Mucking Machine Operator (Air).

LABO0456-005 06/01/2004

	Rates	Fringes
Laborers: (TUNNEL, RAISE AND SHAFT (Compressed Air) for HEAVY CONSTRUCTION ONLY		

Gauge Pressure (Pounds)	Work Period (Hours)		
1-14	7.....	\$ 22.97	3.30
14-18	6.....	\$ 27.02	3.30

FOOTNOTE: On any requirement for air pressure in excess of 18 PSI, work periods and rates should be negotiated at a pre-bid conference.

LABO0456-010 06/01/2004

	Rates	Fringes
Laborers:		
GROUP 1.....	\$ 18.34	3.30
GROUP 2.....	\$ 18.60	3.30
GROUP 3.....	\$ 18.73	3.30
GROUP 4.....	\$ 19.21	2.95
GROUP 5.....	\$ 19.58	2.95
GROUP 6.....	\$ 20.04	2.95
GROUP 7.....	\$ 20.26	2.95
GROUP 8.....	\$ 21.07	2.95

LABORERS CLASSIFICATIONS

GROUP 1: Carloaders, choker setter, concrete crewman, crushed feeder, demolition laborers, including salvaging all material, loading, cleaning up, wrecking, dumpmen, flagmen, fence erector and installer, including installation and erection of fence, guard rails, median rails, reference posts, guide posts and right-of-way markers, form strippers, general laborers, railroad track laborers, riprap man, scale man, stake jumper, structure mover, includes foundation, separation, preparation, cribbing, shoring, jacking and unloading of structures, water nozzleman, timber bucker and faller, truck loader,

water boys, tool room men.

GROUP 2: Combined air and water nozzleman, cement handler, dope pot fireman (nonmechanical), form cleaning machine, mechanical railroad equipment (includes spiker, puller, tie cleaner, tamper, pipe wrapper, power driven wheelbarrows, operators of hand derricks, towmasters, scootcretes, buggymobiles and similar equipment), tamper or rammer operator, trestle scaffold builders over one tier high, power tool operator (gas, electric or pneumatic), sandblast or gunnite tailhose man, scaffold erector, (steel or wood), vibrator operator up to 4 feet) asphalt cutter, mortar men, shorer and lagger, creosote material handler, corrosive enamel or equl, paver breaker and jackhammer operators.

GROUP 3: Multi-section pipe layer, non-metallic clay and concrete pipe layer including caulker, collarman, jointer, rigger and jacker, thermit welder and corrugated metal culvert pipe layer.

GROUP 4: Asphalt block pneumatic cutter, asphalt roller, walker chainsaw operator with attachment, concrete saw (walking), high scalers, jackhammer operator (using over 6 feet of steel), vibrator operator (6 feet and over), well point installer, air trac operator.

GROUP 5: Asphalt screeder, big drills, cut of the hole drills, (1 1/2" piston or larger), down the hole drills (3 1/2" piston or larger), gunnite or sandblaster nozzleman, asphalt raker, asphalt tamper, form setter, demolition torch operator, shotcrete nozzlelemen and potman.

GROUP 6: Powderman, master form setters.

GROUP 7: Brick paver (asphalt block paver, asphalt block sawman, asphalt block grinder; hastings block or similar type)

GROUP 8: Licensed powdermen.

 MARB0002-003 05/01/2004

	Rates	Fringes
Marble & Stone Mason Includes Pointing, Caulking and Cleaning of All types of Masonry, Brick, Stone and Cement Structures.....	\$ 27.47	10.05

 PAIN0051-001 06/01/2004

	Rates	Fringes
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Painters:

All Industrial Work.....	\$ 22.43	6.86
Bridges, Heavy Highway, Lead Abatement and Flame/Thermal Spray.....	\$ 24.32	6.86
Commercial and Mold Remediation, Painters, Drywall Finishers and Wallcoverers.....	\$ 21.01	6.86
Metal Polishing and Refinishing.....	\$ 22.01	6.86

 PLAS0891-003 05/01/2004

	Rates	Fringes
Cement Mason.....	\$ 23.73	4.945

 PLUM0005-002 08/01/2004

	Rates	Fringes
Plumber.....	\$ 29.52	10.89+a

a. PAID HOLIDAYS: Labor Day, Veterans' Day, Thanksgiving Day and the day after Thanksgiving, Christmas Day, New Year's Day, Martin Luther King's Birthday, Memorial Day and the Fourth of July.

 PLUM0602-005 09/01/2004

	Rates	Fringes
Steamfitter, Refrigeration & Air Conditioning Mechanic.....	\$ 29.17	11.22+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King's Birthday, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day and the day after Thanksgiving and Christmas Day.

 SHEE0100-001 07/01/2004

	Rates	Fringes
Sheet Metal Worker.....	\$ 28.43	9.76

TEAM0639-001 03/07/2002

	Rates	Fringes
Truck drivers: (HEAVY & HIGHWAY CONSTRUCTION) Tandem & Triaxle (3 or more axles, including steering axle).....	\$ 15.00	5.02+a
Tractor-trailer, Low-boy....	\$ 18.00	5.02+a

a. VACATION: Employees will receive one (1) week's paid vacation after one (1) year of service.

TEAM0639-002 04/01/2002

	Rates	Fringes
Truck drivers: (HEAVY & HIGHWAY CONSTRUCTION) Concrete Mixer Drivers.....	\$ 15.95	5.07+a+b

a. PAID HOLIDAYS: New Year's Day, Martin Luther King, Jr. Day, Memorial Day, July 4th, Labor Day, Thanksgiving Day, Christmas Day, or any day celebrated publicly in the District of Columbia as one of the above holidays.

b. PAID VACATIONS: Employees with one (1) year of service shall be entitled to a vacation of one (1) week; five (3) years of service are entitled to two (2) weeks; fifteen (10) years of service are entitled to three (3) weeks; twenty (20) years of service are entitled to four (4) weeks.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

In the listing above, the "SU" designation means that rates listed under the identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be

prevailing.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations

Wage and Hour Division

U.S. Department of Labor

200 Constitution Avenue, N.W.

Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

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General Decision Number: DC030001 01/21/2005 DC1

Superseded General Decision Number: DC020001

State: District of Columbia

Construction Types: Heavy (Heavy, and Sewer and Water Line)
and Highway

County: District of Columbia Statewide.

HEAVY CONSTRUCTION PROJECTS (Including Sewer and Water Lines);
HIGHWAY CONSTRUCTION PROJECTS

Modification Number Publication Date

0	06/13/2003
1	10/03/2003
2	10/31/2003
3	01/02/2004
4	03/19/2004
5	04/02/2004
6	05/14/2004
7	06/11/2004
8	06/18/2004
9	06/25/2004
10	07/02/2004
11	07/09/2004
12	07/16/2004
13	08/13/2004
14	08/20/2004
15	09/17/2004
16	09/24/2004
17	10/29/2004
18	11/12/2004
19	01/21/2005

ASBE0024-001 10/01/2004

Rates Fringes

Asbestos Worker/Heat and
Frost Insulator

Includes application of
all insulating materials,
protective coverings,

coatings and finishes to
 all types of mechanical
 systems. Also the
 application of
 firestopping material for
 wall openings and
 penetrations in walls,
 floors, ceilings and
 curtain walls..... \$ 25.00 11.41

 ASBE0024-002 03/01/2004

	Rates	Fringes
Hazardous Material Handler Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials, whether they contain asbestos or not, from mechanical systems.....	\$ 12.43	4.59

 BOIL0193-001 10/01/2004

	Rates	Fringes
Boilermaker.....	\$ 32.17	14.29

 * BRDC0001-001 11/01/2004

	Rates	Fringes
Bricklayer.....	\$ 25.00	5.77

 CARP0132-001 05/01/2004

	Rates	Fringes
Carpenter/Lather.....	\$ 22.50	4.83
Piledriver.....	\$ 20.85	5.50

 CARP0132-003 05/01/2004

	Rates	Fringes
Diver Tender.....	\$ 20.85	5.50
Diver.....	\$ 29.63	5.50

 CARP1831-001 04/01/2003

	Rates	Fringes
Millwright.....	\$ 24.34	4.05

 ELEC0026-001 11/01/2004

	Rates	Fringes
Electrician.....	\$ 29.85	9.57+3%+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King Jr.'s Birthday, Inauguration Day, Memorial Day, Fourth of July, Labor Day, Veterans Day, Thanksgiving Day, the day after Thanksgiving and Christmas Day or days designated as legal holidays by the Federal Government.

 ELEC0026-008 07/01/2003

	Rates	Fringes
Motor Repairmen Removal and reinstallation of electrical motors.....	\$ 23.69	7.73+3%+a

a. PAID HOLIDAYS:
 New Year's Day, Martin Luther King Jr.'s Birthday, Inauguration Day, Memorial Day, Fourth of July, Labor Day, Veterans Day, Thanksgiving Day, the day after Thanksgiving and Christmas Day or days designated as legal holidays by the Federal Government.

 ELEC0070-001 03/31/2002

	Rates	Fringes
Line Construction: Groundmen.....	\$ 14.00	2.45+17.5%
Linemen, Cable Splicers, Equipment Operators.....	\$ 24.48	2.45+17.5%

Truck with winch..... \$ 14.00 2.45+17.5%

 ENGI0077-001 05/01/2004

Rates Fringes

Power equipment operators:
 (HEAVY AND HIGHWAY
 CONSTRUCTION)

GROUP 1.....	\$ 24.74	5.62+a+b
GROUP 2.....	\$ 24.28	5.62+a+b
GROUP 3.....	\$ 23.57	5.62+a
GROUP 4.....	\$ 21.54	5.62+a
GROUP 5.....	\$ 17.00	5.62+a
GROUP 6.....	\$ 26.11	5.62+a

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: 35 ton cranes & above, tower & climbing cranes, derricks, concrete boom pump, drill rigs (equivalent to L & Double L), mole.

GROUP 2: Backhoes, cableways, cranes, cherry pickers, elevating graders, hoists, paving mixers, power shovels, tunnel shovels, batch plants, shields, tunnel mining machines, gradalls, front end loaders, 3 1/2 cu. yds. and above, power driven wheel scoops and scrapers (50 cu. yds. struck capacity or above), rail tamper, draglines, boomcat, mucking machines, graders in tunnels, pile driving engines.

GROUP 3: Front end loaders below 3 1/2 cu. yds, boom trucks, hydraulic backhoes 1/2 yds. capacity or below rubber or track mounted, tug boats, power driven wheel scoops & scrapers, blade graders, motor graders, bulldozers, trenching machines, concrete mixer, speed swing pettibone, ballast regulator, concrete pump, mechanic, welder, mechanic welder, shotcrete machines, Hoeram, locomotive (standard, narrow gauge), tuggers.

GROUP 4: High lifts above 10 feet, boilers (skelton), asphalt spreaders, bullfloat finishing machines, concrete finishing machines, concrete spreaders, fine graders, air compressors, welding machines, pumps, generators, well points, deep wells, hydraulic pumps, elevators, freeze uniits, tunnel motorman or dinky operator, roller,

conveyors, well drilling machines, grout pump, fireman.

GROUP 5: Fork lifts, ditch witch, bobcat 1/3 cu. yd. and below, space heaters, sweepers, assistant engineers, oilers.

GROUP 6: Master mechanic.

a. PAID HOLIDAYS: New Years Day, Inaugural Day, Decoration Day, Independence Day, Labor Day, Martin Luther King's Birthday, Veterans' Day, Thanksgiving Day, Friday after Thanksgiving and Christmas Day.

b. PREMIUM PAY: Tower cranes and cranes 100-ton and over to receive \$1.00 per hour premium over Group One.

ENGI0077-002 06/01/2004

	Rates	Fringes
Power equipment operators: (PAVING AND INCIDENTAL GRADING)		
GROUP 1.....	\$ 20.05	4.75
GROUP 2.....	\$ 18.00	4.75
GROUP 3.....	\$ 17.00	4.75
GROUP 4.....	\$ 16.00	4.75
GROUP 5.....	\$ 14.35	4.75
GROUP 6.....	\$ 20.05	4.55

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

- GROUP 1: Gradall operator, Crane.
- GROUP 2: Boom Truck, Milling Machine, Excavator, Rubber Tire Backhoe, Asphalt Paver, Asphalt Plant Engineer.
- GROUP 3: Motor Grader, Track Loader, Rubber Tire Loader, Track Dozer, Concrete Paver.
- GROUP 4: Broom Truck, Asphalt Roller.
- GROUP 5: Air Compressor, Grade Rollers.
- GROUP 6: Mechanic.

ENGI0077-003 07/12/2004

	Rates	Fringes
Power equipment operators: (SEWER, GAS AND WATER LINE CONSTRUCTION)		

GROUP 1.....	\$ 18.68	4.12+a
GROUP 2.....	\$ 18.28	4.12+a
GROUP 3.....	\$ 18.13	4.12+a
GROUP 4.....	\$ 18.05	4.12+a
GROUP 5.....	\$ 17.94	4.12+a
GROUP 6.....	\$ 17.77	4.12+a
GROUP 7.....	\$ 17.87	4.12+a
GROUP 8.....	\$ 17.77	4.12+a
GROUP 9.....	\$ 18.31	4.12+a
GROUP 10.....	\$ 17.66	4.12+a
GROUP 11.....	\$ 17.54	4.12+a
GROUP 12.....	\$ 17.45	4.12+a

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: Backhoes, Cableways, Cranes, Derricks, Draglines, Power Shovels, Tunnel Shovels, Tunnel Mucking Machines (1 cubic yard capacity or above).

GROUP 2: Backhoes, Boom Cats, Cableways, Cranes, Derricks, Draglines, Elevating Graders, Hoists, Paving Mixers, Pile Driving Engines, Power and Tunnel Shovels, Tunnel Mucking Machines, Batch Plant, Concrete Pumps.

GROUP 3: Operators of Hydraulic Backhoes of below 1/2 yard capacity.

GROUP 4: Trenching machines above 83 inches.

GROUP 5: Trenching machines (up to & including 83"), Boilers (Skelton), Well Drilling Machines.

GROUP 6: Air Compressors (Tunnel).

GROUP 7: Front-end Loaders (Hi-Lift) and Bulldozers on Sewer and Water Line Work.

GROUP 8: Concrete Mixers, Power Driven Wheel Scoops and Scrapers, Blade graders, Motor Graders, Tunnel Mechanics, Tunnel Motormen.

GROUP 9: Mechanics.

GROUP 10: Bulldozers, Hydraulic Tamper and Hoe Pack Operators.

GROUP 11: Rollers.

GROUP 12: Air Compressors, Pumps, Welding Machines, Well Points.

a.PAID HOLIDAYS: New Year's Day, Inaugural Day, Washington's Birthday, Decoration Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Christmas Day and Martin Luther King's Birthday.

IRON0005-001 06/01/2003

	Rates	Fringes
Ironworkers: Structural, Ornamental and Chain Link Fence.....	\$ 24.00	8.975

* IRON0201-001 05/01/2004

	Rates	Fringes
Ironworkers: Reinforcing.....	\$ 23.45	9.73

LABO0074-002 06/01/2004

	Rates	Fringes
Laborers: (HAZARDOUS WASTE REMOVAL, (EXCEPT ON MECHANICAL SYSTEMS): Preparation for, removing & encapsulation of hazardous materials from non-mechanical systems) Skilled Asbestos Abatement Laborers.....	\$ 15.39	3.30
Skilled Toxic and Hazardous Waste Removal Laborers.....	\$ 18.17	3.30

LABO0456-002 06/01/2004

	Rates	Fringes
Laborers: (PAVING & INCIDENTAL GRADING)		

**Washington Metropolitan Area Transit Authority
Design-Build Contract RFP-FN5008/FMP**

**Contract No. FN5008
Date: February 17, 2005**

Asphalt Raker, Concrete		
Saw Operator.....	\$ 15.66	4.00
Asphalt Shoveler.....	\$ 15.17	4.00
Asphalt Tammer, Concrete		
Shoveler.....	\$ 15.39	4.00
Jack Hammer.....	\$ 15.57	4.00
Laborer.....	\$ 15.06	4.00
Sand Setter, Form Setter....	\$ 16.24	4.00

LABO0456-003 06/01/2004

	Rates	Fringes
Laborers: (TUNNEL, RAISE & SHAFT (FREE AIR) (FOR HEAVY AND SEWER & WATER LINES CONSTRUCTION)		
GROUP 1.....	\$ 18.93	3.30
GROUP 2.....	\$ 19.46	3.30
GROUP 3.....	\$ 20.84	3.30
GROUP 4.....	\$ 21.39	3.30

LABORERS CLASSIFICATIONS

GROUP 1: Brakeman, Bull Gang, Dumper, Trackman, Concrete Man.

GROUP 2: Chuck Tender, Powdermen in Prime House, Form Setters and Movers, Nippers, Cableman, Houseman, Groutman, Bell or Signalman, Top or Bottom Vibrator Operator.

GROUP 3: Miners, Re-Bar Underground, Concrete or Gunnite Nozzlemen, Powdermen, Timbermen and Re-Timbermen, Wood Steel Including Liner Plate or any Other Support, Material, Motorman, Caulkers, Diamond Drill Operators, Riggers, Cement Finishers - Underground, Welders and Burners, Shield Driver, Air Trac Operator, Shotcrete Nozzleman and Potman.

GROUP 4: Mucking Machine Operator (Air).

LABO0456-004 06/01/2004

	Rates	Fringes
Laborers: (HEAVY AND HIGHWAY AND SEWER & WATER LINES CONSTRUCTION)		

GROUP 1.....	\$ 18.34	3.30
GROUP 2.....	\$ 18.60	3.30
GROUP 3.....	\$ 18.73	3.30
GROUP 4.....	\$ 18.86	3.30
GROUP 5.....	\$ 19.23	3.30
GROUP 6.....	\$ 19.69	3.30
GROUP 7.....	\$ 19.91	3.30
GROUP 8.....	\$ 20.72	3.30

LABORERS CLASSIFICATIONS

GROUP 1: Carloaders, choker setter, concrete crewman, crushed feeder, demolition laborers, including salvaging all material, loading, cleaning up, wrecking, dumpmen, flagmen, fence erector and installer, including installation and erection of fence, guard rails, median rails, reference posts, guide posts and right-of-way markers, form strippers, general laborers, railroad track laborers, riprap man, scale man, stake jumper, structure mover, includes foundation, separation, preparation, cribbing, shoring, jacking and unloading of structures, water nozzleman, timber bucket and faller, truck loader, water boys, tool room men.

GROUP 2: Combined air and water nozzleman, cement handler, dope pot fireman (nonmechanical), form cleaning machine, mechanical railroad equipment (includes spiker, puller, tie cleaner, tamper, pipe wrapper, power driven wheelbarrows, operators of hand derricks, towmasters, scootcretes, buggymobiles and similar equipment), tamper or rammer operator, trestle scaffold builders over one tier high, power tool operator (gas, electric or pneumatic), sandblast or gunnite tailhose man, scaffold erector, (steel or wood), vibrator operator up to 4 feet) asphalt cutter, mortar men, shorer and lagger, creosote material handler, corrosive enamel or equl, paver breaker and jackhammer operators.

GROUP 3: Multi-section pipe layer, non-metallic clay and concrete pipe layer (including caulker, collarman, jointer, rigger and jacker, thermit welder and corrugated metal culvert pipe layer.

GROUP 4: Asphalt block pneumatic cutter, asphalt roller, walker chainsaw operator with attachment, concrete saw (walking), high scalers, jackhammer operator (using over 6 feet of steel), vibrator operator (6 feet and over), well

point installer, air trac operator.

GROUP 5: Asphalt screeder, big drills, cut of the hole drills, (1 1/2" piston or larger), down the hole drills (3 1/2" piston or larger),gunnite or sandblaster nozzleman, asphalt raker, asphalt tamper, form setter, demolition torch operator, shotcrete nozzle men and potman.

GROUP 6: Powderman, master form setters.

GROUP 7: Brick paver (asphalt block paver, asphalt block sawman, asphalt block grinder; hastings block or similar type)

GROUP 8: Licensed powdermen.

 LABO0456-005 06/01/2004

Rates Fringes

Laborers: (TUNNEL, RAISE AND SHAFT (Compressed Air) for HEAVY CONSTRUCTION ONLY

Gauge Pressure (Pounds)	Work Period (Hours)		
1-14	7.....	\$ 22.97	3.30
14-18	6.....	\$ 27.02	3.30

FOOTNOTE: On any requirement for air pressure in excess of 18 PSI, work periods and rates should be negotiated at a pre-bid conference.

 LABO0456-006 06/01/2004

Rates Fringes

Laborers: (BRICK MASONRY WORK)			
Mason Tenders.....	\$ 13.95		3.30
Scaffold Builders, Mortarmen and Small Equipment Operators.....			
	\$ 14.65		3.30

 MARB0002-003 05/01/2004

Rates Fringes

Marble & Stone Mason
Includes Pointing,
Caulking and Cleaning of
All types of Masonry,
Brick, Stone and Cement
Structures.....\$ 27.47 10.05

MARB0003-001 05/01/2004

	Rates	Fringes
Mosaic & Terrazzo Worker, Tile Layer.....\$ 22.07		8.18

MARB0003-004 05/01/2004

	Rates	Fringes
Marble, Tile & Terrazzo Finisher.....\$ 17.87		7.32

PAIN0051-001 06/01/2004

	Rates	Fringes
Painters: All Industrial Work.....\$ 22.43		6.86
Bridges, Heavy Highway, Lead Abatement and Flame/Thermal Spray.....\$ 24.32		6.86
Commercial and Mold Remediation, Painters, Drywall Finishers and Wallcoverers.....\$ 21.01		6.86
Metal Polishing and Refinishing.....\$ 22.01		6.86

PLAS0891-001 05/01/2004

	Rates	Fringes
Cement Masons: HEAVY CONSTRUCTION ONLY.....\$ 23.73		4.945

PLAS0891-002 06/01/2004

	Rates	Fringes
Cement Masons: (PAVING & INCIDENTAL GRADING)		
Cement Masons.....	\$ 16.25	4.10
Concrete Saw Operators.....	\$ 16.25	4.10
Form Setters.....	\$ 16.25	4.10

PLUM0005-001 08/01/2004

	Rates	Fringes
Plumber.....	\$ 29.52	10.89+a

a. PAID HOLIDAYS: Labor Day, Veterans' Day, Thanksgiving Day and the day after Thanksgiving, Christmas Day, New Year's Day, Martin Luther King's Birthday, Memorial Day and the Fourth of July.

PLUM0602-005 09/01/2004

	Rates	Fringes
Steamfitter, Refrigeration & Air Conditioning Mechanic.....	\$ 29.17	11.22+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King's Birthday, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day and the day after Thanksgiving and Christmas Day.

SHEE0100-001 07/01/2004

	Rates	Fringes
Sheet Metal Worker.....	\$ 28.43	9.76

TEAM0639-001 03/07/2002

	Rates	Fringes
Truck drivers: (HEAVY & HIGHWAY CONSTRUCTION)		
Tandem & Triaxle (3 or more axles, including steering axle).....	\$ 15.00	5.02+a

Tractor-trailer, Low-boy....\$ 18.00 5.02+a

a. VACATION: Employees will receive one (1) week's paid vacation after one (1) year of service.

TEAM0639-002 04/01/2002

	Rates	Fringes
Truck drivers: (HEAVY & HIGHWAY CONSTRUCTION) Concrete Mixer Drivers.....	\$ 15.95	5.07+a+b

a. PAID HOLIDAYS: New Year's Day, Martin Luther King, Jr. Day, Memorial Day, July 4th, Labor Day, Thanksgiving Day, Christmas Day, or any day celebrated publicly in the District of Columbia as one of the above holidays.

b. PAID VACATIONS: Employees with one (1) year of service shall be entitled to a vacation of one (1) week; five (3) years of service are entitled to two (2) weeks; fifteen (10) years of service are entitled to three (3) weeks; twenty (20) years of service are entitled to four (4) weeks.

TEAM0639-005 09/01/2004

	Rates	Fringes
Truck drivers: (PAVING & INCIDENTAL GRADING) All paving projects where the grading is incidental to the paving.....	\$ 13.50	3.39

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.
=====

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

In the listing above, the "SU" designation means that rates listed under the identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations

Wage and Hour Division

U.S. Department of Labor

200 Constitution Avenue, N.W.

Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator

U.S. Department of Labor

200 Constitution Avenue, N.W.

Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board

U.S. Department of Labor

200 Constitution Avenue, N.W.

Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

THIS PAGE NOT USED

General Decision Number: MD030048 01/21/2005 MD48

Superseded General Decision Number: MD020048

State: Maryland

Construction Types: Heavy (Heavy, and Sewer and Water Line)

Counties: Montgomery and Prince George's Counties in Maryland.

**HEAVY CONSTRUCTION PROJECTS; SEWER AND WATER LINE CONSTRUCTION
PROJECTS (Montgomery County, Maryland ONLY)**

Modification Number	Publication Date
0	06/13/2003
1	02/27/2004
2	04/02/2004
3	05/14/2004
4	06/18/2004
5	06/25/2004
6	07/02/2004
7	07/09/2004
8	07/16/2004
9	08/20/2004
10	09/17/2004
11	09/24/2004
12	10/15/2004
13	10/29/2004
14	11/12/2004
15	01/21/2005

ASBE0024-001 10/01/2004

Rates Fringes

**Asbestos Worker/Heat and
Frost Insulator**

Includes application of
all insulating materials,
protective coverings,
coatings and finishes to
all types of mechanical
systems. Also the
application of
firestopping material for

wall openings and
 penetrations in walls,
 floors, ceilings and
 curtain walls.....\$ 25.00 11.41

 ASBE0024-002 03/01/2004

	Rates	Fringes
Hazardous Material Handler Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials, whether they contain asbestos or not, from mechanical systems.....	\$ 12.43	4.59

 * BOIL0193-001 10/01/2004

	Rates	Fringes
Boilermaker.....	\$ 32.17	14.29

 * BRDC0001-001 11/01/2004

	Rates	Fringes
Bricklayer.....	\$ 25.00	5.77

 CARP0132-001 05/01/2004

	Rates	Fringes
Carpenter/Lather.....	\$ 22.50	4.83
Piledriver.....	\$ 20.85	5.50

 CARP0132-003 05/01/2004

	Rates	Fringes
Diver Tender.....	\$ 20.85	5.50
Diver.....	\$ 29.63	5.50

CARP1831-001 04/01/2003

	Rates	Fringes
Millwright.....	\$ 24.34	4.05

* ELEC0026-001 11/01/2004

	Rates	Fringes
Electrician.....	\$ 29.85	9.57+3%+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King Jr.'s Birthday, Inauguration Day, Memorial Day, Fourth of July, Labor Day, Veterans Day, Thanksgiving Day, the day after Thanksgiving and Christmas Day or days designated as legal holidays by the Federal Government.

ELEC0070-001 03/31/2002

	Rates	Fringes
Line Construction:		
Groundmen.....	\$ 14.00	2.45+17.5%
Linemen, Cable Splicers, Equipment Operators.....	\$ 24.48	2.45+17.5%
Truck with winch.....	\$ 14.00	2.45+17.5%

ENGI0077-005 07/19/2004

	Rates	Fringes
Power equipment operators: (SEWER, GAS AND WATER LINE CONSTRUCTION: (Montgomery County, Maryland ONLY))		
GROUP 7.....	\$ 17.87	4.12+a

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: Backhoes, Cableways, Cranes, Derricks, Draglines, Power Shovels, Tunnel Shovels, Tunnel Mucking Machines (1 cubic yard capacity or above).

GROUP 2: Backhoes, Boom Cats, Cableways, Cranes, Derricks, Draglines, Elevating Graders, Hoists, Paving Mixers, Pile

Driving Engines, Power and Tunnel Shovels, Tunnel Mucking Machines, Batch Plant, Concrete Pumps.

GROUP 3: Operators of Hydraulic Backhoes of below 1/2 yard capacity.

GROUP 4: Trenching machines (above 83")

GROUP 5: Trenching machines (up to and including 83"), Boilers (Skelton), Well Drilling Machines.

GROUP 6: Air Compressors (Tunnel).

GROUP 7: Front-end Loaders (Hi-Lift) and Bulldozers on Sewer and Water Line Work

GROUP 8: Concrete Mixers, Power Driven Wheel Scoops and Scrapers, Blade graders, Motor Graders, Tunnel Mechanics, Tunnel Motormen.

GROUP 9: Mechanics.

GROUP 10: Bulldozers, Hydraulic Tamper and Hoe Pack Operators.

GROUP 11: Rollers.

GROUP 12: Air Compressors, Pumps, Welding Machines, Well Points.

a. PAID HOLIDAYS: New Year's Day, Inaugural Day, Washington's Birthday, Decoration Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Christmas Day and Martin Luther King's Birthday.

ENGI0077-006 05/01/2004

Rates Fringes

Power equipment operators:
(HEAVY CONSTRUCTION)

GROUP 1.....	\$ 24.74	5.62+a+b
GROUP 2.....	\$ 24.28	5.62+a+b
GROUP 3.....	\$ 23.57	5.62+a
GROUP 4.....	\$ 21.54	5.62+a
GROUP 5.....	\$ 17.00	5.62+a
GROUP 6.....	\$ 26.11	5.62+a

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: 35 ton cranes & above, tower & climbing cranes, derricks, concrete boom pump, drill rigs (equivalent to L & Double L), mole.

GROUP 2: Backhoes, cableways, cranes, cherry pickers, elevating graders, hoists, paving mixers, power shovels, tunnel shovels, batch plants, shields, tunnel mining machines, gradalls, front end loaders, 3 1/2 cu. yds. and

above, power driven wheel scoops and scrapers (50 cu. yds. struck capacity or above), rail tamper, draglines, boomcat, mucking machines, graders in tunnels, pile driving engines.

GROUP 3: Front end loaders below 3 1/2 cu. yds, boom trucks, hydraulic backhoes 1/2 yds. capacity or below rubber or rack mounted, tug boats, power driven wheel scoops and scrapers, blade graders, motor graders, bulldozers, trenching machines, concrete mixer, speed swing pettibone, ballast regulator, concrete pump, mechanic, welder, mechanic welder, shotcrete machines, Hoeram, locomotive (standard, narrow gauge), tuggers.

GROUP 4: High lifts above 10 feet, boilers (skelton), asphalt spreaders, bullfloat finishing machines, concrete finishing machines, concrete spreaders, fine graders, air compressors, welding machines, pumps, generators, well points, deep wells, hydraulic pumps, elevators, freeze units, tunnel motorman or dinky operator, roller, conveyors, well drilling machines, grout pump, fireman.

GROUP 5: Fork lifts, ditch witch, bobcat 1/3 cu. yd. and below, space heaters, sweepers, assistant engineers, oilers.

GROUP 6: Master mechanic.

a. PAID HOLIDAYS: New Years Day, Inaugural Day, Decoration Day, Independence Day, Labor Day, Martin Luther King's Birthday, Veterans' Day, Thanksgiving Day, Friday after Thanksgiving and Christmas Day.

b. PREMIUM PAY: Tower crane and cranes 100-ton and over to receive \$1.00 per hour premium over Group One.

IRON0005-001 06/01/2003

Rates	Fringes
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Ironworkers:

Structural, Ornamental and Chain Link Fence.....\$ 24.00	8.975
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* IRON0201-001 05/01/2004

Rates	Fringes
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Ironworkers:

Reinforcing.....\$ 23.45	9.73
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LABO0074-002 06/01/2004

	Rates	Fringes
Laborers: (HAZARDOUS WASTE REMOVAL, (EXCEPT ON MECHANICAL SYSTEMS): Preparation for, removing & encapsulation of hazardous materials from non-mechanical systems)		
Skilled Asbestos Abatement Laborers.....	\$ 15.39	3.30
Skilled Toxic and Hazardous Waste Removal Laborers.....	\$ 18.17	3.30

LABO0456-001 06/01/2004

	Rates	Fringes
Laborers: (HEAVY CONSTRUCTION) (Montgomery & Prince Georges Counties) SEWER & WATER LINES (Montgomery County ONLY))		
GROUP 1.....	\$ 18.34	3.30
GROUP 2.....	\$ 18.60	3.30
GROUP 3.....	\$ 18.73	3.30
GROUP 4.....	\$ 18.86	3.30
GROUP 5.....	\$ 19.23	3.30
GROUP 6.....	\$ 19.69	3.30
GROUP 7.....	\$ 19.91	3.30
GROUP 8.....	\$ 20.72	3.30

LABORERS CLASSIFICATIONS

GROUP 1: Carloaders, choker setter, concrete crewman, crushed feeder, demolition laborers, including salvaging all material, loading, cleaning up, wrecking, dumpmen, flagmen, fence erector and installer, including installation and erection of fence, guard rails, median rails, reference posts, guide posts and right- of-way markers, form strippers, general laborers, railroad track laborers, riprap man, scale man, stake jumper, structure mover, includes foundation, separation, preparation, cribbing, shoring, jacking and unloading of structures, water nozzleman, timber buckler and faller, truck loader,

water boys, tool room men.

GROUP 2: Combined air and water nozzleman, cement handler, dope pot fireman (nonmechanical), form cleaning machine, mechanical railroad equipment (includes spiker, puller, tie cleaner, tamper, pipe wrapper, power driven wheelbarrows, operators of hand derricks, towmasters, scootcretes, buggymobiles and similar equipment), tamper or rammer operator, trestle scaffold builders over one tier high, power tool operator (gas, electric or pneumatic), andblast or gunnite tailhose man, scaffold erector,(steel or wood), vibrator operator up to 4 feet) asphalt cutter, mortar men, shorer and lagger, creosote material handler, corrosive enamel or equl, paver breaker and jackhammer operators.

GROUP 3: Multi-section pipe layer, non-metallic clay and concrete pipe layer (including caulker, collarman, jointer, rigger and jacker, thermit welder and corrugated metal culvert pipe layer.

GROUP 4: Asphalt block pneumatic cutter, asphalt roller, walker chainsaw operator with attachment, concrete saw (walking), high scalers, jackhammer operator (using over 6 feet of steel), vibrator operator (6 feet and over), well point installer, air trac operator.

GROUP 5: Asphalt screeder, big drills, cut of the hole drills, (1 1/2" piston or larger), down the hole drills (3 1/2" piston or larger), gunnite or sandblaster nozzleman, asphalt raker, asphalt tamper, form setter, demolition torch operator, shotcrete nozzlelemen and potman.

GROUP 6: Powderman, master form setters.

GROUP 7: Brick paver (asphalt block paver, asphalt block sawman, asphalt block grinder; hastings block or similar type)

GROUP 8: Licensed powdermen.

LABO0456-003 06/01/2004

Rates Fringes

Laborers: (TUNNEL, RAISE &
SHAFT (FREE AIR)
(FOR HEAVY AND SEWER & WATER
LINES CONSTRUCTION)

GROUP 1.....	\$ 18.93	3.30
GROUP 2.....	\$ 19.46	3.30
GROUP 3.....	\$ 20.84	3.30
GROUP 4.....	\$ 21.39	3.30

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GROUP 1: Brakeman, Bull Gang, Dumper, Trackman, Concrete Man.

GROUP 2: Chuck Tender, Powdermen in Prime House, Form Setters and Movers, Nippers, Cableman, Houseman, Groutman, Bell or Signalman, Top or Bottom Vibrator Operator.

GROUP 3: Miners, Re-Bar Underground, Concrete or Gunnite Nozzlemen, Powdermen, Timbermen and Re-Timbermen, Wood Steel Including Liner Plate or any Other Support, Material, Motorman, Caulkers, Diamond Drill Operators, Riggers, Cement Finishers - Underground, Welders and Burners, Shield Driver, Air Trac Operator, Shotcrete Nozzleman and Potman.

GROUP 4: Mucking Machine Operator (Air).

LABO0456-005 06/01/2004

Rates Fringes

Laborers: (TUNNEL, RAISE AND
SHAFT (Compressed Air) for
HEAVY CONSTRUCTION ONLY

Gauge Pressure (Pounds)	Work Period (Hours)		
1-14	7.....	\$ 22.97	3.30
14-18	6.....	\$ 27.02	3.30

FOOTNOTE: On any requirement for air pressure in excess of 18 PSI, work periods and rates should be negotiated at a pre-bid conference.

MARB0002-003 05/01/2004

Rates Fringes

Marble & Stone Mason
Includes Pointing,
Caulking and Cleaning of
All types of Masonry,
Brick, Stone and Cement
Structures.....\$ 27.47 10.05

MARB0003-001 05/01/2004

Rates Fringes

Mosaic & Terrazzo Worker,
Tile Layer.....\$ 22.07 8.18

MARB0003-004 05/01/2004
Rates Fringes

Marble, Tile & Terrazzo
Finisher.....\$ 17.87 7.32

PAIN0051-001 06/01/2004
Rates Fringes

Painters:
All Industrial Work.....\$ 22.43 6.86
Bridges, Heavy Highway,
Lead Abatement and
Flame/Thermal Spray.....\$ 24.32 6.86
Commercial and Mold
Remediation, Painters,
Drywall Finishers and
Wallcoverers.....\$ 21.01 6.86
Metal Polishing and
Refinishing.....\$ 22.01 6.86

PLAS0891-003 05/01/2004
Rates Fringes

Cement Mason.....\$ 23.73 4.945

PLUM0005-001 08/01/2004
Rates Fringes

Plumber.....\$ 29.52 10.89+a

a. PAID HOLIDAYS: Labor Day, Veterans' Day, Thanksgiving Day and the day after Thanksgiving, Christmas Day, New Year's Day, Martin Luther King's Birthday, Memorial Day and the Fourth of July.

PLUM0602-005 09/01/2004
Rates Fringes

Steamfitter, Refrigeration &
Air Conditioning Mechanic.....\$ 29.17 11.22+a

a. PAID HOLIDAYS: New Year's Day, Martin Luther King's Birthday, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day and the day after

Thanksgiving and Christmas Day.

SHEE0100-001 07/01/2004

	Rates	Fringes
Sheet Metal Worker.....	\$ 28.43	9.76

TEAM0639-003 04/01/2002

	Rates	Fringes
Truck drivers: (HEAVY CONSTRUCTION) Concrete Mixer Drivers.....	\$ 15.95	5.07+a+b

a. PAID HOLIDAYS: New Year's Day, Martin Luther King, Jr. Day, Memorial Day, July 4th, Labor Day, Thanksgiving Day, Christmas Day, or any day celebrated publicly in the District of Columbia as one of the above holidays.

b. PAID VACATIONS: Employees with one (1) year of service shall be entitled to a vacation of one (1) week; five (5) years of service are entitled to two (2) weeks; fifteen (15) years of service are entitled to three (3) weeks; twenty (20) years of service are entitled to four (4) weeks.

TEAM0639-004 03/07/2002

	Rates	Fringes
Truck drivers: (HEAVY CONSTRUCTION) Tandem & Triaxle (3 or more axles, including steering axle).....	\$ 15.00	5.02+a
Tractor-trailer, low boy....	\$ 18.00	5.02+a

a. VACATION: Employees will receive one (1) week's paid vacation after one (1) year of service.

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

=====

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

In the listing above, the "SU" designation means that rates listed under the identifier do not reflect collectively bargained wage and fringe benefit rates. Other designations indicate unions whose rates have been determined to be prevailing.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

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Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

=====
END OF GENERAL DECISION

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Serial Number: RFP-FN5008/FMP
Date of Issue: December 3, 2004
Proposal Due Date (Alexandria Option): April 8, 2005

**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 FIFTH STREET, N.W.
WASHINGTON, DC 20001**

March 30, 2005

**AMENDMENT NO. 5
TO**

**METRO MATTERS - Design/Build: Rail Yards Expansion Project
at Brentwood, Greenbelt, and Shady Grove Yards**

Phase II - Request for Technical / Price Proposals for the Alexandria Yard Option

CONTRACT NO. FN5008

TO WHOM IT MAY CONCERN:

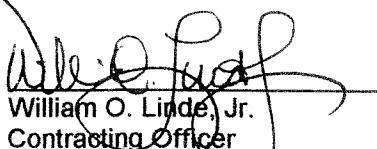
The proposal documents accompanying solicitation RFP-FN5008/FMP are hereby changed in part as follows:

1. The date established for Receipt of Proposals for the Alexandria Option is hereby extended to April 15, 2005 at 2:00 pm.
2. WMATA's responses to Proposer's Questions on the Alexandria Option received to date are attached.
3. Attached please find a separate Listing showing the additional information provided with this Amendment. Included under Item IX are revised drawings to reflect relocation of the wheel truing machine from Track 11 to Track 9A at Brentwood.
4. The Proposer's attention is directed to significant changes in Section 00262, Provision for Stipend and the addition of Supplemental Condition 00893, Steel Price Adjustment as reflected on the following revised and new pages:

Pg. 00200-29	Revised
Pg. 00800-15 to 00800-16	Revised
Pgs. 00800-16a to 00800-16c	New
Appendix A - Project Manual, Pg. 00400-11	Reissued
Appendix A - Project Manual, Pg. 00400-12	Revised

ACKNOWLEDGMENT

Offerors are required to acknowledge receipt of this amendment in writing on the Proposal Form in the space provided or by separate letter or telegram prior to the date established for receipt of proposals.


William O. Linde, Jr.
Contracting Officer
Office of Procurement and Materials

March 30, 2005

Note: For ease of reference, WMATA has indicated the Question Number as received from the Design-Builder in parenthesis at the end of each question (ex. DB ref. 22, if "a" is shown after number it refers to the Alexandria Option only).

Question 1: In reviewing the RFP documents, we were not able to locate As-Built documents which define the locations of existing utility lines. Sheets M255-206 and 207 indicate the as-built information for the train control and communications ductbanks. Sheet M215-103 indicates where the utility lines exit the existing shop, however we were not able to locate the routing of the lines outside of the building foot print. Can WMATA provide As-Built drawings indication the existing utility lines? (DB ref. 1a)

Answer: Reference Answer to Question 26. Additional as-built drawings for the Revenue Collection Facility Contract 1C0116 and the Central Maintenance Facility Contract 1C0115 are being included in this Amendment. With these two contracts and Contracts 1C0111 and 1C0113 provided in Amendment No. 4, all known as-builts have been provided.

Question 2: Can WMATA provide an electronic copy of the RFP drawings? (DB ref. 2a) (Similar to Question 28.)

Answer: Electronic copy included with this Amendment.

Question 3: We were not able to locate any geotechnical information for the Alexandria site. Item #1.05A of the Structural Program Criteria indicates that a Muesser Rutledge Subsurface Investigation Report was to be contained the RFP documents. We did not receive a copy of this report. Can WMATA please provide the geotechnical information? (DB ref. 3a)

Answer: No recent soils investigation has been conducted. Refer to Drawings M215-37 to M215-41 in the set of Section C-11b, Alexandria Service and Inspection Shop, drawings included with Amendment No. 4. Drawings contain soil boring information done at the time the Shop was constructed. Included with this Amendment one copy each of the following Mueser, Rutledge soils reports done at the time of the Alexandria Yard design and construction:

- Report No. 115, MRWJ Series, Section C011a, Huntington-Springfield Routes, Service and Inspection Yard, Subsurface Investigation, October 25, 1974.
- Report No. 116, MRWJ Series, Section C011a, Huntington-Springfield Routes, Service and Inspection Shop Building,

Subsurface Investigation, October 31, 1974.

Question 4: During a recent site visit to the Alexandria site, several questions were raised regarding the new inspection pit in Area 3A. These questions are as follows:

1. Sheet M1210-520 indicates that the existing stairs going down into the existing inspection pit are to be removed. During the site visit, we were informed that the platform East of the existing inspection pit was to remain. Is it really the intent to demolish the existing stairs into the existing inspection pit?
2. Sheet M1210-520 does not indicate new stairs between tracks 2 and 3 into the new inspection pits. During the site visit, the need to have stairs going from the platform West of the new inspection pit down into the new inspection pit. Please verify that a new stair shall be installed between the tracks for track #2 and track #3.
3. Sheet M1210-520 indicates that the existing wall along column line 20 to be demolished between tracks 2 and 3. During the site visit, it became apparent that this wall has structural concrete column supporting the roof steel on each end. In addition, this wall appears to have the controls for the existing stinger system. Is it really necessary to demolish this existing wall? (DB ref. 4a)

Answer:

1. Stairs will not be demolished. A revised Drawing M1210-520 reflecting this change is included with this Amendment.
2. New stairs will be installed between tracks 2 and 3. Revised drawing is being issued with this Amendment.
3. Yes, demolition of this wall is required for workflow transition and delivery of material to the pit.

Question 5: Note 1 on sheet M1210-520 indicates that "3rd rail servicing between tracks 2 and 3 to mirror 3rd rail servicing method in the existing building." During a recent site visit, we were unable to identify and 3rd rail service in the existing building. Does this requirement relate to providing stinger power in the new inspection pit similar to the stinger power in the existing inspection pit? (DB ref. 5a)

Answer: Yes, provide stinger power similar to existing operations.

Question 6: Section 1.06 of the Architectural Program Criteria states that "The design builder shall coordinate the procurement of equipment for the shops with WMATA's representative responsible for the purchasing of such equipment. The following equipment for each location shall be purchased using the specifications that follow, and is included within the Contract Documents."

Please Clarify that the Design-Builder is responsible for furnishing and installing the car maintenance equipment listed in section 1.06. (DB ref. 6a)

Answer: Design-Builder is responsible for furnishing and installing the car maintenance equipment listed in Architectural Program Criteria Section 1.06. Car Maintenance Equipment and installation shall be procured and installed in the same manner as the equipment and installation for the other three Metro Matters Shops.

Question 7: Sheet M1210-521 indicates that two of the truck repair hoists are future on the release track. Item 1.03.C.2.b indicates to "provide for two truck repair hoist to be installed in the future."

Please clarify what the Design-Builder's responsibilities are for these future truck repair hoists. Are we to provide blockouts in the concrete and electrical service to the area for these pits? Please clarify. (DB ref. 7a) (Similar to Question 40.)

Answer: The Design Builder shall provide all infrastructure required, (concrete pits, electrical power, etc) necessary to accommodate the installation of the lift at a later date. Lift manufacture shall supply a "street cover" designed and manufactured to allow for truck access over the future lift pits.

Question 8: The price schedule included in the RFP documents is a little misleading. The confusing items are as follows:

1. Item 3 appears to be a carryover from the Greenbelt Price schedule as we cannot locate any equipment numbers nor were we provided with a fixed equipment list.
2. It appears that Schedule G is also a carryover from the Greenbelt Price Schedule.

Please clarify if the Price schedule is correct as provided or provide a new price schedule. (DB ref. 8a)

Answer: Refer to Answer to Question 17. Revised Price Schedule addressing above question is being issued with this Amendment.

Question 9: Item 1.01.A.1 states that "the facilities will be designed to facilitate scheduled inspections, minor repairs, car cleaning, truck repair and replacement, and minor painting." Please define what minor painting will occur in this shop. Is any special ventilation requirements needed to accommodate the minor painting? (DB ref. 9a)

Answer: Paint booths or any special ventilation for painting is not included in the scope of work at this time.

Question 10: Item 1.03.C.3.b indicates that the Design Builder is to "provide restricted access to this space (blow pit)." Please clarify what is meant by restricted access? (DB ref. 10a)

Answer: Provision for restricted access is not required. Delete this requirement.

Question 11: On Page 0200-2 of the Alexandria Project Manual Book 1, Item 2 of the Value of Design Solutions requires a Contractor plan for "Replacement of compressed air plant while minimizing loss of service duration". Project Manual Book 2, Mechanical Design Criteria, Page 9, paragraph 1.11A.2 states "new compressors shall be rotary screw....." However, the existing plant appears to be in good working condition and according to the as-built mechanical drawings it consists of two (2) 75HP water-cooled compressors with summer cooling coils on the roof, and winter coils embedded in heating and ventilating unit HV-8. Can this plant continue to remain in long-term operation, and does the Design Builder have leeway to propose his best solution for overall compressed air needs, or is it a requirement to replace the existing compressed air plant? (DB ref. 11a)

Answer: The Design Builder has the option of proposing the best solution for the overall compressed air needs of the Alexandria Shop.

Question 12: On Page 2 of the Alexandria Project Manual Book, Architectural Design Criteria Item 5.a.1 requires that the three (3) vehicle lift systems shall be outfitted with body hoists and spinning posts. Please confirm that spinning posts are required on all proposed new lifts. (DB ref. 12a)

Answer: Confirmed. Spinning posts are required.

Question 13: Page 4 of the Mechanical Design Criteria states, generally, that the process piping shall be modified and expanded as required to accommodate the new additions. It is understood that a compressed air system will be required in the new spaces however, at the site visit it was evident that portable containers for waste oil, grease and lube oil systems were in use at Alexandria. No automated systems were found. Can the bidder assume there is no scope requirement for waste oil, grease and lube oil systems in the new spaces? If not, please provide a scope of work statement. (DB ref. 13a)

Answer: There are no requirements for waste oil, grease, or oil lube systems in the scope of work at this time.

Question 14: In order to properly analyze the capacity of the existing electrical system to determine expansion capability we would like to obtain the load demand

information for the Alexandria Shop. Specific information for only the shop building is desired. Since the VEPCO metering appears to be located within the traction power substation and apparently meters the shop and TP sub together, can WMATA supply utility, internal metering or billing information to help the bidders determine the expansion capacity of the existing electrical equipment? (DB ref. 14a)

Answer: See Answer to Question 51. The Dominion-Virginia Power system is different from PEPCO's system where WMATA has metering at various facilities. The Dominion-Virginia Power design is called a loop system where WMATA has two metering locations with two feeders per meter (therefore 4 feeders) that serve the entire segment from the Alexandria Yard to Franconia/Springfield. Each delivery point (i.e. station, traction substation, shop) has two feeds one from each metering location. WMATA has billing data for each metering point but unfortunately we can't specifically allocate electrical consumption and demand by each facility.

Question 15: The proposed shop lead tracks shown in the RFP documents are short and do not appear to be in compliance with the WMATA design criteria. Our investigation indicates that a fully compliant geometric design may not be possible given the site constraints? A short tangent length in front of the shop will require a wider opening of the shop doors to account for vehicle overhang. Also, given the short length of the lead tracks trains accessing the shop will appear to foul the existing lead ladder track until the trains are completely within the building. Is it safe to assume that WMATA will accept this operational condition?

Since we were not provided with geometric mathematization for the trackwork in the RFP, it appears that the "diagonal" shop lead track has limited clearance to the revenue control building tracks. Is this clearance acceptable? Will these tracks need to be relocated to accommodate the new proposed tracks? (DB ref. 15a)

Answer: WMATA is aware that Alexandria will not have a fully compliant geometric trackwork design, similar to Shady Grove, and is willing to accept this. WMATA will work with the Design-Builder to verify the alignment and grant the required waivers. Amendment 5 includes revisions to Drawing C11-A-04 (M1210-521) widening the overhead doors.

Question 16: The RFP package for the Alexandria site did not provide any preliminary stormwater requirements. According to the City of Alexandria any site that will have improvements made to an existing facility without stormwater controls currently in place will require that controls (ie. SWM pond, underground storage) be constructed to account for both new and existing drainage areas. In reviewing the site plans their may not be enough room

on the site to construct adequate stormwater management. Does WMATA have an agreement or can you obtain a waiver with the city or state that will allow for this site to be improved without on-site quantity and/or quality controls for new and existing stormwater drainage? (DB ref. 16a)

Answer: WMATA is initiating a SWM report for Alexandria, similar to what we did for the other three sites, and this subject will be discussed with the City.

Question 17: In Amendment #4, the Price Schedule (section 00434), lists an Item #3 under the Schedule F (Major Shop Equipment) and Item #3 on the Schedule G (Minor Shop Equipment) that appear to have been copied from the Greenbelt Price schedules. Please verify that this is correct, or revise these items on the price schedule to reflect the Alexandria project. (DB ref. 147)

Answer: Item #3 in Schedule F will be revised. Item #3 in Schedule G will be deleted. Revised pages are included in this Amendment.

Question 18: No "Fixed Equipment List" has been provided for the Alexandria project. Please provide, or confirm that no additional equipment is needed beyond what is described in the Architectural Program Criteria. (DB ref. 148)

Answer: No additional shop equipment is required beyond what is listed in the Architectural Program Criteria.

Question 19: The Architectural Program Criteria for the Alexandria project lists a Steam Cleaner Pressure Washer System (paragraph 1.06.A.5). This item was deleted from the other projects in Amendment 4, Question 4. Please verify that this item is not to be included with this option pricing, or provide additional technical information describing the requirements of this system. (DB ref. 149)

Answer: Steam Cleaner Pressure Washer is to be included, Better Engineering Model T-7000P or equal.

Question 20: Please clarify if there are any schedule constraints or suggested staging notes and/or sequences. (DB ref. 150)

Answer: West side construction to be completed before east side starts. Blow pit construction to be expedited to minimize down time.

Question 21: Please clarify the location of the proposed contractor's staging area. (DB ref. 151)

Answer: Staging area is limited. The triangle southwest of the shop where the Alstom trailers are located will be available. Also the ballasted area on the east side of the shop between track 3 and 4. Access can be provided across tracks 4, 5 and 6. Other than these areas nothing can be guaranteed. The area on the corner of Bluestone Road and Eisenhower Avenue, is a possibility but it may have environmental ramifications and will require further investigation.

Question 22: Please clarify the proposed location for the new dust collector for the Blow Down Pit extension. (DB ref. 152)

Answer: Dust collector may be located on roof or at any appropriate location that conforms to and complements the design.

Question 23: Drawing C11-A-05 indicates "insulating concrete roof fill". Please clarify if this is a project requirement, or are we able to use alternative roofing systems? (DB ref. 153)

Answer: Other approved roofing systems, as described as described in Project Manual Book 2 of RFP FN5008/FMP, will be considered by the Authority.

Question 24: The Architectural Program Criteria indicates that the entire blow pit platform shall have a "brush type edge seal". Please provide us with technical specifications for this product. (DB ref. 154)

Action: Included with Amendment on CD #1 is an electronic photo of a brush type seal. More information can be obtained on the Internet searching for "brush type seal". Refer to web sites such as Precision Brush or Memtech.

Question 25: The Architectural Program Criteria indicates that metal framed skylights are included in the project. Please clarify the extent of the metal framed skylights. (DB ref. 155)

Answer: Layout and spacing of new metal framed skylights to match existing. See as-built drawing C11b-A-5.

Question 26: Please provide us with drawings for the site improvements west of the existing service and inspection shop. We believe that this area was constructed with the Revenue Collection Facility Building contract. We would require the civil/site drawings in particular. (DB ref. 156)

Answer: Issued with this Amendment on CD #1 are electronic files in TIF format for the following as-built drawings:

- Revenue Collection Facility Contract 1C0116: Control,

General, Paving & Restoration, Survey Plot, Utilities, Trackwork, Landscape, Soils, Cover Sheet and Index drawings

- Cental Maintenance Facility Contract 1C0115: Complete as-built set of drawings.

Question 27: Please provide updates if any initial storm water management plans or design have been developed. In addition, provide any meeting minutes with Authorities. (DB ref. 157)

Answer: To date no Storm Water Management plans or studies have been developed or undertaken. There has been no coordination with jurisdictional authorities or utilities.

Question 28: Please provide us with an electronic copy of the complete RFP documents associated with the Alexandria Yard option. (DB ref. 158) (Similar to Question 2.)

Answer: Electronic copy is provided as an attachment to this Amendment on CD #1.

Question 29: The bid form Schedule F, item 4 lists Environmental Mitigation. Please clarify the scope of the environmental mitigation. Have any environmental site assessments been performed? Are soil contaminates known to exist? (DB ref. 159)

Answer: Environmental site assessments have not been performed to date, but are planned in the near future.

An electronic copy in PDF format of the Consolidated Plan (Hazardous Waste Contingency Plan; Spill Prevention, Control and Countermeasures Plan; and Stormwater Pollution Prevention Plan) for Alexandria Yard dated January 21, 2002 is included with this Amendment on CD #1. Similar Plans were provided for other three Yards.

Question 30: Please clarify where we are to relocate the existing salt dome. (DB ref. 160)

Answer: Salt dome does not have to be relocated. Drawing C11-C-01 (M1210-513) and C11-C-02 (M1210-514) will be revised to delete the proposed parking spaces immediately west of the salt dome and the curb work on its east side. Drawing are being reissued with this Amendment.

Question 31: The note on drawing C11-A-02 states to "Relocate (E) dust collector". The existing dust collector does not appear to be in adequate condition for it to

be cost effective to relocate this equipment. Please verify that we are to provide a new dust collector and "remove" the existing dust collector. (DB ref. 161)

Answer: Design-Builder to recommend to the Authority whether or not the dust collector should be relocated or replaced based on condition of equipment and cost-effectiveness.

Question 32: During our recent site visit, it was mentioned that "employee welfare areas" may be added to the current scope of this project. Please clarify if any "employee welfare areas" will be included in the project at this time. (DB ref. 162)

Answer: No employee welfare areas are included in the scope of work for this proposal at this time.

Question 33: Regarding the modifications to the existing truck elevator to accommodate truck access from the new expansion, please confirm that all modifications will occur at the top platform level only. Confirm that the lower platform will not be modified to receive trucks from the direction of the new expansion. (DB ref. 163)

Answer: It is the intent of the Authority that the truck elevator be accessible from the proposed release track in the new expansion. The Design Builder will be required to modify the elevator, including the lower platform, as necessary, to accommodate trucks from the new expansion.

Question 34: Regarding access to build the Inspection Pit Area Expansion at the east end of the facility, please confirm that it is acceptable to build a ramp from the adjacent parking lot and construct grade crossings on Tracks 4, 5, and 6. (DB ref. 164)

Answer: Accommodation will be made for the Design-Builder to access the work area from the adjacent roadway crossing tracks 4, 5 and 6. An approved construction phasing plan will be required.

Question 35: Regarding access to build the Blow Pit Area Expansion and the Truck & Body Hoist Area Expansion at the west end, please confirm that the existing temporary trailers will be relocated by others. (DB ref. 165)

Answer: Temporary trailers to be relocated by the Design-Builder. Current plans are to relocate the trailers from their existing location to the triangle just across the by-pass track next to the salt dome. WMATA will extend the electric and telephone service. No water or sewer hook-ups are needed.

Question 36: Are the existing light poles that conflict with the new expansions to be demolished and disposed of or salvaged and turned over to WMATA? (DB ref. 166)

Answer: Salvage if in good, re-usable condition. Design builder may re-use existing poles as necessary to maintain adequate yard lighting per the Authority's Design Criteria.

Question 37: Are there any additional security measures required at the Alexandria Yard because it also includes operations associated with revenue collection? (DB ref. 167)

Answer: No additional security measures required other than what is already specified.

Question 38: The as-built drawings show that the current inspection pit area was designed and built to accommodate a "future" center platform. Please confirm that we are not to include any provisions for a "future" center platform (ie footings). (DB ref. 168)

Answer: Confirmed

Question 39: We have been unable to find where the Civil Program Criteria requires the Design Build team to provide the track design required for the Alexandria Yard. Please clarify if the Design Build team is responsible for the complete and final design of the track for this option. (DB ref. 169)

Answer: Design-Builder responsible for complete and final design of all aspects of the Alexandria Shop expansion which will include track, traction power and train control. (Also reference Answer to Question 15.)

Question 40: Drawing C11-A-04 shows two future truck hoist openings. Please clarify what we are to provide to cover the opening so that the Release Track may extend through the pits. (DB ref. 170)

Answer: The Design Builder's Truck Hoist manufacturer shall supply a pre-manufactured street plate with running rails to cover pits of future truck hoist. (Also, reference Answer to Question 7.)

Question 41: On the north side of Track No. 2 in the Blow Pit Extension area, there will be a large gap between the new wall on column line C and the north side of the train. Is there a requirement to seal the north car side in the new Blow Pit Extension? If so, please provide us with additional information describing this condition. (DB ref. 171)

Answer: North side of track 2 blow pit to be sealed (with brush type seal) at the elevated platform level. It is the intent of the Authority to replace the existing bladder seal in the existing blow pit with new brush type seals to match the proposed seals to be used in the blow pit expansion. See Sheet. C11-A-05 for cross section. Drawing C11-A-02 will be re-issued in this amendment to show edge of platform. (Also reference Answer to Question 24.)

Question 42: There appears to be an existing sanitary line that was abandoned on the west side of the facility. When this line was abandoned, was the pipe filled? (DB ref. 172)

Answer: No further information is available regarding abandoned Sanitary Sewer at this time.

Question 43: At the Posted Rail Expansion shown on drawing C11-A-03, a drawing note indicates that we are to demolish the existing walls and stairs. Please verify that the existing stairs at the east end of the existing pits are to be removed. (DB ref. 173)

Answer: Existing stairs to remain. Revised drawing is being issued in this amendment.

Question 44: In the Yard Signal Program Criteria, page 3; para 1.04.B.6.b, the narrative describes a new Track 3AE at the East end of Shop Building. The narrative also describes replacing existing Signals 226, 228 & 230 because of this new Track 3AE. We have been unable to locate Track 3AE on the drawings. Please verify that there is no new Track 3AE and the existing Signals are to remain as is, if they don't interfere with the new Inspection Pit Expansion. (DB ref. 174)

Answer: There is no track 3AE on east side of the Alexandria shop. Only track work required is to support a two bay shop expansion on the east side. Design Builder shall modify track work, signals and traction power as necessary to accommodate a two bay expansion as shown on drawing C11-C-03 and C11-A-03. Alexandria Yard Signal Program Criteria has been revised to reflect this and is being reissued with this Amendment.

Question 45: Drawing C11b—52, Partial First Floor Plan-Segment 1-HVAC, shows existing below grade asbestos cement duct along column line C1 and column line 1. Partial Plan Blow & Inspection Pits-Segment 1-HVAC shows asbestos cement duct below the concrete floor slab parallel to column line 4. Since we are modifying the dust collection system are we to demolish the existing acid wash slabs and ground floor slabs to abate all the existing asbestos cement duct? Can the existing undisturbed asbestos cement duct

remain in place since it is inaccessible? (DB ref. 175)

Answer: Abatement of asbestos is only required when it is disturbed.

Question 46: Reference drawings C11b—52, 53, and 54 which show an existing 16" and 12" diameter asbestos cement duct running below the concrete slab on grade and parallel to column line C1 from column line 5 to column line 17. Are we to abate this existing asbestos cement duct? Please confirm. (DB ref. 176)

Answer: Abatement of asbestos cement duct is only required if disturbed. If construction doesn't require its disturbance, abatement is not required.

Question 47: On drawing C11b—1, Note 11 indicates that all underdrain piping shall be perforated asbestos cement. Drawing C11b—9 shows underdrain along the perimeter of the foundation wall. Please clarify if we are to abate the underdrain beyond the limits that we disturb. Please clarify if the underdrain system is to extend around the new shop expansion. (DB ref. 177)

Answer: Abatement of asbestos cement underdrain is only required if disturbed. No need to abate beyond limits of disturbance.

Question 48: Will parking for construction workers be allowed on the site? Could the existing areas in the far northeast and southwest corners of the WMATA property be temporarily converted to surface parking lots if they are fully restored upon completion? (DB ref. 178)

Answer: There is no space in the Yard for construction workers to park, except what would be available in the Design-Builders staging area. One possibility is to construct the 21 spaces in the program first and use them, keeping in mind that the triangular area where this new parking is to go is where the Alstom trailers will be relocated to. Another possibility is to park at the end of Bluestone Road, but this would have to be cleared with City of Alexandria, which currently enforces a two-hour limit for parking there. Track and Structures (TRST) has plans for the area in the far northeast corner which it will be implementing soon. The area in the far southwest corner outside the Yard loop track on the corner of Bluestone Road and Eisenhower Avenue, is a possibility, but it may have environmental ramifications and will require further investigation.

Question 49: The Mechanical Program Criteria specifies the use of an Automated Energy Management System (AEMS) but the existing drawing show pneumatic control of the existing equipment. Please clarify the following:

- Is there an existing automated energy management system?

- What is the existing system if there is an existing one?
- Will the existing system be able to interface with any other system?
- Is there any existing AEMS in any other site?
- Will it require remote communication and communication with the main office or among sites? (DB ref. 179)

- Answer:
1. There is an existing system call the AEMS currently monitoring power usage throughout the Metro system. The system also monitors and controls station HVAC, elevators, escalators, generators, lighting, etc.
 2. The existing system is a SCADA system manufactured by QEI providing control, status and analog functions.
 3. The system can be interface with other systems thru standard protocols such as Modbus. For this project, a digital interface will be required to the Allen/Bradley controller for all new elevators. All other equipment interfaces can be accomplish thru discreet wiring or a standard digital interface.
 4. There are existing AEMS RTU's at Shady Grove, Greenbelt and Alexandria Yard S & I shop. There is no RTU at Brentwood; it will have to be supplied by WMATA. The new buildings will require new RTU's to be provided by the Design-Builder.
 5. Communications from the RTU to an existing COMM room in the S&I shop will be required.

Question 50: Please confirm that the existing Dominion Power overhead 34.5KV power line located west of the existing shop building will be relocated by others in a timely manner that will not affect the construction schedule of the new shop addition. (DB ref. 180)

Answer: Existing Dominion Power line will be relocated under a WMATA work authorization prior to the Design-Builder starting work.

Question 51: From our site visits and electrical load calculations, it appears that the existing electrical rooms and equipment are not adequate to support the added electrical loads from the proposed expansions. Has WMATA had any meetings with Dominion Power to discuss the proposed expansion? Has WMATA preformed any calculations or load tests? Do you have an actual demand history? Is there any as-built information available on the incoming electrical service? (DB ref. 181) (Similar to Question 14.)

Answer: WMATA has not met with Dominion Power to discuss this matter.

WMATA's consultant is currently performing a load analysis.

The Dominion-Virginia Power system is different from PEPCO's system where WMATA has metering at various facilities. The Dominion-Virginia Power design is called a loop system where WMATA has two metering locations with two feeders per meter (therefore 4 feeders) that serve the entire segment from the Alexandria Yard to Franconia/Springfield. Each delivery point (i.e. station, traction substation, shop) has two feeds one from each metering location. WMATA has billing data for each metering point but unfortunately we can't specifically allocate electrical consumption and demand by each facility.

Available as-built information has been provided. WMATA will double-check with the Alexandria facility to see if something was missed.

Question 52: The Architectural Program Criteria, page 6; para 3.c states that "the entire blow pit floor shall be constructed and renovated to provide a non-conductive grating walking surface over a new concrete floor." Are we to remove the entire 1'-0" thick mat in the existing blow pit and repour a new concrete mat? (DB ref. 182)

Answer: Yes. The intent of the current criteria includes renovation of the existing blow pit floor, which would require removal of the existing concrete blow pit floor.

Question 53: As a follow-up to the RFI above, the Architectural Program Criteria, page 6; para 3.c also states that "the non-conductive walking surface shall be a constant 5'-0" below the top of the rail." The current shop floor is located 5'-0" below the top of the rail. In order to comply with this requirement, the entire existing slab must be removed and repoured at a lower elevation. This lowering of the slab will conflict with the existing footings that are supporting the center platform. This seems to be a costly and unique requirement (this is not a requirement at any of the other shops). Please verify that this is indeed the intent that you require for this space. (DB ref. 183)

Answer: This is the current intent for Alexandria and also Shady Grove, and should be included in the proposal. It could be reviewed in the future pending cost and schedule impacts.

Attachments/Enclosures

I. Reference Answers to Questions 1 and 26

CD #1 containing electronic files in TIF format for the following as-built drawings:

- Revenue Collection Facility Contract 1C0116: Control, General, Paving & Restoration, Survey Plot, Utilities, Trackwork, Landscape, Soils, Cover Sheet and Index drawings
- Central Maintenance Facility Contract 1C0115: Complete as-built set of drawings.

II. Reference Answer to Questions 2 and 28.

- CD #2 containing electronic files of the Alexandria RFP documents.

III. Reference Answer to Question 3.

One (1) copy copy each of the following Mueser, Rutledge soils reports done at the time of the Alexandria Yard design and construction:

- Report No. 115, MRWJ Series, Section C011a, Huntington-Springfield Routes, Service and Inspection Yard, Subsurface Investigation, October 25, 1974.
- Report No. 116, MRWJ Series, Section C011a, Huntington-Springfield Routes, Service and Inspection Shop Building, Subsurface Investigation, October 31, 1974.

IV. Reference Answer to Questions 4, 15, 30, 41 and 43.

Following revised Alexandria Yard drawings are being reissued with revisions:

<u>Dwg. No.</u>	<u>File No.</u>	<u>Revision</u>
C11-C-01	M1210-513	Revised proposed parking.
C11-C-02	M1210-514	Revised proposed parking.
C11-A-01	M1210-518	East side inspection pit: added stairs, removed requirement to delete existing stairs, deleted proposed door. West side inspection addition: revised width of overhead doors. Blow pit: showed platform.
C11-A-02	M1210-519	Showed platform in blow pit.
C11-A-03	M1210-520	Added stairs, removed requirement to delete existing stairs, deleted proposed door at east side inspection pit.
C11-A-04	M1210-521	Revised width of overhead doors at west side

Attachments/Enclosures

inspection addition.

V. Reference Answer to Question 17.

The following Specification Division 00434 Price Schedule pages are being reissued/revised:

Page 00400-11	Reissued
Page 00400-12	Revised

VI. Reference Answer to Question 24.

CD #1 containing electronic file in jpg format of the following:

- Photo of Brush Type Seal

VII. Reference Answer to Question 29.

CD #1 containing electronic file in PDF format of following document:

- Consolidated Plan (Hazardous Waste Contingency Plan; Spill Prevention, Control and Countermeasures Plan; and Stormwater Pollution Prevention Plan) for Alexandria Yard dated January 21, 2002.

VIII. Reference Answer to Question 44.

Alexandria Yard Signal Program Criteria is being revised to delete unnecessary signal work on east side of Shop. The following Criteria pages are being reissued/revised:

Page 1	Reissued
Page 2	Revised
Page 3	Revised
Page 4	Revised

IX. The following Brentwood documents have been revised and are being reissued to reflect relocation of the wheel truing machine from Track 11 to Track 9A and resulting impacts to the Shop structure.

- Drawings:

<u>Dwg. No.</u>	<u>File No.</u>	<u>Revision</u>
B5-A-09	M1210-224	Revised location of wheel truing machine, vehicle lift pits, freight elevator, equipment rooms and overhead and egress doors. Added Notes 3 and

Attachments/Enclosures

B5-A-11	M1210-226	4. Revised location of wheel truing machine, vehicle lifts and wire mesh partitions. Added Note 4.
B5-A-12	M1210-227	Revised location of vehicle lifts, freight elevator, and equipment room. Added Notes 3 and 4.
B5-A-13	M1210-228	Revised location of wheel truing machine, vehicle lifts, freight elevator and door. Added Notes 3.
B5-A-15	M1210-230	Revised location of wheel truing machine and vehicle lifts. Added Note 4.
B5-A-16	M1210-231	Revised location of vehicle lifts, freight elevator, and overhead and egress doors. Added Notes 4 and 5.
B5-A-18	M1210-233	Revised roof addition. Added Note 3.

- Architectural program Criteria:

Page 29	Revised
Page 30	Reissued

be used post-award if such is determined to be in the best interests of the Authority. They will not be used for technical leveling of the proposals prior to award.

- # Designs of unsuccessful proposers who choose to accept the stipend payment may be used after selection on a best design basis has been completed and prior to actual award, but will not be used as part of the evaluation process for selection of the awardee.

Proposers will be required to indicate whether or not they will be accepting the stipend payment as part of their Final Proposal Revisions. #

END OF SECTION

SUBMITTAL PROCEDURES a certificate of compliance with the Fly America requirements. The Design-Builder agrees to include the requirements of this Paragraph in all subcontracts that may involve international air transportation.

L. Seismic Safety:

The Design-Builder agrees that any new building or addition to an existing building will be designed and constructed in accordance with the standards for Seismic Safety required in Department of Transportation Seismic Safety Regulations 49 CFR Part 41 and will certify to compliance to the extent required by the regulation. The Design-Builder also agrees to ensure that all work performed under this Contract including work performed by a subcontractor is in compliance with the standards required by the Seismic Safety Regulations and the certification of compliance issued on the project.

M. Energy Conservation:

The Design-Builder agrees to comply with standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act.

N. Recovered Materials:

The Design-Builder agrees to comply with all the requirements of Section 6002 of the Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 6962), including but not limited to the regulatory provisions of 40 CFR Part 247, and Executive Order 12873, as they apply to the procurement of the items designated in Subpart B of 40 CFR Part 247.

00893 STEEL PRICE ADJUSTMENT (Added by AM 5)

- A. A price adjustment clause is included in this Contract to provide additional compensation to the Contractor or a credit to WMATA for fluctuations in steel prices. This price adjustment is dependent upon either: an increase or decrease in the price of steel used in the production of products utilized on this project or an increase or decrease in the ratio of the Bureau of Labor Statistics - Producer Price Index listed below. Payment or credit for steel price adjustment will be evaluated under the following conditions. Payment or credit will be made under the Contract Pay Item: Provisional Sum - Steel Price Escalation.

- B. The conditions of this provision are as follows:
1. This provision shall only apply to material cost changes that occur between the date of bid opening and the date of certified invoice. The Contractor is expected to order materials promptly upon Notice to Proceed (or upon shop drawing approval) and take possession of materials as quickly as reasonably possible.
 2. A price adjustment to provide additional compensation to Contractor will be considered and paid only where the price increase in steel is due to market conditions beyond the control of Contractor and its suppliers or vendors. No adjustment is allowed under this provision for increases due to any other cause or peril (including, but not limited to, strike, weather, vendor backlog, and delay in fabrication). If a price adjustment is sought under this provision, the Contractor shall certify to WMATA that the price increase was due solely to market conditions beyond its control or that of its suppliers and that Contractor exercised its best efforts to mitigate any price increase. WMATA reserves the right to verify the accuracy of such certification as a condition of payment.
 3. This price adjustment clause only applies to structural steel, reinforcing steel, post tensioning steel and anchors, rail, steel excavation foundation support elements, and miscellaneous guideway steelwork including handrail elements and OCS pole anchor plates and bolt assemblies. To be considered, the category of material must have a total dollar value of \$25,000 or greater.
 4. The Contractor shall submit, within 10 days of Notice of Award, the fabricator's or Supplier's material price quotes for the items listed above that meet the requirements of Paragraph B.3. The Contractor must certify that they are the actual quoted prices incorporated into the Contractor's bid (or proposal) amount submitted to WMATA for the represented pay item. WMATA has the right to inspect the Contractor's bid (or proposal) preparation documents to verify the accuracy of such certification. Assuming such certification is accurate, these certified quotes will constitute the baseline steel material price. The quote must clearly identify the pay item(s) by number and description, describe the weights of the steel material, how the steel material will be utilized in the final project, and a breakdown of all costs including material, labor, equipment, overhead and profit. This steel price escalation provision shall only apply to the steel component of the material quote. It shall not apply to any other materials used in the fabrication of an item supplied to the Contractor.
 5. For the items listed above that meet the requirements of Paragraph B.3,

the increase or decrease in the steel materials unit cost must be in excess of 5 percent of the original quoted prices or the Producers Price Index (PPI) as described below, for a price adjustment to the Contract to be allowed.

6. If there is an increase or decrease in steel materials cost in excess of 5 percent from the original quoted unit prices (or the PPI as described in Paragraph E below), WMATA will evaluate and determine an increased or decreased payment(s) under this Contract as follows:

The adjustment will be determined by computing the mathematical difference between the unit price which is 5 percent above (or below or decreases in price) the base unit price (bid quote) and the actual invoice unit price of the steel component. The final dollar value will be determined by multiplying this adjustment by the represented quantity of steel.

- C. The Contractor shall submit to WMATA certified invoices as soon as steel material is purchased. The invoices shall be listed in chronological order and contain a tabulation of quantity, the order date, the date shipped from the steel manufacturer, and the price per unit weight (reflecting all deductions from quantity shipments) with a breakdown as stipulated in Paragraph B.4 above. Freight charges shall be listed separately and are not included in this price adjustment. These invoices shall be subject to audit verification.
- D. WMATA will verify the increased or decreased percentage between certified original quote and the actual invoice payment.
- E. This change shall be supported by the U.S. Department of Labor - Bureau of Labor Statistics index entitled "Producers Price Index". The values contained in the PPI are subject to revision 4 months after original publication. The price adjustment for steel shall be a function of the percentage of change to the price index for "Carbon Steel Scrap" Series ID WPU101211. Do not use seasonally adjusted indices. This index is available on the internet at: <http://data.bls.gov/labjava/outside.jsp?survey=wp>.
- F. The Producers Price Index (PPI) listed above must increase or decrease by at least 5 percent over the same time period for Paragraph B.4 to be valid.
- G. For price increases, if the invoiced price increase, expressed or decrease by at least 5 percent over the same time period for Paragraph B.4 to be valid.
- H. For price increases, if the invoiced price increase, expressed as a percentage exceeds the PPI increase, expressed as a percentage, for the same period, the adjustment will be based on the PPI percent increase; if the invoiced price

increase, expressed as a percentage, is less than the PPI increase, expressed as a percentage, for the same period, the adjustment will be based on the invoiced price increase.

- I. For price decreases, if the value of the invoiced price decrease, expressed as a percentage, is greater than the calculated value of the PPI decrease, expressed as a percentage, for the same period, the adjustment will be based on the value of the invoiced percent decrease. If the value of the invoiced price decrease, expressed as a percentage, is less than the value of the PPI decrease expressed as a percentage, for the same period, the adjustment will be based on the PPI percent decrease.
- J. If the PPI controls in determining the price adjustment, WMATA will review the PPI 4 months after initial publication to ensure that the data have not been revised. Final payments will be adjusted accordingly.

K. Adjustment Formulas:

1. If Invoice Price Controls:

a. Price Increase:

$$(1) \text{ Factor} = (PC/PB - 1.05)$$

If Factor is equal to or less than 0.0, no adjustment will be made.

If Factor is greater than 0.0, continue: $PA = \text{Factor} \times Q \times PB$

b. Price Decrease:

$$(1) \text{ Factor} = (PC/PB - 0.95)$$

If Factor is equal to or greater than 0.0, no adjustment is made.

If Factor is less than 0.0, continue: $PA = \text{Factor} \times Q \times PB$

Where: PA= Steel manufacturing price adjustment, in lump sum dollars
PB= Fabricator/supplier quoted price in bid (converted to dollars per pound)
PC= Current certified invoice price (converted to dollars per pound)
Q= Quantity of manufactured steel, in pounds

2. If PPI controls:

a. Price Increase

$$(1) \text{ Factor} = (IC/IB - 1.05)$$

If Factor is equal to or less than 0.0, no adjustment is made.

If Factor is greater than 0.0, continue: $PA = \text{Factor} * Q * PB$

b. Price Decrease:

(1) Factor - $(IC/IB - 0.95)$

If Factor is equal to or greater 0.0, no adjustment is made.

If Factor is less 0.0, continue: $PA = \text{Factor} * Q * PB$

Where: PA = Steel manufacturing price adjustment, in lump sum dollars

PB = Fabricator/supplier quoted price in bid (converted to dollars per pound)

IB = BLS PPI index at the time of bid

IC = BLS PPI index at the time material is purchased from mill (invoice date; after final US DOL BLS adjustments)

Q = Quantity of manufactured steel, in pounds

END OF SECTION

00434 PRICE SCHEDULE - Submit with Price Proposal

A. DESCRIPTION OF WORK:

The Design-Builder shall Design and Build the Facilities satisfactorily completed for its intended use in the manner and at the locations set forth in the Requirements of the Project Manual and the Project Drawings of this solicitation, and in accordance with the Technical and Price Proposals as finally accepted by the Authority. The Design-Builder shall design the facility pursuant to the Authority's Design Criteria, and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities, and shall construct the facility in strict accordance with the Final Design Specifications and Final Design Drawings and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities.

Schedule F: ALEXANDRIA YARD OPTION

Item	Description	Unit	Amount
1	Sitework		
1-A	Demolition	LS	\$ _____
1-B	Earthwork	LS	\$ _____
1-C	Paving and Surfacing	LS	\$ _____
1-D	Piped Utilities	LS	\$ _____
1-E	Site Improvements	LS	\$ _____
1-F	Yard Electrical Work	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration		
2-A	Demolition and Earthworks	LS	\$ _____
2-B	Concrete and Masonry	LS	\$ _____
2-C	Metals	LS	\$ _____
2-D	Thermal and Moisture Protection	LS	\$ _____
2-E	Interior Construction and Finishes	LS	\$ _____
2-F	Conveying Systems	LS	\$ _____
2-G	Mechanical	LS	\$ _____

Item	Description	Unit	Amount
2-H	Electrical	LS	\$ _____
2-I	Building Communication and Electrical Specialties	LS	\$ _____
3	Major Shop Equipment	LS	\$ _____
4	Environmental Mitigation	LS	\$ _____
5	Systems	LS	\$ _____
5-A	Trackwork	LS	\$ _____
5-B	Traction Power	LS	\$ _____
5-C	Automatic Train Control	LS	\$ _____
5-D	Train Control Communications	LS	\$ _____
6	Design for Items 1 thru 5	LS	\$ _____
7	Project General Conditions	LS	\$ _____
SUBTOTAL Schedule F			\$ <u>33,437,000</u>

Schedule G: MISCELLANEOUS ALLOWANCES FOR ALEXANDRIA YARD OPTION

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ <u>20,000</u>
2	Disputes Review Board (Section 01260)	LS	\$ <u>43,000</u>
3	Spare Parts (Section 01780 1.07)	LS	\$ <u>500,000</u>
TOTAL Schedules F & G			\$ <u>34,000,000</u>

SECTION 10600

STORAGE RETRIEVAL SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. The general extent and scope of work to be performed under this Section consist of the furnishing and installation of a storage and retrieval system, including storage equipment noted below, in the new Component Parts Storage rooms at the Greenbelt Annex and the Shady Grove Shop. The existing storage and retrieval system in the Greenbelt Shop may be dismantled and reused in the Shady Grove Shop with modifications as necessary to generally conform to the requirements of this specification.

1. Storage and Retrieval System
2. Storage Cabinet, Drawer Type, 8-Drawer
3. Storage Cabinet, Drawer Type, 10-Drawer
4. Storage Cabinet, Drawer Type, 6-Drawer
5. Storage Cabinet, Drawer Type, Double Wide
6. Cabinet, Tool Lock-Up
7. Cage, Gas Cylinder
8. Shelving Unit, 18 in. Deep
9. Pallet rack (4'x9')
10. Storage Cabinet
11. Safety Storage Cabinet

B. The provisions of Section 11001, Equipment General Requirements, apply to work of this Section.

1.02 QUALITY ASSURANCE:

A. Experience: Equipment shall be produced by a manufacturer of established reputation with a minimum of five years experience supplying specified equipment.

B. Manufacturer's of drawer cabinet units shall provide documentation from an independent testing laboratory, certifying that the drawer suspension system has been tested under full rated load conditions and has experienced an average of 3,000 cycles without failure.

C. Reference Standards:

1. ANSI - American National Standards Institute
2. OSHA - Occupational Safety & Health

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

1. Certificates: Fourteen days prior to shipment, submit four copies of certification that equipment to be delivered is in compliance with applicable codes

2. Shop Drawings: In accordance with the requirements of Section 01330; Design Construction Submittal Procedures, submit six copies of complete shop drawings to the Authority for approval, including but not limited to:
 - a. Equipment arrangement
 - b. Equipment outline dimensions
 - c. Assembly and subassemblies
 - d. Air systems
 - e. Wiring diagrams and schematics
 - f. Installation

3. Operations and Maintenance Manual: Submit in accordance with the requirements of General Conditions, Section 01780; Closeout Submittals.

4. Operations and Maintenance Training: Submit in accordance with requirements of General Conditions, Section 01820; Demonstration and Training, and Section 11001; Equipment General Requirements

5. Contract Record Drawings: Submit in accordance with the General Requirements, Section 01330; Design Construction Submittal Procedures, and Section 01780, Closeout Submittals.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A Ship equipment upon notification by the Engineer.
- B Package, handle and store to prevent damage

1.05 WARRANTY

- C Furnish warranty for the work in this Section in accordance with the General Conditions.
- D Provide a Manufacturer's full service, parts and labor, warranty for a period of 3 years from date of acceptance by the Authority.

1.06 TRAINING PROGRAM:

- A Design Builder is responsible for training as outlined in General Requirements Section 01820; Demonstration and Training, and Section 11001; Equipment General Requirements
- B Number of Personnel to be Trained and class size:

Level of Training	Approximate Number of Individuals to be Trained	Maximum Class Size	Minimum Number of classes
Level I	8	8	1
Level II	4	4	1

PART 2 - PRODUCTS

2.01 STORAGE RETRIEVAL SYSTEM:

- A. General: This specification covers a storage retrieval system employing 1) integral lifting forks mounted on top of 2) variable location racks which accept 3) removable steel pallets. It includes the physical and mechanical requirements of that equipment, as well as the engineering assistance to be supplied by the vendor.
- B. Features and Construction
1. Storage racks
 - a. The storage rack shall have a maximum capacity of 25,000 pounds per section and 50,000 pounds per bay.
 - b. The overall height of the storage rack shall be 13'-0"
 - c. The clear opening between columns shall be 1 ½" greater than the pallet width.
 - d. The overall depth of each rack shall be 1 ½" greater than the pallet depth.
 2. Columns
 - a. Columns shall be accurate and straight.
 - b. Columns shall be 13'-0" long.
 - c. Roll formed front columns shall be a minimum of 3 ½" wide (left to right) by a minimum 2 ½" deep by a minimum 12 gauge thick steel and shall rest on a 5 ½" by 8" (minimum of 44 sq. in.) Bearing pad
 - d. Formed rear columns shall be a minimum 7-7/8" wide (left to right) by a minimum 2-5/8" deep by a minimum 10 gauge steel and shall rest on a 5 ½" by 8" (minimum of 44 sq. in.) Bearing pad
 - e. Each bearing pad shall be anchored to the floor with a minimum of two ½" diameter expansion anchors.
 - f. Each bearing pad shall have a minimum ½" diameter leveling screw, independent of the anchors, with a vertical adjustment of 5/16" minimum.
 - g. Each column shall have pallet retainer notches spaced a maximum of 3-7/8" on center.
 - h. The notches on the front columns shall be hooked for positive pallet engagement, while the notches on the rear columns shall be designed to facilitate loading and unloading without resistance or snagging.
 - i. Column spacing shall be a maximum of 5" on center greater than the pallet width.

3 Bridge Assembly

- a. The bridge assembly shall run on rails mounted lengthwise on the top of the storage rack and shall support the trolley and mast assemblies free and clear above the floor.
- b. The bridge shall be constructed of rectangular welded box construction using 6" x 12 pound/ft wide flange beam construction and shall be capable of supporting 2,000 pounds live load.
- c. The bridge wheels shall be 9" diameter double flange type with needle roller bearings with pressure grease fittings.
- d. A rail sweep shall be mounted in front of each wheel for derailment protection.
- e. Bridge shall have a cantilevered extension at one end.

4 Trolley Assembly

- a. The trolley assembly shall run on four wheels inside the flanges of the bridge beam and shall support the mast assembly.
- b. The wheels shall be a minimum 5" diameter flange-less wheel with permanently lubricated ball bearings.
- c. The trolley must be capable of supporting 2,000 pounds live load and shall be constructed of integral flanged steel plate to prevent binding of the turntables.
- d. In addition to the load bearing wheels, four stabilizing bearings shall be used to keep the trolley aligned within the bridge.
- e. Multiple trolleys shall be provided to serve all aisles.

5 Rails

- a. The rails shall be constructed of a minimum 20 pound per yard ASCE steel.
- b. The rails shall be mounted with sufficient accuracy to provide a smooth riding runway and must be capable of supporting the weight of the bridge, trolley, mast assemblies, and a 2,000 pound load.
- c. Rails shall terminate with stops capable of restraining a fully loaded bridge/mast assembly.

6 Mast Assembly

- a. The mast shall be constructed of two 6" minimum steel channels connected by ladder type truss members and shall be mounted to the trolley with a 360 degree continuous rotation turntable.
- b. The turntable shall be a ball bearing type and capable of free rotation when carrying a 2,000 pound load.
- c. The rollers supporting the fork mounting plate assembly must operate inside the channels on high strength machined rails.

- d. There shall be sufficient rollers to keep the fork assembly square and stable as it is raised and lowered by the chain hoist.
 - e. The mast shall be provided with a positive stop lock mechanism to prevent free-fall of the fork assembly in case of hoist chain breakage. The mechanism must restrain the free falling load in 3/4" travel or less.
 - f. Mast operating handles shall be mounted outboard of the mast for ease of rotation and shall be shrouded to prevent operator injury.
 - g. A minimum of 1/4" thick Plexiglass viewing window that is a minimum of 17" square shall be located in the mast at eye level.
 - h. A protective canopy and a trolley stop shall be provided over the operator for operator safety
7. Forks
- a. The forks shall be mounted, adjustable for pitch and width, and have a 2,000 pound capacity measured 21" from the root.
 - b. The forks shall be minimum 4" wide by 1 1/4" thick by a minimum of 1" less than the depth of the pallet.
8. Pallets
- a. Steel pallets shall be capable of holding 2,000 pound uniformly distributed load
 - b. The pallets shall mate with the racks and be adjustable using the forks of the mast assembly described above.
 - c. The pallets shall be a minimum of No. 16 gauge steel and shall be reinforced with three to five "v" supports running left to right or perpendicular to the forks
 - d. The pallets shall have two-way (front to back) entry with enclosed fork guides on the front and shall have hooks at the front to provide self-centering engagement on the front columns
 - e. Provide 5 pallets per individual storage section. Design Builder to verify total number of pallets prior to shipping. Pallets shall each have a back lip 1 1/2" high and a magnetic label holder.
9. Tub Kits
- a. A tub kit shall consist of four sidewalls which can be attached to a pallet to form a tub.
 - b. Each tub shall be designed such that it can be divided into four equal size compartments using one partition (running back to front) and two dividers (running left to right).
 - c. Sidewalls, partitions, and dividers shall be a minimum No. 14 gauge steel

- d. Provide six tub kits, each with a wall height of 8 3/4".

10. Electrical Operation

- a. Each mast and trolley/bridge system shall be provided with an electrically operated hoist capable of raising and lowering a 2,000 pound load at a speed of 16 feet per minute.
- b. The hoist shall have a 1 HP motor and shall be dual voltage with electrical characteristics: 208 volt, 3 phase, 60 hertz, or 460 volt, 3 phase, 60 hertz. The hoist shall be wired for 208 volt, 3 phase, 60 hertz for this project. All 115V power requirements for controls and lights shall be provided through a step-down transformer.
- c. The hoist shall be provided with a mechanical load brake (positive-stop type) connected to the load sheave, a solenoid-operated spring set multiple disc-type motor brake, and an overload limiting clutch (wet cone type) located in the hoist transmission.
- d. An insulated four bar power system and sliding power collector with replaceable shoes shall be provided to supply the electrical power to the trolley/bridge as specified above. Three of the bars shall supply power and the fourth bar shall be ground.
- e. Up/down controls operating with 115V control circuit shall be by push-button and located on the mast assembly convenient to a standing operator.
- f. The system shall have a key-lock power on/off switch. The key shall not be removable in the ON position. All key-lock power switches shall be keyed alike.
- g. Two 150 watt minimum reflector type flood lights shall be mounted on the trolley/bridge to provide in-use illumination. The lights shall operate on 115 VAC.
- h. The light control shall be integral with the on/off switch such that the lights are on when the system is on.
- i. Electrical components of the system shall conform to the applicable standards of UL and NEMA. All items of the same type and rating shall be identical.
- j. All electrical wiring shall conform to the standards of the National Electric Code and applicable UL standards.
- k. Protective insulated bushings shall be provided at all places where wiring passes through openings in metal panels and frames.
- l. All electrical connections shall be suitably supported to prevent breakage and other damage.
- m. Wiring shall be coded so that each wire can be easily identified from maintenance manuals, wiring schematics, and other documentation.

11. Safety Mesh

- a. Safety Mesh shall be provided to cover the rear of the individual storage bays and the open ends.

12. Finish

- a. Color shall be manufacturer's standard blue for the storage support structure; green for the pallets and safety yellow for the mast.
- b. All painted surfaces shall be cleaned and iron phosphated and shall be coated with enamel and backed in accordance with supplier's directions.
- c. The finish shall level out to produce a smooth, uniform surface without runs, wrinkles, grit areas of thin film, and separation of color.

13. Manufacturer

- a. Specifications are based on equipment identified herein by Manufacturer's name and model, and shall serve as the basis for determining acceptable standards of quality, performance, workmanship, construction and minimum features. Storage and retrieval System as manufactured by:

Stanley Vidmar
11 Grammess Road
Allentown, Pennsylvania 18103
Telephone: (215) 797-6600;
or approved equal.

2.02 DRAWER TYPE STORAGE CABINETS

- A. Drawer type storage cabinets as specified herein shall be furnished and installed as indicated on the Contract Drawings.

1. Dimensions and Capacities:

- a. Overall Dimensions:
 - (1) 27 3/4 inches deep
 - (2) 30 inches wide
 - (3) 59 inches high
- b. Capacity: 400 lbs per drawer

2. Performance Criteria

- a. Drawers, loaded to their maximum rated capacity, shall perform minimum average of 3,000 cycles each without failure
- b. Drawers, loaded to one-half their maximum rated capacity, shall perform minimum average of 12,000 cycles each without failure.
- c. Test Parameters: Manufacturer shall provide documented evidence from an independent laboratory, that the drawer suspension system has been tested

under full rated load conditions and has experienced an average of 3,000 cycles without failure. A cycle shall be defined as full extension and return with a maximum required pull force of 50 pounds.

- d. All drawers shall extend 100% out of the housing exposing all contents to reach and visibility.
- e. **Useable Drawer Space:** Drawers shall be square measuring 25.5" x 25.5" with a minimum base drawer area of 650 sq. in. Drawers shall have a minimum 631 square inches of usable drawer space. Total useable drawer space of 631 square inches times the total number of drawers specified per each unit, times the quantity of units, establishes the total square inches of drawer space for this Project.

3. Features and Construction

- a. Draw cabinet shall be of unitary design and unwelded construction. Provide welded on pallet base with detachable kick-plates.
- b. All drawer runners and carriage brackets shall be manufactured from high strength steel to provide a hardened surface for bearing wear. All drawers shall have a capacity rating of 400 pounds and a fail-safe carriage and drawer stop system which is strong enough to repeatedly contain working drawers without damage. All drawers shall have full suspension carriage systems.
- c. Each drawer front shall have a drawer pull and label system at least 22" long, and so designed to accept a label at least 1-1/8" high. Label and its clear plastic shield shall be retained in a positive manner, with plastic end caps that shield the drawer pull end from sharp edges and contribute to an enclosed system.
- d. Each drawer cabinet shall have matching shelf cabinet securely mounted on top. The shelf cabinet shall be from the same manufacturer as the drawer unit. The shelf cabinet shall be 33 inches high and have matching width and depth dimensions with the drawer unit. Each shelf cabinet shall be equipped with two (2) shelves each with a capacity of 800 lbs
- e. Each drawer cabinet shall be lockable with a single built-in lock cylinder. One key for each cabinet shall be supplied
- f. All free standing cabinets shall be bolted together following manufacturer's recommendations and using manufacturer's hardware
- g. All cabinets shall be fully assembled with all partitions screwed in place and dividers installed.
- h. The finish shall be of durable enamel in the Manufacturer's standard color.

4. Model Numbers:

- a. Eight (8) drawer cabinets, Stanley Vidmar Model #SEP 3163-AL with 104 compartments, or equal.
- b. Ten (10) drawer cabinets, Stanley Vidmar Model #SEP 3110-AL with 164 compartments, or equal.

- c. Six (6) drawer cabinets, Stanley Vidmar Model #SEP 3203-AL with 64 compartments, or equal.

2.03 CABINETS, DRAWER, DOUBLE WIDTH

- A. Double wide, drawer type storage cabinets as specified herein shall be furnished and installed as indicated on the Contract Drawings
 - 1. Dimensions and Capacities:
 - a. Dimensions:
 - (1) 60 inches wide
 - (2) 27-3/4 inches deep
 - (3) 59 inches high
 - b. Capacities: 400 lbs per drawer
 - 2. Performance Criteria:
 - a. Drawers, loaded to their maximum rated capacity, shall perform minimum average of 3,000 cycles each without failure
 - b. Drawers, loaded to one-half their maximum rated capacity, shall perform minimum average of 12,000 cycles each without failure.
 - c. Test Parameters: Manufacturer shall provide documented evidence from an independent laboratory, that the drawer suspension system has been tested under full rated load conditions and has experienced an average of 3,000 cycles without failure. A cycle shall be defined as full extension and return with a maximum required pull force of 50 pounds
 - d. All drawers shall extend 100% out of the housing exposing all contents to reach and visibility
 - e. Useable Drawer Space: Drawers shall be square measuring 55.75" x 25.5" with a minimum base drawer area of 1422 sq in. Drawers shall have a minimum 1391 square inches of usable drawer space. Total useable drawer space of 1391 square inches times the total number of drawers specified per each unit, times the quantity of units, establishes the total square inches of drawer space for this Project.
 - 3. Features and Construction:
 - a. Draw cabinet shall be of unitary design and unwelded construction. Provide welded on pallet base with detachable kick-plates
 - b. All drawer runners and carriage brackets shall be manufactured from high strength steel to provide a hardened surface for bearing wear. All drawers shall have a capacity rating of 400 pounds and a fail-safe carriage and drawer stop system which is strong enough to repeatedly contain working drawers without damage. All drawers shall have full suspension carriage systems
 - c. Each drawer front shall have a drawer pull and label system at least 22" long, and so designed to accept a label at least 1-1/8" high. Label and its clear

plastic shield shall be retained in a positive manner, with plastic end caps that shield the drawer pull end from sharp edges and contribute to an enclosed system. Provide label and covers.

- d. Each drawer cabinet shall have matching shelf cabinet securely mounted on top. The shelf cabinet shall be from the same manufacturer as the drawer unit. The shelf cabinet shall be 33 inches high and have matching width and depth dimensions with the drawer unit. Each shelf cabinet shall be equipped with two (2) shelves each with a capacity of 800 lbs.
 - e. Each drawer cabinet shall be lockable with a single built-in lock cylinder. One key for each cabinet shall be supplied.
 - f. All free standing cabinets shall be bolted together following manufacturer's recommendations and using manufacturer's hardware
 - g. All cabinets shall be fully assembled with all partitions screwed in place and dividers installed.
 - h. The finish shall be of durable enamel in the Manufacturer's standard color.
4. Model Numbers:
- a. Seven (7) drawer cabinets, Stanley Vidmar Model Number RP 3457, with 68 compartments, or equal.

2.04 CABINET, TOOL LOCK-UP

- A. Tool Lock-Up/Storage cabinets, as specified here shall be furnished and installed as indicated on the Contract Drawings.
- 1. Dimensions and Capacities:
 - a. Dimensions:
 - (1) 27 3/4 inches deep
 - (2) 30 inches wide
 - (3) 59 inches high
 - b. Capacities: 800 lbs per shelf
 - 2. Features and Construction:
 - a. Tool cabinet shall be a Stanley Vidmar Model SD-340, with three (3) shelves, model CS-80L, or equal.
 - b. Each cabinet shall have a lockable door.
 - c. Each drawer cabinet shall have matching shelf cabinet securely mounted on top. The shelf cabinet shall be from the same manufacturer as the drawer unit. The shelf cabinet shall be 33 inches high and have matching width and depth dimensions with the drawer unit. Each shelf cabinet shall be equipped with two (2) shelves each with a capacity of 800 lbs.

- d. The finish shall be of durable enamel in the Manufacturer's standard color.

2.05 GAS CYLINDER CAGE

- A. Portable gas cylinder cage as specified herein shall be furnished and installed as indicated on the Contract Drawings.

- 1. Dimensions and Capacity:

- a. Dimensions:

- (1) 56 inches wide
- (2) 42 inches deep
- (3) 68-1/2 inches high

- b. Capacity: Sixteen (16), 9-inch diameter tanks

- 2. Features and Construction:

- a. All welded heavy angle frame construction with flattened expanded mesh on all four sides, and top.
- b. Two hinged doors, lockable.
- c. The finish shall be of durable enamel in the Manufacturer's standard color
- d. "NO SMOKING" sign riveted to door.
- e. Gas cylinder cage shall be a Hodge Manufacturing Co. Model EVC-4256, or equal

2.06 GENERAL SHELVING UNITS-36" WIDE

- A. Closed offset shelving unit shall be furnished, assembled and installed as indicated on the Contract Drawings

- 1. Dimensions and Capacities

- a. Dimensions:

- (1) 36 inches wide
- (2) 18 inches deep
- (3) 84 inches high
- (4) The installed shelf height from finish floor shall be

- (a) Top shelf; 84 inches
- (b) Second shelf; 75 inches
- (c) Third shelf; 66 inches
- (d) Fourth shelf; 52.5 inches
- (e) Fifth shelf; 36 inches
- (f) Sixth shelf; 19.5 inches
- (g) Bottom shelf; 1.5 inches

- b. Capacity:

- (1) Shelf: Minimum 1300 lbs per shelf for an evenly distributed load.
- (2) Upright: Minimum 10,000 lbs per upright.

2. Features and Construction:

- a. The shelf shall be of a Class 2 rating and constructed of 18 gauge steel with continuous roll formed channel along the shelf perimeters. Front and back edges shall be triple flanged, sides shall be double flanged. Front and rear shelf edge reinforcing angles shall be installed for all shelves.
- b. The uprights shall consist of T-Post rear and front upright, constructed of minimum 16 gauge steel with bracket slots punched on 1-1/2 inch centers for vertical shelf adjustment. The shelves shall be secured by slip-in shelf brackets to reinforce and securely lock shelves into place on all four corners.
- c. The shelving units shall be equipped with a back panel and side panels. Where shelving unit are placed back to back or side to side, one back panel for the two units will be acceptable.
- d. Label holders shall be provided for the length of each shelf.
- e. These units shall be designed for assembly and adjustment without tools.
- f. All units shall be anchored to the floor.
- g. The finish shall be of durable enamel in the Manufacturer's standard color.
- h. Shelving unit as manufactured by Lyon Metal Products, Aurora Illinois, or Lista International, Holliston, Massachusetts, or equal.

2.07 PALLET RACK (4'x 9')

A Pallet racks with wire metal decks shall be furnished and installed as indicated on the Contract Drawings.

1 Dimensions and Capacities

a Dimensions

- (1) Beams: 108 inches long x 6 inches high, minimum
- (2) Upright: 48 inches deep x 144 inches high
- (3) Upright Post: 3 inches x 3 inches, minimum
- (4) Installed height, top of beam to finished floor:

- (a) 48 inches
- (b) 96 inches
- (c) 144 inches

b Capacity

- (1) Beams: 10,000 lbs per pair, with max. deflection of 0.60" for an evenly distributed load
- (2) Uprights: 32,000 lbs per upright, with 60" max. vertical spacing of beams. Minimum 3 inch x 3 inch post constructed of 13 gauge steel
- (3) Decking: Minimum 4,000 lbs. capacity per section

2. Features and Construction:

- a. The upright frame shall be continuous steel uprights with heavy duty cross and diagonal members, fabricated from minimum 13 gauge steel. They shall be punched to accept horizontal beams, adjustable at 4 inch increments on center.
- b. The base plate shall be of heavy gauge steel arc welded to uprights with holes for anchoring to the floor.
- c. The beam construction shall be of a minimum 6" high, welded step-type minimum 14 gauge steel box channel. Step shall measure 1-5/8"H x 3/4"D. There shall be three pair per section.
- d. Decking shall be heavy wire mesh type. Decking shall measure 48"D x 52"W and shall be constructed of minimum #4 gauge wire on a 2" x 4" pattern, with reinforcing channels as required to support specified capacity. The reinforcing channels shall be designed to fit the step beam specified above. Decking shall be finished with an aluminum paint.
- e. The pallet racks shall be anchored to the floor using a minimum of two 1/2" x 3" expansion bolts per anchor plate.
- f. Post protectors shall be provided for the aisle side of the upright frame.
- g. The finish shall be of durable enamel in the Manufacturer's standard color.
- h. Pallet rack as manufactured by Material Storage Products, Valdosta, Georgia, or Republic Storage Systems Company, Canton, Ohio, or Lyon Metal Products, Aurora, Illinois, or equal

2.08 STORAGE CABINET

A. Storage Cabinets shall be furnished and installed as indicated on the Contract Drawings.

1. Dimensions and Capacities

a. Dimensions

- (1) Width: 36 inches
- (2) Depth: 20 inches
- (3) Height: 42 inches

b. Capacity: Minimum, 1400 pounds per shelf.

2. Features and Construction:

- a. Full welded construction
- b. Shelves adjustable in two inch increments
- c. Shelves: - 14 gauge steel
- d. Sides and Bottom Shelf 12 gauge, one piece wrap-around construction

- e Doors - 12 gauge; 8 gauge welded hinges; 200 degree swing
- f Handle: 3 point locking device.
- g. Storage cabinets, Strong Hold Products Model Number 33 5-202, or equal.

2.09 SAFETY STORAGE CABINET

- A. Safety storage cabinets shall be furnished and installed as specified herein and indicated on the Contract Drawings.
 - 1. Dimensions and Capacities:
 - a. Dimensions:
 - (1) 43 inches wide
 - (2) 18 inches deep
 - (3) 65 inches high
 - b. Capacity: 45 gallons per cabinet
 - 2. Features and Construction:
 - a. Flammable storage cabinets shall meet NFPA code #30 and OSHA requirements.
 - b. Cabinets shall have two middle shelves adjustable on 1 5/8 inch centers.
 - c. Each cabinet shall be equipped with self-closing doors
 - d. The finish shall be of durable enamel in safety yellow
 - e. Each cabinet shall be marked "FLAMMABLE MATERIALS" with minimum 3" red letters.
 - f. Safety storage cabinet as manufactured by Equipto, Aurora, Illinois, Model Number 1792SC or equal

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install equipment specified herein in strict accordance with the approved shop drawings and manufacturer's installation instructions
- B. Install material storage units at locations indicated on the approved Design and Shop Drawing following installation procedures recommended by the manufacturer. Provide mounting hardware as required.

3.02 FIELD QUALITY CONTROL:

- A. Provide the services of a qualified manufacturer's representative to perform the following:
 - 1. Supervise installation

2. Supervise testing, in the presence of the Engineer to ensure proper operation of the equipment.
3. Provide instruction to the Authority's personnel in the proper operation and maintenance of the equipment.

END OF SECTION

Serial Number:
Date of Issue:
Final Proposal Due Date:

RFP-FN5008/FMP
December 3, 2004
May 16, 2005

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 FIFTH STREET, N.W.
WASHINGTON, DC 20001

May 6, 2005

AMENDMENT NO. 6
TO

METRO MATTERS - Design/Build: Rail Yards Expansion Project
at Brentwood, Greenbelt, and Shady Grove Yards

Phase II - Request for Final Technical / Price Proposals for all Projects

CONTRACT NO. FN5008

TO WHOM IT MAY CONCERN:

The proposal documents accompanying solicitation RFP-FN5008/FMP are hereby changed in part as follows:

1. Final Proposal Revisions are due no later than May 16, 2005 at 2:00 pm.
2. Attached please find a separate Listing showing the additional information provided with this Amendment. Included under Item IX are revised drawings to reflect relocation of the wheel truing machine from Track 11 to Track 9A at Brentwood.
3. The Proposer's attention is directed to significant changes in the Price Schedules associated with new Unit Prices (Lump Sums are to be inserted in the Price Schedule and Unit Prices will be determined by dividing the Lump Sum total by the total estimated quantities shown) for Environmental Mitigation and revised Fixed Prices for each facility. The following attached documents are to be submitted as part of your Final Proposal Revision:

Greenbelt/Shady Grove/Brentwood Projects

Pg. 00400-5 to 00400-6 Final Technical/Price Proposal Form
Pg. 00400-11 Compliance/Exception Information
Pg. 00400-15 to 00400-20a Price Schedule

Alexandria Project Option

Pg. 00400-5 to 00400-6 Final Technical/Price Proposal Form
Pg. 00400-9 Compliance/Exception Information
Pg. 00400-11 to 00400-13 Price Schedule

ACKNOWLEDGMENT

Offerors are required to acknowledge receipt of this amendment in writing on the Proposal Form in the space provided or by separate letter or telegram prior to the date established for receipt of Final Proposal Revisions


William O. Linde, Jr.
Contracting Officer

I. Interim Completion Dates and Liquidated Damages

- A. Interim Completion Dates added for Greenbelt construction. Division 0 Article 00825.A.1.a is hereby changed as follows:

Greenbelt Annex complete and operational -	NTP + 420 cd's
Greenbelt S&I Shop and Yard complete and operational -	NTP + 660 cd's

- B. Liquidated Damages for Greenbelt. Division 0 Article 00888 A.1.a is changed as follows:

Greenbelt Annex complete and operational -	\$2,940 per calendar day
Greenbelt S&I Shop and Yard complete and operational -	\$2,940 per calendar day

II. Revisions to Answers provided in previous amendments. Delete those answers and substitute the revised answer provided below:

- A. **Question 100 in Amendment No. 4:** Answer stated that two of the existing truck lifts in the Greenbelt Shop must always be operating and that temporary lifts would not be permitted. This requirement would result in phasing of work Areas 5 and 6

Revised Answer: Design-Builder is permitted access to areas 5 & 6 at the same time in order to minimize construction duration, with following constraints:

1. In north-south direction Design-Builder shall limit work to area just south of column line 8 where new truck tracks interface with existing truck tracks to the CMU wall just south of column line 19.
2. In the east west direction Design-Builder shall limit work to area just east of column line F to just east of the eastern most truck hoists. The truck hoist track and turntables closest to column line D must remain in operation to move truck assemblies to and from Tracks 6 and 7.
3. Existing 15 ton Overhead crane between column lines D and F must remain in operation to transport truck assemblies.
4. Since all four existing truck hoists will be out of service, Design-Builder shall furnish and install temporary mechanical lifts in area 4 while areas 5 & 6 are out of service. Temporary lifts must be compatible with track gauge (4' - 8 1/2") and load rating (12 tons) specified in Specification Section 14520, Truck Repair Hoist...., and provide the same inspection/maintenance capabilities as permanent lifts. Temporary lifts and their location shall be subject to approval

of WMATA. Four (4) temporary lifts are to be provided. Two of the temporary lifts shall be located in an area remote from Greenbelt Yard at the Branch Avenue Yard Shop. Costs for transportation and installation of all four temporary lifts shall be included in proposal. Training and manuals to be provided by the Design-Builder. Lifts to become property of WMATA upon installation and operation of permanent lifts.

- B. **Question 56 in Amendment 4** requested clarification on Program Criteria requiring that the Greenbelt Annex be 60 feet clear of adjacent Paint Shop and fact that loading dock intruded into this clear space. Answer stated that WMATA was coordinating with Prince George's County Fire Department to obtain a variance to the 60-foot requirement. Variance was not obtained, and therefore answer is revised as follows:

Revised Answer: To provide 60-foot clearance from Paint Shop, the footprint of Annex building shall remain as located, but loading dock will be flipped from east side of Annex next to Paint Shop to west side of Annex. This will cause first and second floor rooms to be flipped so storage room is on same side of building as loading dock, and the second floor passageway will now break into the corner of the lunch room of the existing Shop, reducing area of lunch room by about 220 SF out of about 1820 SF. New interior wall to be constructed in lunch room shall be glass. See following revised Drawings issued in Amendment 6:

<u>Drawing No.</u>	<u>File No.</u>	<u>Revision</u>
E11-A-09	M1210-061	Revised Floor Plan
E11-A-10	M1210-062	Revised Floor Plan
E11-A-16	M1210-068	Revised Floor Plan
E11-A-17	M1210-069	Revised Floor Plan
E11-A-18	M1210-070	Revised Floor Plan
E11-A-19	M1210-071	Revised Floor Plan

- C. **Question 39 in Amendment 4** requested clarification on inconsistencies in track design at Shady Grove between Track Plans and Architectural Drawings. Answer stated that the track alignment drawings would be revised to match the Architectural plans. Following Drawings have been revised and are being issued in Amendment No. 6:

<u>Drawing No.</u>	<u>File No.</u>	<u>Revision</u>
A16-TA-01	M1210-339	Revised track alignment in its entirety.
A16-TA-02	M1210-340	Revised track alignment in its entirety.
A16-TA-03	M1210-341	Revised track alignment in its entirety.
A16-TA-04	M1210-342	Revised track alignment in its entirety.
A16-TA-05	M1210-343	Revised track alignment in its entirety.
A16-TA-21	M1210-345	Revised track alignment in its entirety.

A16-TA-22	M1210-346	Revised track alignment in its entirety.
A16-TA-23	M1210-347	Revised track alignment in its entirety.
A16-TW-03	M1210 - 351	Revised track alignment in its entirety.
A16-TW-08	M1210 -351A	Revised track alignment in its entirety.

D. **Question 47 in Amendment No. 3** issued a Specification Section 10600, Storage Retrieval System. This Specification is being revised in Amendment 6 to include additional required storage equipment.

<u>Page No.</u>	<u>Revised/New</u>
10600-1 through 8	Revised
10600-9 through 15	New

Also, Information Drawings (listed below) showing the Storage Room layout for the Branch Avenue Yard Shop from Contract 1F0111 are being issued to provide guidance on the layout and quantity of Storage Room equipment. The Branch Avenue Storage Room layout is a suggested arrangement, final design is the responsibility of the Design-Builder.

<u>Drawing No.</u>	<u>File No.</u>	<u>Description</u>
F11a-EQ-3	M1014-817	Equipment Location Plan
F11a-EQ-5	M1014-819	Equipment Schedule
F11a-A-301	M1014-413	Layout Plan
F11a-A-304	M1014-416	First Floor Plan
F11a-A-311	M1014-423	Cross Sections

III. Additional Revisions to Criteria, Specifications and Drawings:

A **Deletion of Maintenance of Way Track Relocation at Greenbelt:** Refer to various Greenbelt drawings showing relocation fo Maintenance of Way FY-1 and FY-2 and replacement with a new 80-car parking lot, and Summary of Work Specification Section 01110, Sections 1.04 A.4.b. (3), (4) and (5)

- 1 Delete relocation of Maintenance of Way tracks and delete the construction of the new 80-space parking lot, with the following conditions:
 - a. Construction of new 26-space parking lot in Area M to remain.
 - b. Design-Builder to provide manpower and vehicles to transport materials stored in existing parking areas in the southwest and southeast corners of Greenbelt Yard to property owned by WMATA located in Prince George's County at the northeast corner of Britannia Way and Auth Place near Branch Avenue Station. Materials to be shrink-wrapped and placed on pallets for transportation and storage.
 - c. Design Builder to clear area of approximately 15,000 SF and provide a six-inch

compacted stone base, no grading to be done. Design-Builder to remove existing fence and scrap it, and then install approximately 250 LF of new six-foot high steel chain link fence with a 12-foot wide gate and barbed wire as specified in Specification Section 02820, Fencing, except fence posts may be driven into ground; concrete footings not required. Preparation of site and fencing to be approved by WMATA.

- d. Above work a. through c. to be performed prior to taking access of existing parking lot to be displaced by Annex building.

B Turntables: Refer to Specification Section 11300, Motorized Turntables.

1. WMATA will permit the use of non-motorized turntables in lieu of the motorized turntables currently specified. A revised specification will not be issued at this time. Non-motorized turntables shall meet the requirements of Section 11300, except for electric motor requirements. Final requirements for non-motorized turntables will be subject to the approval of WMATA. Additional requirements for non-motorized turntables include, but are not necessarily limited to, the following :

- a. The Turntable and support frame shall be all welded steel construction and shall be held in the center by an anti-friction bearing. The structural design of the Turntable shall meet criteria established in AISC (ASD 9th edition) while loaded with the specified static load and a 20% dynamic load factor, except for the suddenly applied load effect when wheel loads are transferred from the building floor rails to the Turntable rails. A 67% dynamic load factor shall be applied to the specified static load to account for the suddenly applied load effect. The center bearing shall be capable of supporting the loads including dynamic load factors while performing its primary function

- b. Operation

- (1) The Turntable shall be designed to be manually rotated by an average man when loaded with the specific weight.
- (2) The Turntable shall be capable of a rotation of 360° degrees in either direction.
- (3) Manual locking shall be provided at 90° degree positions and set to align the Turntable rails with the shop rails.
- (4) Locking devices, pit covers and other devices which protrude above floor level when the Turntables are being rotated shall be recessed below the floor deck.

C Removal of spoils from excavation at Shady Grove Yard. Reference Summary of Work Specification Section 01110.

1. Revise Article 1.04.A.4.c.(5) under Shady Grove Site Specific Features to add: "All spoils from excavation shall be removed from site and not stock-piled on site."

D. Maintenance of Way Tracks at Shady Grove

1. Revise Article 1.04.A.4.c.(7) under Shady Grove Site Specific Features to add: "Minimum two MOW tracks are required during construction totaling 900+ feet of storage track."

E. Electrical Program Criteria:

1. Revise Article 1.05.B.2.b for Brentwood Yard to add following: "Existing distribution can be reconfigured to free up two breakers to be used to feed new panelboard(s) for the new loads. Cabling to be modified, if required." Restriction on not tapping bus remains.
2. Article 1.05.B.3.c. for Shady Grove states: "Do not connect or reconnect to panelboards no longer available from their manufacturer, but replace with new equipment." Revise to say: "Where an existing panelboard is operational and not to be relocated, maintain it in use. Where an existing panelboard has to be physically relocated, replace it with a new panelboard."

F. Brentwood and Alexandria Fire and Intrusion Alarm System: Reference Summary of Work Specification Section 01110.

1. Revise Article 1.04.A.4.a.(7) for Brentwood to add: "Entire fire alarm system (existing and new) shall be addressable; each alarm shall be identified on the new panel."
2. Above requirement for Brentwood shall also apply to the Alexandria S&I Shop expansion.

G. Mechanical Program Criteria: FM200 fire suppression for electrical rooms

1. Mechanical Program Criteria, Article 1.10.I states: "Where fire suppression systems in electrical rooms are required by the local jurisdiction, Clean Agent (CF3CHFCF3) shall be provided in accordance with NFPA 2001 Standards and as follows:.....". Add the following: "Fire extinguishers in lieu of a clean agent system may be provided for electrical rooms if the following conditions are met:
 - a. Contents of room is 85% non-combustible.
 - b. Room is 3-hour rated.
 - c. Two-hour fire-rated door is provided."

H. Embedment material for shop tracks

1. Yards and Shops Program Criteria, page 3, Article 1.03M3.b. requires use of embedment material to fill the void between the rail and the edges of pocket that rail sits in. Reference Brentwood Drawing B5-TW-02 (M1210-187) and Shady Grove Drawing A16-TW-02 (M1210-350). Embedment material shall be engineered rubber railseal as manufactured by Performance Polymers, Inc. or equal, meeting all requirement of criteria article referenced above. Top of seal shall be flush with top of rail and top of floor, except for required flangeway. Installation shall be per manufacturers recommendations. Final railseal configuration and properties will be subject to WMATA approval.

IV. Proposers' Question received too late to address in Amendment 5

Question: In reviewing "Appendix A Project Manual Book 2" for Amendment 4, the Program Criteria for "Signal Control and interlocking System" page 2 section 1.04 Scope of Work, indicates the realignment of tracks on the East side of the S&I building. Specific sections are as Follows:

- 1.04.B.2a
- 1.04.B.3a
- 1.04.B.6b

The RFP drawings do not show any track realignment on the East side of the shop. During our site visit, we asked if there was to be any trackwork on the east of the S&I building. WMATA's response was that no realignment work was required.

Please confirm that no track realignment is required on the east side of the S&I building? (DB Ref17a)

Answer: Confirmed. See answer to Question 44 and revised Program Criteria pages issued in Amendment No. 5.

V. Major Subcontractors:

- A. Procurement Requirement 00204.D.3.D delete the following , "Identify all major subcontractors who will be performing twenty (20) percent or more of the work based on the target price for the project.." and insert the following "..... Identify the subcontractors to perform the following major areas of work, ATC, Communications, AC and DC Electrical, Traction Power, Mechanical and Trackwork"

VI. Section 01111 - Key Design-Builder Functions:

- A. Section 1.03.C - Design Professional: Add the following item 7: "The ATC and Communications systems shall be designed and sealed by a competent designer who shall

also be responsible for inspecting and approving the installation. The designer of record who seals these drawings shall supervise the testing and approval of all sub-systems and the overall system. The designer of record shall certify to WMATA that the systems function as designed and are safe for operation and use.

VII. Section 00204 - Proposal Format, Procedures and Evaluation Factors, and Instructions.

- A. Section 00204.D.2 - Work Approach / Schedule Compliance, item F, add the following: "A CPM Schedule shall be provided with the Final Proposal Revision (FPR). This schedule shall cover the first 120 days of the project in detail and will be used by the project in lieu of the traditional 90 day schedule required under section 01322".

VIII. Specification Section 01142, Coordination with Occupants and Operations, Under Article 1.06, Specific Conditions:

- A. Add Paragraph I to say: "Work may commence on the Brentwood Shop Ground Floor after the new Greenbelt Annex is operational and may run concurrently with modifications to the Greenbelt S&I Shop on condition that the Brentwood truck and wheel shop in Area 2 between column lines F and H and column lines 10 and 16 remains in service. This includes the wheel press, wheel boring machine, the four truck hoists and all associated equipment and furniture. Proposed work in this area to install new turntables and truck rail shall not begin until the expanded truck and wheel maintenance operation in the Greenbelt S & I Shop is operating. Should separate awards be made, contractor will need to coordinate work at Brentwood with contractor at Greenbelt."

00413 FINAL TECHNICAL/PRICE PROPOSAL FORM

DATE OF REQUEST: PHASE 2 - May 5, 2005

PROJECT: FN5008 METRO MATTERS: RAIL YARDS EXPANSION PROJECT
AT BRENTWOOD, GREENBELT, AND SHADY GROVE YARDS

REQUEST FOR PRICE PROPOSAL containing information requested herein shall be submitted by the Proposer so as to be received before: **2:00 p.m. on May 16, 2005** at the Washington Metropolitan Area Transit Authority, Office of Procurement, PRMT FILE Room 3C-02, 600 Fifth Street, N.W., Washington, D.C. 20001. Questions may be directed to the Contract Administrator, Fred M. Pohlmann at (202) 962-1529, FAX to (202) 962-6247.

In response to your Request For Price Proposal for the above referenced Contract, the undersigned hereby proposes to furnish all labor, equipment and materials and perform all work to design and construct the Project in strict accordance with the Contract requirements for the consideration of the amount proposed on the Price Schedule. If awarded the Contract within the Proposal Acceptance Period, the undersigned agrees to execute the Design-Build Contract within 10 calendar days and to furnish, if required, performance and payment bonds on standard Authority forms with good and sufficient surety or sureties.

If the Contract is executed, the undersigned further agrees to commence the work within 10 calendar days after the receipt of Notice to Proceed and to complete the work within the time specified in the Contract.

The undersigned acknowledges receipt of the following amendments to the **Request for Price Proposal under FN5008/FMP** (give number and date of each):

Amendment Number _____, dated _____
Amendment Number _____, dated _____
Amendment Number _____, dated _____
Amendment Number _____, dated _____

Note: Failure to acknowledge receipt of all amendments may cause the Price Proposal to be considered not responsive to the request, which would require rejection of the Price Proposal as unacceptable.

00413 PRICE PROPOSAL FORM (CONT.)

PROPOSER:

_____	By _____
Firm Name	
_____	_____
Address	Printed name
_____	_____
Zip Code	Title
_____	_____
Telephone	DUNS Number
_____	_____
Representative Authorized To Act on Proposer's Behalf	Alternate Authorized Representative

DIRECTIONS FOR SUBMITTING OFFER:

1. Read and comply with the Solicitation Instructions. This form is to be submitted with your Price Proposal. The Price Proposal and Price Proposal Attachments shall be submitted separately from the Technical Proposal, and the Technical Proposal shall not contain any information relating to costs.
2. The Price Proposal Form and related required documents must be sealed, marked, and addressed as follows:

WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY
PRMT FILE ROOM 3C-02
600 FIFTH STREET, N.W.
WASHINGTON, D.C. 20001

PRICE OFFER UNDER FN5008/FMP

**PRICE PROPOSALS SHALL BE TIMELY MAILED OR HAND DELIVERED TO REACH WMATA
BEFORE 2:00 p.m. (LOCAL TIME) ON DAY OF PROPOSAL CLOSING.**

00432 COMPLIANCE / EXCEPTION INFORMATION - Submit with Technical Proposal

Indicate whether the proposal submitted is intended to fully comply with the Requirements of this Request for Proposals, or if certain exceptions are taken. If exceptions are taken, the proposer shall clearly identify any exception to the requirements, terms, or conditions of any part of this RFP. Each exception must be specifically related to the particular part of the RFP to which the exception is taken. The proposer must support and explain the reason for any exceptions taken and explain the impact, if any, on the RFP requirements and state the necessity for or advantage of the exception.

Check one statement below. If exceptions are taken, explain the exceptions per the following instructions.

- The proposer certifies that its proposal is intended to comply fully with all Requirements.
- The proposer certifies that its proposal is intended to comply fully with all Requirements, except as noted (add additional sheets to explain).

00413 FINAL TECHNICAL/PRICE PROPOSAL FORM

DATE OF REQUEST: PHASE 2 - May 5, 2005

PROJECT: FN5008 METRO MATTERS: RAIL YARDS EXPANSION PROJECT, ALEXANDRIA
YARD OPTION

REQUEST FOR PRICE PROPOSAL containing information requested herein shall be submitted by the Proposer so as to be received before: **2:00 p.m. on May 16, 2005** at the Washington Metropolitan Area Transit Authority, Office of Procurement, PRMT FILE Room 3C-02, 600 Fifth Street, N.W., Washington, D.C. 20001. Questions may be directed to the Contract Administrator, Fred M. Pohlmann at (202) 962-1529, FAX to (202) 962-6247.

In response to your Request For Price Proposal for the above referenced Contract, the undersigned hereby proposes to furnish all labor, equipment and materials and perform all work to design and construct the Project in strict accordance with the Contract requirements for the consideration of the amount proposed on the Price Schedule. If awarded the Contract within the Proposal Acceptance Period, the undersigned agrees to execute the Design-Build Contract within 10 calendar days and to furnish, if required, performance and payment bonds on standard Authority forms with good and sufficient surety or sureties.

If the Contract is executed, the undersigned further agrees to commence the work within 10 calendar days after the receipt of Notice to Proceed and to complete the work within the time specified in the Contract

The undersigned acknowledges receipt of the following amendments to the Request for Price Proposal under FN5008/FMP (give number and date of each):

Amendment Number _____, dated _____

Amendment Number _____, dated _____

Amendment Number _____, dated _____

Amendment Number _____, dated _____

Note: Failure to acknowledge receipt of all amendments may cause the Price Proposal to be considered not responsive to the request, which would require rejection of the Price Proposal as unacceptable.

00413 PRICE PROPOSAL FORM (CONT.)

PROPOSER:

By _____
Firm Name

Address _____ Printed name _____

Zip Code _____ Title _____

Telephone _____ DUNS Number _____

Representative Authorized _____ Alternate Authorized Representative
To Act on Proposer's Behalf

DIRECTIONS FOR SUBMITTING OFFER:

1. Read and comply with the Solicitation Instructions. This form is to be submitted with your Price Proposal. The Price Proposal and Price Proposal Attachments shall be submitted separately from the Technical Proposal, and the Technical Proposal shall not contain any information relating to costs.
2. The Price Proposal Form and related required documents must be sealed, marked, and addressed as follows:

WASHINGTON METROPOLITAN AREA
TRANSIT AUTHORITY
PRMT FILE ROOM 3C-02
600 FIFTH STREET, N.W.
WASHINGTON, D.C. 20001

PRICE OFFER UNDER FN5008/FMP

**PRICE PROPOSALS SHALL BE TIMELY MAILED OR HAND DELIVERED TO REACH WMATA
BEFORE 2:00 p.m. (LOCAL TIME) ON DAY OF PROPOSAL CLOSING.**

00413 Price Proposal Form
Page 2 of 2

00432 COMPLIANCE / EXCEPTION INFORMATION - Submit with Technical Proposal

Indicate whether the proposal submitted is intended to fully comply with the Requirements of this Request for Proposals, or if certain exceptions are taken. If exceptions are taken, the proposer shall clearly identify any exception to the requirements, terms, or conditions of any part of this RFP. Each exception must be specifically related to the particular part of the RFP to which the exception is taken. The proposer must support and explain the reason for any exceptions taken and explain the impact, if any, on the RFP requirements and state the necessity for or advantage of the exception.

Check one statement below. If exceptions are taken, explain the exceptions per the following instructions.

- The proposer certifies that its proposal is intended to comply fully with all Requirements.
- The proposer certifies that its proposal is intended to comply fully with all Requirements, except as noted (add additional sheets to explain).

00434 PRICE SCHEDULE - Submit with Price Proposal

A. DESCRIPTION OF WORK:

The Design-Builder shall Design and Build the Facilities satisfactorily completed for its intended use in the manner and at the locations set forth in the Requirements of the Project Manual and the Project Drawings of this solicitation, and in accordance with the Technical and Price Proposals as finally accepted by the Authority. The Design-Builder shall design the facility pursuant to the Authority's Design Criteria, and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities, and shall construct the facility in strict accordance with the Final Design Specifications and Final Design Drawings and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities.

Schedule A: GREENBELT YARD EXPANSION

Item	Description	Qty	Unit	Amount
1	Sitework			
1-A	Demolition	1	LS	\$ _____
1-B	Earthwork	1	LS	\$ _____
1-C	Paving and Surfacing	1	LS	\$ _____
1-D	Piped Utilities	1	LS	\$ _____
1-E	Site Improvements	1	LS	\$ _____
1-F	Yard Electrical Work	1	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration			
2-A	Demolition and Earthworks	1	LS	\$ _____
2-B	Concrete and Masonry	1	LS	\$ _____
2-C	Metals	1	LS	\$ _____
2-D	Thermal and Moisture Protection	1	LS	\$ _____
2-E	Interior Construction and Finishes	1	LS	\$ _____
2-F	Conveying Systems	1	LS	\$ _____
2-G	Mechanical	1	LS	\$ _____

Item	Description	Qty	Unit	Amount
2-H	Electrical	1	LS	\$ _____
2-I	Building Communication and Electrical Specialties	1	LS	\$ _____
3	Major Shop Equipment (Drwg. E11a-A-06, Sections 1003 - 1009, 1012 - 1021, 1024, 1044-1046, 1048)	1	LS	\$ _____
4	Environmental Mitigation			
4-A	Petroleum Contaminated soil removal & disposal	120	CY	\$ _____
4-B	Petroleum Contaminated Ground water removal & disposal	20	1000 GLS	\$ _____
4-C	Other (Detergent, etc.) Contaminated soil removal & disposal	0	CY	\$ _____
4-D	Other (Detergent, etc.) Contaminated ground water removal & disposal	200	1000 GLS	\$ _____
5	Systems			
5-A	Trackwork	1	LS	\$ _____
5-B	Traction Power	1	LS	\$ _____
5-C	Automatic Train Control	1	LS	\$ _____
5-D	Train Control Communications	1	LS	\$ _____
6	Design for Items 1 thru 5	1	LS	\$ _____
7	Project General Conditions	1	LS	\$ _____
SUBTOTAL Schedule A				\$ <u>41,415,000</u>

Schedule B: SHADY GROVE YARD EXPANSION

Item	Description	Qty	Unit	Amount
1	Sitework			
1-A	Demolition	1	LS	\$ _____
1-B	Earthwork	1	LS	\$ _____
1-C	Paving and Surfacing	1	LS	\$ _____

Item	Description	Qty	Unit	Amount
1-D	Piped Utilities	1	LS	\$ _____
1-E	Site Improvements	1	LS	\$ _____
1-F	Yard Electrical Work	1	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration			
2-A	Demolition and Earthworks	1	LS	\$ _____
2-B	Concrete and Masonry	1	LS	\$ _____
2-C	Metals	1	LS	\$ _____
2-D	Thermal and Moisture Protection	1	LS	\$ _____
2-E	Interior Construction and Finishes	1	LS	\$ _____
2-F	Conveying Systems	1	LS	\$ _____
2-G	Mechanical	1	LS	\$ _____
2-H	Electrical	1	LS	\$ _____
2-I	Building Communication and Electrical Specialties	1	LS	\$ _____
3	Major Shop Equipment (Drwg. A-16-A-02; Equip No. 1000-1002, 1023, 1026, 1029-1030, & 1032)	1	LS	\$ _____
4	Environmental Mitigation			
4-A	Petroleum Contaminated soil removal & disposal	2500	CY	\$ _____
4-B	Petroleum Contaminated Ground water removal & disposal	100	1000 GLS	\$ _____
4-C	Other (Detergent, etc.) Contaminated soil removal & disposal	0	CY	\$ _____
4-D	Other (Detergent, etc) Contaminated ground water removal & disposal	0	1000 GLS	\$ _____
5	Systems			
5-A	Trackwork	1	LS	\$ _____
5-B	Traction Power	1	LS	\$ _____
5-C	Automatic Train Control	1	LS	\$ _____
5-D	Train Control Communications	1	LS	\$ _____

Item	Description	Qty	Unit	Amount
6	Design for Items 1 thru 5	1	LS	\$ _____
7	Project General Conditions	1	LS	\$ _____

SUBTOTAL Schedule B \$ 54,800,000

Schedule C: MISCELLANEOUS ALLOWANCES FOR GREENBELT/SHADY GROVE PROJECT

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ <u>20,000</u>
2	Disputes Review Board (Section 01260)	LS	\$ <u>86,000</u>
3	Minor Shop Equipment (Greenbelt Yard Only)	LS	\$ <u>1,500,000</u>
4	Spare Parts (Section 01780 1.07)	LS	\$ <u>500,000</u>

TOTAL Schedules A, B, C \$ 98,321,000

Schedule D: BRENTWOOD YARD EXPANSION

Item	Description	Qty	Unit	Amount
1	Sitework			
1-A	Demolition	1	LS	\$ _____
1-B	Earthwork	1	LS	\$ _____
1-C	Paving and Surfacing	1	LS	\$ _____
1-D	Piped Utilities	1	LS	\$ _____
1-E	Site Improvements	1	LS	\$ _____
1-F	Yard Electrical Work	1	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration			
2-A	Demolition and Earthworks	1	LS	\$ _____
2-B	Concrete and Masonry	1	LS	\$ _____

Item	Description	Qty	Unit	Amount
2-C	Metals	1	LS	\$ _____
2-D	Thermal and Moisture Protection	1	LS	\$ _____
2-E	Interior Construction and Finishes	1	LS	\$ _____
2-F	Conveying Systems	1	LS	\$ _____
2-G	Mechanical	1	LS	\$ _____
2-H	Electrical	1	LS	\$ _____
2-I	Building Communication and Electrical Specialties	1	LS	\$ _____
3	Major Shop Equipment (Drwg. B-5-A-05 M210-220, Equip. No. 1010, 1011, 1022 & 1035)	1	LS	\$ _____
4	Environmental Mitigation			
4-A	Petroleum Contaminated soil removal & disposal	1000	CY	\$ _____
4-B	Petroleum Contaminated Ground water removal & disposal	40	1000 GLS	\$ _____
4-C	Other (Detergent, etc.) Contaminated soil removal & disposal	1600	CY	\$ _____
4-D	Other (Detergent, etc.) Contaminated ground water removal & disposal	65	1000 GLS	\$ _____
5	Systems			
5-A	Trackwork	1	LS	\$ _____
5-B	Traction Power	1	LS	\$ _____
5-C	Automatic Train Control	1	LS	\$ _____
5-D	Train Control Communications	1	LS	\$ _____
6	Design for Items 1 thru 5	1	LS	\$ _____
7	Project General Conditions	1	LS	\$ _____

SUBTOTAL Schedule D \$ 41,508,000

Schedule E: MISCELLANEOUS ALLOWANCES FOR BRENTWOOD PROJECT

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ <u>20,000</u>
2	Disputes Review Board (Section 01260)	LS	\$ <u>43,000</u>
3	Spare Parts (Section 01780 1.07)	LS	\$ <u>500,000</u>

TOTAL Schedules D + E \$ 42,071,000

TOTAL PROPOSAL PRICE (SCHEDULES A + B + C + D + E) \$140,392,000

NOTES TO PROPOSERS:

1. The Contract(s) will be awarded to responsible contractor(s) on the basis of the proposal that provides the overall best value to the Authority in terms of design solutions, innovativeness, and technical factors based on an integrated assessment within the stated target price as shown in the Price Schedule for each Project. Multiple contracts will be awarded, however, it is required that proposals be submitted for both Projects and all items, therefore failure to submit an offer on all items may result in rejection of the proposal.
2. Unless otherwise specified, each LUMP SUM priced line item includes all labor, material, equipment, and other incidentals, ready for its intended use including, but not limited to, furnishing, installation and testing. The successful Offeror will be required to provide a detailed breakdown to the Authority Representative of all LUMP SUM items for payment purposes.
3. Schedules C and E of the Price Schedule is for items where a specific allowance is set aside by the Authority for payment. This is an estimated amount subject to negotiation and is not guaranteed. Schedule C, Item 3 is for Minor Greenbelt Shop Equipment only, all Major Shop Equipment for Greenbelt Yard is to be priced under Schedule A, Item 3 as shown.
4. As part of the determination of responsibility, the pre-award data submitted must indicate compliance with the requirement that 15% of the work is to be performed by the Design/Build contractor.
5. The proposers are advised that this contract contains Davis-Bacon provisions. The

Contractor will be required to submit certified payrolls on a weekly basis. Also, the Authority will monitor compliance by performing Labor Standards Interviews of the labor force. The Authority will hold retainage in a sufficient amount as may be considered necessary for any under payments of wages and/or fringes until they are fully resolved in accordance with the Labor Provisions of the contract.

6. The offerors are advised that the Authority will complete a "Performance Evaluation" at the end of the contract. The Performance Elements will include: Quality of Work, Timely Performance, Effectiveness of Management, Compliance with labor Standards, Compliance with Safety Standards and an Overall Evaluation. The Performance Evaluation may be used in determinations of responsibility for future WMATA contracts.
7. DBE data (See Appendix B) shall be submitted with the Final Proposal Revisions (FPR) if the Total Proposal Price is \$500,000 or more. It is required that in order to be counted towards meeting the DBE goal established for each Project, proposed DBE firms must be pre-certified by WMATA prior to submittal of FPRs. Although non-certified DBE firms can be utilized, they will not be counted towards meeting the goal.

END OF PRICE SCHEDULE

00434 PRICE SCHEDULE - Submit with Price Proposal

A. DESCRIPTION OF WORK:

The Design-Builder shall Design and Build the Facilities satisfactorily completed for its intended use in the manner and at the locations set forth in the Requirements of the Project Manual and the Project Drawings of this solicitation, and in accordance with the Technical and Price Proposals as finally accepted by the Authority. The Design-Builder shall design the facility pursuant to the Authority's Design Criteria, and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities, and shall construct the facility in strict accordance with the Final Design Specifications and Final Design Drawings and in full compliance with the Terms and Conditions of the Contract and the Rules and Regulations of the jurisdictional authorities.

Schedule F: ALEXANDRIA YARD OPTION

Item	Description	Qty	Unit	Amount
1	Sitework			
1-A	Demolition	1	LS	\$ _____
1-B	Earthwork	1	LS	\$ _____
1-C	Paving and Surfacing	1	LS	\$ _____
1-D	Piped Utilities	1	LS	\$ _____
1-E	Site Improvements	1	LS	\$ _____
1-F	Yard Electrical Work	1	LS	\$ _____
2	New Shop and Existing Shop Reconfiguration			
2-A	Demolition and Earthworks	1	LS	\$ _____
2-B	Concrete and Masonry	1	LS	\$ _____
2-C	Metals	1	LS	\$ _____
2-D	Thermal and Moisture Protection	1	LS	\$ _____
2-E	Interior Construction and Finishes	1	LS	\$ _____
2-F	Conveying Systems	1	LS	\$ _____
2-G	Mechanical	1	LS	\$ _____

Item	Description	Qty	Unit	Amount
2-H	Electrical	1	LS	\$ _____
2-I	Building Communication and Electrical Specialties	1	LS	\$ _____
3	Major Shop Equipment	1	LS	\$ _____
4	Environmental Mitigation			
4-A	Petroleum Contaminated soil removal & disposal	1500	CY	\$ _____
4-B	Petroleum Contaminated Ground water removal & disposal	90	1000 GLS	\$ _____
4-C	Other (Detergent, etc.) Contaminated soil removal & disposal	0	CY	\$ _____
4-D	Other (Detergent, etc.) Contaminated ground water removal & disposal	0	1000 GLS	\$ _____
5	Systems			
5-A	Trackwork	1	LS	\$ _____
5-B	Traction Power	1	LS	\$ _____
5-C	Automatic Train Control	1	LS	\$ _____
5-D	Train Control Communications	1	LS	\$ _____
6	Design for Items 1 thru 5	1	LS	\$ _____
7	Project General Conditions	1	LS	\$ _____
SUBTOTAL Schedule F				\$ 34,972,000

Schedule G: MISCELLANEOUS ALLOWANCES FOR ALEXANDRIA YARD OPTION

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ 20,000
2	Disputes Review Board (Section 01260)	LS	\$ 86,000
3	Minor Shop Equipment (Greenbelt Yard Only)	LS	\$ 1,500,000
4	Spare Parts (Section 01780 1.07)	LS	\$ 500,000
TOTAL Schedules F & G			\$ 35,535,000

NOTES TO PROPOSERS:

1. The Contract(s) will be awarded to responsible contractor(s) on the basis of the proposal that provides the overall best value to the Authority in terms of design solutions, innovativeness, and technical factors based on an integrated assessment within the stated target price as shown in the Price Schedule for each Project. Multiple contracts will be awarded, however, it is required that proposals be submitted for both Projects and all items, therefore failure to submit an offer on all items may result in rejection of the proposal.
2. Unless otherwise specified, each LUMP SUM priced line item includes all labor, material, equipment, and other incidentals, ready for its intended use including, but not limited to, furnishing, installation and testing. The successful Offeror will be required to provide a detailed breakdown to the Authority Representative of all LUMP SUM items for payment purposes.
3. Schedule G of the Price Schedule is for items where a specific allowance is set-aside by the Authority for payment. This is an estimated amount subject to negotiation and is not guaranteed.

Serial Number: RFP-FN5008/FMP
Date of Issue: December 3, 2004
Final Proposal Due Date: May 18, 2005

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
600 FIFTH STREET, N.W.
WASHINGTON, DC 20001

May 6, 2005

AMENDMENT NO. 7
TO

METRO MATTERS - Design/Build: Rail Yards Expansion Project
at Brentwood, Greenbelt, and Shady Grove Yards

Phase II - Request for Final Technical / Price Proposals for all Projects

CONTRACT NO. FN5008

TO WHOM IT MAY CONCERN:


The proposal documents accompanying solicitation RFP-FN5008/FMP are hereby changed in part as follows:

1. Final Proposal Revisions due date is extended to May 18, 2005 at 2:00 pm.
2. The Proposer's attention is directed to changes made in Price Schedule G, Miscellaneous Allowances for Alexandria Yard Option. Replace the following page issued in Amendment 6 with the attached revised page and include in your Final Proposal Revision:

Alexandria Project Option
Pg. 00400-12 Price Schedule

ACKNOWLEDGMENT

Offerors are required to acknowledge receipt of this amendment in writing on the Proposal Form in the space provided or by separate letter or telegram prior to the date established for receipt of Final Proposal Revisions


William O. Linde, Jr.
Contracting Officer

Washington Metropolitan Area Transit Authority Contract No. FN5008
Design-Build Contract RFP-FN5008/FMP Date: February 17, 2005

Item	Description	Qty	Unit	Amount
2-H	Electrical	1	LS	\$ _____
2-I	Building Communication and Electrical Specialties	1	LS	\$ _____
3	Major Shop Equipment	1	LS	\$ _____
4	Environmental Mitigation			
4-A	Petroleum Contaminated soil removal & disposal	1500	CY	\$ _____
4-B	Petroleum Contaminated Ground water removal & disposal	90	1000 GLS	\$ _____
4-C	Other (Detergent, etc.) Contaminated soil removal & disposal	0	CY	\$ _____
4-D	Other (Detergent, etc.) Contaminated ground water removal & disposal	0	1000 GLS	\$ _____
5	Systems			
5-A	Trackwork	1	LS	\$ _____
5-B	Traction Power	1	LS	\$ _____
5-C	Automatic Train Control	1	LS	\$ _____
5-D	Train Control Communications	1	LS	\$ _____
6	Design for Items 1 thru 5	1	LS	\$ _____
7	Project General Conditions	1	LS	\$ _____

SUBTOTAL Schedule F \$ 34,972,000

Schedule G: MISCELLANEOUS ALLOWANCES FOR ALEXANDRIA YARD OPTION

Item	Description	Unit	Amount
1	Partnering (Section 00890)	LS	\$ 20,000
2	Disputes Review Board (Section 01260)	LS	\$ 43,000
3	Spare Parts (Section 01780 1.07)	LS	\$ 500,000

TOTAL Schedules F & G \$ 35,535,000



**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
CONTRACT MODIFICATION**

Contractor: Hensel Phelps Construction Co.
4437 Brookefield Corporate Dr.
Chantilly, Virginia 20151

Modification No. 001
 Date May 22, 2006
 Contract No. FN5008

Project Description Metro Matters - Shops Expansion Program

- Contract Modification Issued Pursuant To General Conditions Article 00791
- Supplemental Agreement to Contract _____
- Pending Change Orders Included in This Modification PCO 003 (C-35B not issued)

The Contract is hereby changed as follows:

I. Compensate the Design-Builder for expenses incurred in procuring the plumbing permit for the new Annex Building. The WSSC System Development Charge (SDC) is an Owner obligation and not covered in the base contract price.

II. As a result of this change, add the following new pay item to the Contract Unit Price Schedule:

Pay Item No.	Description	Quantity	Unit	Amount
M00100	WSSC System Development Charge	1	L. S.	\$49,546.00

FINAL

III. Any adjustment in the Contract value as a result of performing the work described above shall be included for purposes of measuring the Contractor's performance relative to the goal for Disadvantaged Business Enterprise (DBE) Participation as specified in Article 00453 of the Special Provisions of the Contract and Appendix B.

IV. The terms and conditions of this contract modification constitute a full accord and satisfaction for all costs and time of performance related to the actions described or referenced herein.

Change in Contract Time:	None	Change in Contract Amount:	INCREASE \$49,546.00
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Except as provided herein all terms and conditions of the Contract as heretofore modified remain unchanged.

ACCEPTED

Hensel Phelps Construction Company
 Name of Contractor
 BY [Signature] 5/22/06
 Signature Date
William D. Stephens
 Typed Name
Project Manager
 Title

WASHINGTON METROPOLITAN AREA
 TRANSIT AUTHORITY
 BY [Signature] 05.22.06
 Signature Date
Edward M Shepperson
 Typed Name
Authority Representative



**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
CONTRACT MODIFICATION**

Contractor: Hensel Phelps Construction Co.
4437 Brookefield Corporate Dr.
Chantilly, Virginia 20151

Modification No. 002
Date 7/21/06
Contract No. FN5008

Project Description Metro Matters - Shops Expansion Program

- Contract Modification Issued Pursuant To General Conditions Article 00791
- Supplemental Agreement to Contract _____
- Pending Change Orders Included in This Modification 007, 008 & 010 (C-35Bs not issued)

The Contract is hereby changed as follows:

- I. The Design-Builder is to add options to the Tool Room Lathe (Equip. # 1014), Tool Room Lathe (Equip. # 1015) and CNC Lathe (Equipment # 1018), as described on the attached Forms C-35A for PCO Nos. 007, 008 and 010.
- II. As a result of this change, add the following new pay item to the Contract Unit Price Schedule:

Pay Item No	Description	Quantit	Unit	Amount
M00200	Options for Lathe Equipment	1	L. S.	\$38,900.00

- III. Any adjustment in the Contract value as a result of performing the work described above shall be included for purposes of measuring the Contractor's performance relative to the goal for Disadvantaged Business Enterprise (DBE) Participation as specified in Article 00453 of the Special Provisions of the Contract and Appendix B.
- IV. The terms and conditions of this contract modification constitute a full accord and satisfaction for all costs and time of performance related to the actions described or referenced herein.

Change in Contract Time: <u>None</u>	INCREASE
Change in Contract Amount: Amount:	\$38,900.00

Except as provided herein all terms and conditions of the Contract as heretofore modified remain unchanged.

ACCEPTED

FINAL

Hensel Phelps Construction Company
 Name of Contractor
 BY [Signature] 7.21.06
 Signature Date
William D. Stephens
 Typed Name
Project Manager
 Title

WASHINGTON METROPOLITAN AREA
 TRANSIT AUTHORITY
 BY [Signature] 7.21.06
 Signature
Edward M Shepperson
 Typed Name
Authority Representative



**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
CONTRACT MODIFICATION**

Contractor: Hensel Phelps Construction Co.
4437 Brookefield Corporate Dr.
Chantilly, Virginia 20151

Modification No. 003
 Date 7/21/06
 Contract No. FN5008

Project Description Metro Matters - Shops Expansion Program

- Contract Modification Issued Pursuant To General Conditions Article 00791
- Supplemental Agreement to Contract _____
- Pending Change Orders Included in This Modification 006 and 009 (C-35Bs not issued)

The Contract is hereby changed as follows:

- I. The Design-Builder is to add options to the Vertical Milling Center - 30" x 16" x 20" (Equip. # 1013) Vertical Milling Center - 50" x 20" x 25" (Equip. # 1016), as described on the attached Forms C-35A for PCO Nos. ~~007, 008 and 010~~ 006 and 009 *IB 9/9/06*
- II. As a result of this change, add the following new pay item to the Contract Unit Price Schedule:

Pay Item No	Description	Quantit	Unit	Amount
M00300	Options for Vertical Milling Center	1	L. S.	\$78,500.00

- III. Any adjustment in the Contract value as a result of performing the work described above shall be included for purposes of measuring the Contractor's performance relative to the goal for Disadvantaged Business Enterprise (DBE) Participation as specified in Article 00453 of the Special Provisions of the Contract and Appendix B.
- IV. The terms and conditions of this contract modification constitute a full accord and satisfaction for all costs and time of performance related to the actions described or referenced herein.

Change in Contract Time: <u>None</u>	Change in Contract Amount: Amount: <u>\$78,500.00</u>	<small>INCREASE</small>
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Except as provided herein all terms and conditions of the Contract as heretofore modified remain unchanged.

ACCEPTED

FINAL

Hensel Phelps Construction Company
 Name of Contractor

BY *[Signature]* 7.21.06
 Signature Date

William D. Stephens
 Typed Name

Project Manager
 Title

WASHINGTON METROPOLITAN AREA
 TRANSIT AUTHORITY

BY *[Signature]* 7/21/06
 Signature

Edward M Shepperson
 Typed Name

Authority Representative



**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
CONTRACT MODIFICATION**

Contractor: Hensel Phelps Construction Co.
4437 Brookefield Corporate Dr.
Chantilly, Virginia 20151

Modification No. 004
 Date 8/16/06
 Contract No. FN5008

Project Description Metro Matters - Shops Expansion Program

- Contract Modification Issued Pursuant To General Conditions Article 00791
- Supplemental Agreement to Contract _____
- Pending Change Orders Included in This Modification 001 (Form C-35B not issued)

The Contract is hereby changed as follows:

- I. The Design-Builder is to provide all labor, materials, use of equipment and all necessary incidentals to provide sufficient field office work space for approximately 15 WMATA employees, files and related office equipment and furnitures. and adequate parking spaces.
- II. As a result of this change, add the following new pay item to the Contract Unit Price Schedule:

Pay Item No	Description	Quantit	Unit	Amount
M00400	Authority Representative Facility Changes	1	L. S.	\$63,000.00

- III. Any adjustment in the Contract value as a result of performing the work described above shall be included for purposes of measuring the Contractor's performance relative to the goal for Disadvantaged Business Enterprise (DBE) Participation as specified in Article 00453 of the Special Provisions of the Contract and Appendix B.
- IV. The terms and conditions of this contract modification constitute a full accord and satisfaction for all costs and time of performance related to the actions described or referenced herein.

Change in Contract Time: <u>None</u>	Change in Contract Amount: <u>\$ 63,000.00</u>
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Except as provided herein all terms and conditions of the Contract as heretofore modified remain unchanged.

ACCEPTED

FINAL

Hensel Phelps Construction Company
 Name of Contractor

BY [Signature] 8.16.06
 Signature Date

William D. Stephens
 Typed Name

Project Manager
 Title

WASHINGTON METROPOLITAN AREA
 TRANSIT AUTHORITY

BY [Signature] 8/16/06
 Signature Date

Edward M Shepperson
 Typed Name

Authority Representative
 Title