CONSTRUCT RAIL CARS ACCESS PLATFORMS AT NEW CARROLLTON, WEST FALLS CHURCH

September 22, 2014
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CONTRACT NO. FQ15206

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05 12 00  Structural Steel Framing
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SELECTIVE SITE DEMOLITION

PART 1  GENERAL

1.1  SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90—New Carrollton Maintenance Facility (NC)
   2. K90—West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. The work specified in this section consists of the demolition, removal, and disposal of existing construction from the areas shown on the Contract Drawings and as required to execute the work of this Contract.
   2. Abandonment and removal of existing utilities and utility structures.
   3. Selective demolition of building mechanical, plumbing and electrical equipment and systems, including inter-unit and inter-system utility lines.

1.2  RELATED SECTIONS

A. Book 1 – Bidding and Contracting Requirements

1.3  REFERENCES

C. Codes and regulations of the jurisdictional authorities.
D. Conform to applicable code for demolition work, safety to structure, and dust control.

1.4  NOTED RESTRICTIONS

A. Notify affected utility companies before starting work and comply with their requirements.
B. Do not close or obstruct egress width to exits.
C. Do not disable or disrupt building fire or life safety systems without 3 day prior written notice to the Authority Representative.
D. Conform to procedures applicable when discovering hazardous or contaminated materials.

1.5  SUBMITTALS

A. See Book 1 – Bidding and Contracting Requirements, Section 2.5 - Contractor’s Submittals
B. Site and Building Plan showing:
   1. Areas for temporary construction and field offices.
C. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
   1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and
      construction of barricades and fences.
   2. Identify demolition firm and submit qualifications.

D. Project Record Documents: Accurately record actual locations of capped and active utilities
   and subsurface construction.

E. Documentation:
   1. Permits and releases from each owner of property where demolition debris will be
      deposited absolving the Authority of responsibility in connection with such disposal.

1.6 QUALITY ASSURANCE:

   A. Demolition Firm: Company specializing in the type of work required.

   B. Codes, Regulations, Reference Standards, and Specifications:
      1. Comply with codes and regulations of the jurisdictional authorities.

1.7 JOB CONDITIONS:

   A. During the bid period, personally inspect and examine the construction site and existing
      construction to be removed and determine the type of demolition required or dismantlement
      procedure, physical conditions, and any contingency that could be encountered during the
      demolition procedures.

   B. Prior to performing any demolition, schedule and conduct a walk-through of the site with the
      Authority to discuss scope of demolition.

   C. Existing conditions shown on the drawings are based on available plans and may not always
      reflect the actual field condition(s) due to unrecorded changes or modifications. During the
      demolition work, verify and report actual field conditions prior to demolition work and record
      the conditions which will remain.

   D. Consider the safety of the work and that of people and property on and adjacent to the work
      site when determining equipment movement and use of materials and equipment on the work
      site. Comply with the safety requirements specified in the General Provisions and Special
      Provisions.
      1. Where the safety of persons is endangered within or adjacent to the area of demolition
         work, provide barricades and warning lights.

   E. Protection and Restoration:
      1. Prevent damage to pipes, conduits, wires, cables, and other fixtures which are not
         designated for removal. Repair or replace damaged items.

PART 2 PRODUCTS

2.1 MATERIALS

   A. Provide all required temporary materials as required for the proper execution of the work of
      this Section.
PART 3 EXECUTION

3.1 PROTECTION

A. Construct, maintain, and remove on completion of work, temporary structures provided for protection of people and existing structure to remain.

3.2 SCOPE

A. Demolish, remove, and/or relocate items as indicated and as necessary for the completion of all new work activities.

B. Promptly repair, restore, or replace any damage, disturbance, or impairment of existing facilities or systems to remain.

C. Conduct demolition to minimize interference with adjacent building areas. Maintain protected egress and access at all times.

D. Provide, erect, and maintain temporary barriers and security devices.

E. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as required so that required rough grade elevations do not subside within one year after completion.

3.3 DEMOLITION AND REMOVAL

A. General:
   1. Except as otherwise specified herein, demolish entirely and remove from the site all existing construction as indicated on the Contract Drawings to be removed, or as approved by the Authority Representative to be removed.
      a. Saw cut concrete where only portions of the slab are to be removed. Cut edges to a neat, clean finish.
      b. Where indicated on the drawings to leave existing reinforcement within the concrete to be demolished, take care to chip concrete away from reinforcement without damaging the reinforcement. Clean reinforcement and coat with a rust inhibitor prior to placing new concrete.
      c. Demolition by high pressure jet cutting shall not be permitted unless written approval is given by the Authority Representative.
   2. Repair, replace, or "dress-up" as required, surfaces adjacent to demolished areas that require such work as a result of the demolition work.
   3. Prevent damage to pipes, conduits, wires, cables, and structures above and below ground which are not designated for removal. Repair or replace damaged items to the satisfaction of the owner at Contractor's sole expense.
   4. Remove trash and debris daily unless otherwise directed by the Authority Representative and do not allow waste materials to accumulate.
   5. Control and prevent the spread of dust to occupied portions of the site and avoid creation of a nuisance in the surrounding area. Use approved dust control palliatives.
   6. During construction, notify the Authority Representative of items interfering with construction and not indicated on the Contract Drawings or specified herein to be removed.

3.4 EXISTING UTILITIES

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
B. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to the Authority Representative and obtaining proper approvals and permits from local authorities having jurisdiction.

C. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to the Authority Representative, and obtaining proper approvals and permits from local authorities having jurisdiction.

D. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

E. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.5 SELECTIVE DEMOLITION FOR ALTERATIONS

A. General:
1. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   a. Verify that construction and utility arrangements are as shown.
   b. Report discrepancies to WMATA before disturbing existing installation.
   c. Beginning of demolition work constitutes acceptance of existing conditions.
2. Separate areas in which demolition is being conducted from other areas that are still occupied.
   a. Provide, erect, and maintain temporary dustproof partitions of construction specified in Book1, Section 2.50 – Pollution Abatement.
3. Remove existing work as indicated and as required to accomplish new work.
   a. Remove items indicated on drawings.
   a. Remove existing systems and equipment as indicated.
      1) Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
      2) Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
      3) Verify that abandoned services serve only abandoned facilities before removal.
      4) Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
   b. Demolition of fire protection services must be in compliance with local, state and federal regulations. Obtain all necessary approvals and permits prior to demolition.
5. Protect existing work to remain.
   a. Prevent movement of structure; provide shoring and bracing if necessary.
   b. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   c. Repair adjacent construction and finishes damaged during removal work.
   d. Patch as specified for patching new work.

B. Preparation/Protection
1. Erect and maintain weatherproof closures for exterior openings.
2. Protect existing items which are not indicated to be altered.
3. Disconnect, remove, and cap designated utility services within demolition areas.
4. Mark location of disconnected utilities. Identify and indicate capping locations on Project Record Documents.
5. Do not interfere with use of adjacent buildings. Maintain free and safe passage to and from.
6. Prevent movement or settlement of structures. Provide and place bracing or shoring and be responsible for safety and support of structure. Assume liability for such movement, settlement, damage, or injury.
7. Cease operations and notify the Authority Representative immediately, if safety of structure appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.
8. Provide, erect and maintain barricades, lighting, and guardrails as required by applicable regulatory agency to protect occupants of building and workers.

C. Execution
1. Demolish in an orderly and careful manner. Protect existing foundation and supporting structural members.
2. Except where noted otherwise, immediately remove demolished materials from site. No "on-site" salvage sales permitted.
3. Relics, antiques, and similar objects remain the property of WMATA. Notify the Authority Representative prior to removal and obtain acceptance regarding method of removal.
4. Remove materials to be re-installed or retained in manner to prevent damage. Store and protect in dry location in manner to prevent water or physical damage.
5. Remove material and equipment to be retained by WMATA. Deliver to location agreed upon. Verify items to be retained with WMATA.
6. Protect the following materials and equipment
   a. Existing wall and roof panels to remain.
   b. Existing doors to remain.
   c. Existing structural members to remain.
7. Remove and promptly dispose of contaminated, vermin infested, or dangerous materials encountered.
8. Do not bum or bury materials on site.
9. Remove demolished materials from site as work progresses. Upon completion of work, leave areas of work in clean condition.
10. If in the event hazardous materials (asbestos, PCP's, etc...) are encountered during the course of the demolition work, or if it is even suspected that such materials will or have been encountered cease work immediately in the affected area and promptly notify the Authority Representative.

D. Cutting
1. Make new openings neat, as close as possible to profiles indicated and only to extent necessary for new work.
2. Do not cut or alter structural members unless specifically indicated or approved, and do not damage reinforcing or structural steel to remain.
3. At concrete, masonry, paving, and other materials where edges of cuts and holes will remain exposed in the completed work, make cuts using power-sawing and -coring equipment. Do not overcut at corners of cut openings.
4. Upon completion of cutting and coring, clean remaining surfaces of loose particles and dust.

E. Pipes, Ducts, and Conduit
1. Remove deactivated mechanical, plumbing, and sprinkler piping, ducts, and electrical conduit, including fastenings, connections, and other related appurtenances and accessories which would otherwise be exposed in the completed work or interfere with construction operations.
2. These facilities above ceilings may remain in place if their presence does not result in interference with new work, in which case they shall be removed to extent necessary.
3. Cap deactivated piping systems at points of cutoff.
F. Reconditioning Existing Substrates
1. Clean surfaces on which new materials will be applied, removing adhesives, bitumen, and other adhering materials, as necessary to furnish acceptable substrates for new materials.
2. Perform sandblasting, chipping, grinding, acid washing, etching, and other work as required by conditions encountered and new materials involved.
3. Use of acids or other cleaning agents shall include neutralizing, washing, rinsing, and drying, as applicable.
4. Determine substrate requirements for reconditioned surfaces in cooperation with the manufacturer’s representative and installer of each new material involved.
5. Repair existing doors to remain with salvaged material and hardware from doors to be removed or new as required to full operation and weather seal. Paint in accordance with Section 09900 Paint and Coatings.

G. Electrical Demolition
1. Preparation
   a. System De-activation: Prior to performance of demolition and removal work, de-activate such existing electrical systems as indicated.
      1) Use such means and methods for permanent disconnection which render the remaining electrical systems and apparatus in conformity with the National Electrical Code.
   b. Provide temporary wiring and connections to maintain existing systems in service during construction.
      1) Temporary wiring shall conform to the requirements of NEC Article 305.
      2) Temporary electrical service work as specified in Book 1, section 2.12 Temporary Utilities and Electrical Service.

2. Existing Equipment
   a. Existing electrical equipment shall be either disconnected and removed; retained, modified and reconnected or retained and reconnected as indicated and/or as detailed on the Contract Drawings.

3. Existing Conduits
   a. All existing in-place conduits that are indicated to be re-used for new conductors shall be swabbed clean, as specified for new conduits in this Contract, prior to the installation of new conductors.
   b. Existing conduits that have been removed during the shop upgrade shall not be utilized anywhere in the project.

4. Existing Conductors
   a. Existing conductors that have been removed during the shop upgrade work shall not be utilized anywhere in the project.

5. Performance
   a. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor, except as otherwise specified. However, equipment used, and methods of demolition and removal will be subject to approval of the Authority Representative.
      1) Remove, relocate, and extend existing installations to accommodate new construction as indicated and/or as required.
      2) Remove exposed abandoned conduit systems.
      3) Remove wiring in abandoned conduit systems to source of power supply.
      4) Maintain access to existing electrical installations which remain active. Modify installations and provide access panels or plates as appropriate.
      5) Extend existing installations using materials and methods compatible with existing electrical installations, and as specified in other Sections of these Specifications.
   b. Wiring Devices:
a) Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduits serving them is abandoned and removed. Provide blank covers for abandoned outlets which are not removed.
b) Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

7) Lighting:
a) Disconnect and remove abandoned luminaires, poles, and lighting fixtures. Remove brackets, stems, hanger, and other accessories.

8) Telephone System: Only where so indicated and/or detailed on the Contract Drawings shall the telephone system be disconnected and removed, which shall include all associated service conduits.

9) Equipment:
a) Disconnect and remove electrical equipment where so indicated on the Contract Drawings.
b) Disconnect and remove abandoned distribution equipment, panelboards, disconnect switches and motor starters as indicated on the drawings or as otherwise required due to the removal of associated equipment.

10) In exposed through-structure conduit locations, or where concealed conduits become exposed by penetrating a structural floor, wall or ceiling, the abandoned conduits shall be cut below the finished structural surface in order to perform surface patching.

b. Abandoned and Salvageable Equipment and Materials
1) Abandoned electrical equipment and apparatus: Existing electrical equipment and apparatus in or on the structures, not claimed as salvage by WMATA, shall become the property of the Contractor and may not be disposed of on the Site but removed and disposed of in a lawful manner, off site.

2) Salvage: WMATA shall have the right to claim as salvage any items and materials removed under the work of this Section. Should such right of salvage be exercised by WMATA, move and neatly store removed items on site at a location agreeable to WMATA, in a manner approved by the Authority Representative.

3.6 DISPOSAL
A. Remove debris resulting from demolition work to locations outside Authority's right-of-way.

B. Legally 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. Do not burn debris at demolition site.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS
A. The selective site demolition work of this Section shall not be measured for payment.

4.2 PAYMENTS
A. The selective site demolition work of this Section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 03 60 00

GROUTING

PART 1  GENERAL

1.1  SECTION INCLUDES

A.  This Specification is applicable at the following Facilities:
   1.  D90—New Carrollton Maintenance Facility (NC)
   2.  K90—West Falls Church Maintenance Facility (WFC)

B.  This Section specifies the grouts for the individual grouting requirements stated in other Sections of the Specifications and where indicated on the Drawings.

1.2  RELATED SECTIONS

A.  Section 05 12 00: Structural Steel Framing.

1.3  REFERENCES

A.  American Concrete Institute (ACI):
   4.  ACI 308: Standard Practice for Curing Concrete.
   5.  ACI 351.1R: Grouting between Foundations and Bases for Support of Equipment and Machinery.

B.  ASTM International (ASTM):

1.4  SUBMITTALS

A.  Action Submittals:
   1.  Submit the following for approval:
      a.  Product Data:
         1)  Non-shrink metallic grout.
         2)  Non-shrink non-metallic grout.
      b.  Certificates:
         1)  Grout manufacturer non-shrink certification.

B.  Informational Submittals:
   1.  Submit the following for information:
      a.  Manufacturer’s Instructions:
1) Manufacturer’s placing instructions.

1.5 QUALITY REQUIREMENTS

A. Non-Shrink Grout Performance Qualifications: Furnish the grout manufacturer’s current independent laboratory test results indicating the grout conforms to the following:
   1. Early height change of 0.0% to 4.0%, according to ASTM C827.
   2. Hardened height change of 0.0% to 0.3% according to ASTM C1090.
   3. Compressive strength of 4,000 psi strength developed with a trowelable mix within 24 hours when tested in accordance with the requirements of ASTM C109 modified in accordance with the requirements of ASTM C1107.
   4. Placement time based on initial set of not less than 60 minutes at 70º F.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide protective covering over materials to prevent moisture damage and contamination of grout materials.

B. Store and pre-condition grout and grout materials in accordance with the grout manufacturer’s requirements. Provide air-conditioned storage if required.

C. Store grout materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.7 PROJECT CONDITIONS

A. Environmental Requirements: Protect against high and low temperatures and unfavorable environmental conditions in accordance with American Concrete Institute standards for placement of concrete (ACI 305R, 306R, and 306.1).

PART 2 PRODUCTS

2.1 MATERIALS

A. Non-Shrink Non-Metallic Grout:
   1. A factory-premixed material containing no corrosive iron, aluminums, chemicals, or gypsums meeting ASTM C1107 Grades A, B, and C.
      a. Provide a ready-mix type of grout requiring only the addition of water.
      b. Do not add other materials to the grout.
      c. For grout applications not in contact with sewage, provide grout manufactured using Type I (Normal) cement as specified in Subparagraph 2.01C this specification.
      d. For grout applications in contact with sewage, provide grout manufactured using Type II (Sulfate Resistant) cement as specified in Subparagraph 2.01C this specification.
   2. Acceptable manufacturers for non-shrink non-metallic grout include the following:
      a. Five Star Products, Inc.
      b. Euclid Chemical Company.
      c. Or approved equal.

B. Non-Shrink Metallic Grout:
   1. A factory-premixed material containing no corrosive iron, aluminums, chemicals, or gypsums meeting ASTM C1107 Grades A, B, and C.
      a. Provide a ready-mix type of grout requiring only the addition of water.
      b. Do not add other materials to the grout.
c. For grout applications not in contact with sewage, provide grout manufactured using Type I (Normal) cement as specified in Subparagraph 2.01C this specification.

d. For grout applications in contact with sewage, provide grout manufactured using Type II (Sulfate Resistant) cement as specified in Subparagraph 2.01C this specification.

e. To enhance impact resistance, provide grout containing metallic aggregate.

2. Acceptable manufacturers for non-shrink metallic grout include the following:

   a. Five Star Products, Inc.
   b. Euclid Chemical Company.
   c. Or approved equal.

C. Portland Cement:
   1. Portland Cement conforming to the requirements of ASTM C150 Type I or Type II as specified.
      a. Provide Type II (sulfate resistant) cement for applications in contact with sewage.

D. Aggregates:
   1. Fine aggregate conforming to the material quality requirements of ASTM C33.

2.2 MIXES

A. Neat Cement:
   1. Use Type I Portland Cement and water in the same proportions specified in Section 03 30 00 for Class A cast-in-place concrete, but omit the fine and coarse aggregates from the mix.

PART 3 EXECUTION

3.1 PREPARATION

A. Preparation of Surface: Clean surfaces to be grouted to be free of oil, grease, laitance, dirt and other contaminants. Remove loose material. Remove rust, paint, and oil from metal components in contact with grout.
   1. Additional Preparation: Perform additional surface preparation in accordance with manufacturer's instructions.

B. Formwork: Use forming procedures that allow proper and complete placement of grout.
   1. Pre-treat wood forms with forming oils so they do not absorb moisture.
   2. Anchor Support elements of formwork so no movement is possible. Remove supports only after grout has hardened.

C. Grout Mixing: Use power operated mechanical mixer of sufficient capacity to carry out batch mixing without interruption.
   1. Mix Non-Shrink Grout in accordance with manufacturer's instructions.

3.2 INSTALLATION

A. Provide support for equipment and machinery by placing grout between the foundations of supporting structures and the equipment and machinery bases in accordance with the requirements of ACI 351.1R.

B. Non-Shrink Non-Metallic Grout:
   1. Place non-shrink non-metallic grout in exposed and unexposed areas at locations indicated on the Contract Drawings.
2. Mix and place non-shrink non-metallic grout in accordance with the manufacturer’s published instructions.

C. Non-Shrink Metallic Grout:
   1. Place non-shrink metallic grout in areas where grouting is subject to heavy vibratory forces and at location indicated on the Contract Drawings.
   2. Mix and place non-shrink metallic grout in accordance with the manufacturer’s published instructions.

3.3 SITE QUALITY CONTROL

A. Site Tests and Inspections:
   1. During the period when grout is being placed, the Testing and Inspection Agency (Approved Agency) must perform routine and other testing of materials.
      a. Advise the Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
      b. Provide and maintain adequate and separate facilities for safe storage and proper curing of grout test samples on the Work Site for the sole use of the Approved Agency.
      c. Provide containers for transporting grout test samples to the testing laboratory.
      d. The Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements
      e. Failure of the Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered; neither does it obligate the Engineer or Owner to grant final acceptance of the Work.
   2. Compressive Strength Test:
      a. Test Procedure:
         1) A test sample will be obtained from the first placement of the day and for every 3 cubic yards of grout placed each day.
         2) The grout will be tested in accordance with the requirements of ASTM C109 modified in accordance with the requirements of ASTM C1107.
      b. Acceptance Criteria:
         1) Grout meeting the requirements specified in Subparagraph 1.05 will be acceptable.
   3. Inspections:
      a. All grout placement will be visually inspected to verify if proper placement procedures are being followed.

B. Non-Conforming Work
   1. Remove under-strength grout, and replace the removed grout with grout meeting the specified requirements.
PART 4  MEASUREMENTS AND PAYMENTS

4.1  MEASUREMENTS

   A. The grouting work of this Section provided complete in place as shown on the Contract Drawings, including required surface preparation, formwork, mixing, and application: and approved by the Engineer shall not be measured for payment.

4.2  PAYMENTS

   A. The grouting work of this Section shall not be measured for payment, but shall be considered incidental to roof top access platform at New Carrollton, West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Specification is applicable at the following Facilities:
   1. D90—New Carrollton Maintenance Facility (NC)
   2. K90—West Falls Church Maintenance Facility (WFC)

B. This Section covers the fabrication, and installation of structural metal framing.

1.2 RELATED SECTIONS

A. Section 03 60 00: Grout.

B. Section 05 31 00: Steel Decking.

C. Section 05 53 00: Metal Gratings.

D. Section 05 52 13: Pipe and Tube Railings.

E. Section 09 90 00: Painting and Coating.

1.3 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. AISC 360; Specification for Structural Steel Buildings.
   2. AISC 303; Code of Standard Practice for Steel Buildings and Bridges.

B. American National Standards Institute (ANSI):
   1. ANSI B18.22.1, Plain Washers.

C. ASTM International (ASTM):
   6. ASTM A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   10. ASTM A992, Standard Specifications for Structural Steel Shapes.

D. American Welding Society (AWS):
   1. AWS D1.1 Structural Welding Code - Steel.

E. SSPC; The Society for Protective Coatings:
   1. SSPC Painting Manual.

1.4 SUBMITTALS

A. Structural Steel Shop Drawings:
   1. Submit shop drawings identifying the details as indicated on Drawings, indicating completely the location in the project, the size and weights of the members, the methods of joining various components, the quantity, finish, the location and type of anchors and necessary measurements.
   2. Provide easy-to-read markings on shop and erection drawings for shop assemblies which require markings for erection identification.
   3. Note on shop drawings variations in tolerances or clearances between various products.
   4. Use standard welding symbols of the AWS on shop drawings; show size, length, and type of each weld.
   5. Provide shop drawings prepared under the supervision of and sealed by a Professional Engineer licensed in the state where the project is located experienced in structural engineering.

B. Working Drawings:
   1. Furnish setting diagrams, templates, and directions for the installation of structural framing anchor bolts, bearing plates, and other embedded items.

C. Project Standards:
   1. Submit standards for typical beam, girder, column splices, and moment connection details prior to submitting detail drawings; standards shall be prepared under the supervision of and sealed by a Professional Engineer licensed in the state where the project is located.

D. Product Data:
   1. Submit data for approval related to the following:
      a. For items defined in Paragraph 2.01B this specification.
      b. Welding electrodes.
      c. Headed type studs.
      d. Paint primer.

E. Welding Certifications:
   1. Prior to commencing work requiring welding, submit the procedure which will be used for prequalifying welders and welding procedures. For all procedures other than those set forth in AWS D1.1, submit a copy of procedure qualification test records.
2. Submit certified copy of qualification test record showing each welder, welding operator, and tacker who will be employed in the work has satisfactorily passed AWS qualification tests for welding procedures.

3. Submit certified copy of reports for all analyses and tests required by referenced ASTM Specifications, including test reports for filler metals for welding, and mechanical tests for high-strength threaded fasteners.

F. Test Results:
1. Submit reports signed by the manufacturer certifying their products comply with requirements specified.
2. Submit test reports certifying material conforms to ASTM specification.
3. Submit guarantee showing all steel used for this project is American-made.
4. Submit written affidavits from steel manufacturer indicating the percentage of post-industrial recycled content (90% min.) and post-consumer recycled content (75% min.).

G. Qualification Statement:
1. Submit qualification statement denoting the requirements of this specification are met by the following:
   a. Structural steel fabricator qualifications
   b. Structural steel erector qualifications
   c. Professional Land Surveyor
   d. Hot-Dip Galvanizing Company.

H. An Independent Testing and Inspection Agency (Approved Agency) shall submit inspection and testing reports required by this Section.


1.5 QUALITY CONTROL

A. Qualifications:
1. Fabricator: Company experienced in fabricating structural steel similar to that indicated for the project who has a successful in-service performance for a minimum of 5 continuous years and sufficient production capacity.
   a. Fabricator shall conform to at least one of the following three items, and submit evidence of such per 1.04.G.1.a:
      1) Participate in the AISC Quality Certification Program and be designated an AISC Certified Plant with Category STD at time of bid.
      2) Be accredited by IAS Fabricator Inspection Program for Structural Steel (AC172)
      3) Employ an independent inspection or quality control agency, approved by the Authority’s Representative, to conduct periodic, in plant inspections at the fabricator’s plant at a frequency that will assure the fabricator’s conformance to the requirements of the inspection agency’s approved quality control program.
   b. Fabricator shall have sufficient production capacity to produce and deliver the materials on time to meet the approved construction schedule for this Contract.

2. Erector: Company experienced in erecting structural steel work similar to that indicated for the project who has a successful in-service performance with a minimum of 5 continuous years of experience.

3. Welder, Tacker, and Welding Operator Qualifications: Use welders, tackers, and welding operators who have been previously qualified by tests as prescribed in the Structural Welding Code, AWS D1.1 of the American Welding Society to perform type of work required.

4. Land Surveyor: A surveyor licensed in the state where the work is performed who is qualified to determine and verify the top of steel elevations and the edge of slab locations for each elevated framed level and to verify the structure is square, plumb, and level in
accordance with AISC tolerances.

5. Hot-Dip Galvanizing Plant Qualification:
   a. Company shall be a member of the American Galvanizers Association (AGA).
   b. Submit letter denoting plant location proposed for the defined work and number of years of experience performing galvanizing work similar to work denoted in this Contract.
C. Comply with applicable provisions listed in those references stated in Paragraph 1.03 of this specification unless otherwise indicated.

D. Structural Tests and Special Inspection
1. Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field by an Independent Testing and Inspection Agency (Approved Agency).
2. Such inspections and tests will not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
   a. Promptly remove and replace materials or fabricated components that do not comply.
   b. Requirements for code-related Special Inspections are defined in General and Special Provisions.

3.4 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials to site at such times and intervals to ensure continuity of installation and uninterrupted progress of work.
B. Store steel on platforms, skids, blocking or other supports to prevent dirt and debris contact. Protect from exposure to conditions that produce rust.
C. Handle steel so no parts are bent, broken, or otherwise damaged and avoid damage to other material and work. Store beams with webs vertical. Exercise care to avoid scraping and over stressing the steelwork.
D. Mark weight on all members. Match-mark all shop pre-fitted members.
E. Ship small parts, such as bolts, nuts, washers, pins, fillers, and small connecting plates and anchors in boxes, crates, or barrels. Pack separately each length and diameter of bolt and each size of nut and washer. Plainly mark an itemized list and description of the contents on the outside of each container.
F. Replace pieces bent or damaged unless repairs are authorized by the Engineer.

3.5 JOB CONDITIONS
A. Provide anchor rods and other anchorage items to be embedded in or attached to concrete, masonry, or other materials in ample time to not delay work.
   1. Furnish setting drawings, templates, and installation directions.

PART 2 PRODUCTS
2.1 MATERIALS
A. Steel
   1. Structural Steel: ASTM A36, ASTM A572 Grade 50, ASTM A992; as noted on drawings.
   2. Structural Steel Rectangular (Square) HSS Tubing: ASTM A500, Grade B.
   3. Structural Steel Pipe: ASTM A53, Grade B.
B. Fasteners
   1. High-Strength Bolts: ASTM A325.
      b. Hardened Steel Washers: ASTM F436, Type 1.
d. Direct Tension Indicators (for use in slip-critical and pre-tensioned connections):
   ASTM F959, Type 325.
e. Twist-Off-Type Tension Control Bolt Assemblies: ASTM F1852.

2. Fastener Assemblies:
a. Supply nuts that are lubricated.
b. The bolt, lubricated nut, and washer assembly shall be tested prior to shipment.

3. Anchor Rods:
a. Rods: ASTM F1554, Grade 36, 55, 105 as noted on drawings.


5. Adhesive Anchoring System: Provide adhesive anchors that meet ACI 318 Appendix D requirements for cracked concrete and that have a current approved ICC-ES Evaluation Report. The adhesive anchor setting system shall be composed of anchors and fasteners as specified, and a self-contained cartridge system capable of dispensing epoxy components in the proper mixing ratio.
a. Anchor Assembly
   1) Standard Anchor Rod Assembly: Chamfered end threaded stud rod of ASTM F1554 Grade 36 steel with nut and washer. Stud size as indicated on Drawings.
   2) Stainless Steel Anchor/Fastener: Chamfered end threaded stud rod of AISI Type 304 stainless steel, with nut and washer of AISI Type 316 stainless steel.
   3) Deformed Reinforcing Bar conforming to ASTM A615.
   4) Anchor element shall meet a tested elongation of 14% and a reduction of area of at least 30% per ACI 318 Appendix D.
b. Adhesive Cartridge: The dual cartridge shall contain both hardener and resin and shall be dispensed from the dual cartridge through a static mixing nozzle.
   1) The Pre-mixed adhesive shall be injected directly into the prepared anchor hole. The anchor/fastener shall be inserted in the adhesive in accordance with the adhesive manufacturer’s installation instructions. Only injection tools and static mixing nozzles as recommended by manufacturer shall be used.
   c. Use of Fast-Setting Epoxies is expressly prohibited.
d. Use of Adhesive Anchors for overhead or direct tension applications is prohibited.
e. Adhesive anchors shall not resist gravity loads in fire-rated construction.
f. Acceptable Manufacturers:
   4) Approved equal.

C. Welding Electrodes:
   1. AWS D1.1, E70XX.
   2. Use low-hydrogen electrodes for field welding.

D. Paints and Coatings:
   1. Primer Coat:
      a. Primer shall be compatible with selected finish coat.
      b. Provide a two-component, fast-curing, low volatile organic compound (VOC), metallic zinc-rich epoxy primer complying with the requirements specified in SSPC Paint 20 to steel members that do not receive intumescent finish paint coating.
   2. Finish Coat: See Section 09 90 00.
   3. Below Grade Coating: Coal tar epoxy.
   4. Galvanizing: Hot-dip galvanize steel members and fabrications specified to be galvanized in accordance with ASTM A123.
b. Repair areas damaged by welding, flame cutting or during handling, transport and erection by an approved method in accordance with ASTM A780.

E. Non-Shrink, Non-Metallic Grout: As specified in Section 03 60 00.

F. Headed Type Studs:
   1. ASTM A108; weld in accordance with AWS D1.1
   2. For shear connector application to floor beams, see Specification 05 31 00.

2.2 FABRICATION

A. Fabricate structural steel in accordance with the Contract Drawings and the AISC standards referenced in Paragraph 1.03A.

B. Perform shearing, flame cutting, and chipping carefully and accurately so as not to induce residual stress in the metal being cut.
   1. Flame-cut the edges of members subjected to dynamic loading either by using a mechanically guided torch or by hand, and remove all nicks.
      a. Fabricate the radii of re-entrant gas-cut fillets as large as practicable, but in no case less than ¾ inch.
      b. Perform flame cuttings so that the metal is not carrying stress.
      c. Finish the exposed edges of members that were flame-cut by hand by grinding.
   2. Add additional reinforcing as required where members are cut or coped to meet framing conditions.

C. Bolt Holes:
   1. Punch, drill, subpunch, subdrill, and ream holes for bolts as required in accordance with the requirements specified in the AISC Specifications referenced in Paragraph 1.03A.

D. Holes for Other Work:
   1. Provide holes required for securing other work to structural steel framing and for passage of other work through members as shown on final approved shop drawings.
      a. Ream, drill, or punch holes perpendicular to metal surface.
      b. Do not flame-cut holes or enlarge by burning.
   2. Do not make additional openings in members not shown on the final approved shop drawings unless approval to do so is received from the Engineer.

E. Mill the ends of columns and other members that will transmit loads in bearing.

F. Except where welded connections are shown, use ASTM A325 bolts for shop connections.
   1. Install and tighten high-strength bolts in accordance with the requirements of the RCSC Specification for Structural Joints Using High-Strength Bolts.
   2. Arrange the bolts as indicated on the Contract Drawings; or if not indicated, arrange the bolts so heads show in areas exposed to view.
   3. Clearly indicate the bolt arrangements on shop drawing submittals.

G. Welding:
   1. Perform all welding in accordance with AWS D1.1 except as modified herein.
   2. Use a welding procedure and sequence of welding that prevents needless distortion and minimize stresses.
      a. If it is necessary to straighten transverse warpage of flanges, use controlled heating along outside face.
      b. Allow for expected weld shrinkage when laying out and assembling members in the shop.
      c. Trim members to size only when most or all of welding has been completed.
3. Weld tabs for temporary bracing and safety cabling at points concealed from view in the completed structure.

H. Properly mark and match-mark materials to facilitate handling and field assembly.
   1. Mark each member with its weight.
   2. Match-mark all shop pre-fitted members.

2.3 FINISHES

A. Cleaning:
   1. After fabrication, clean heavy deposits of oil and grease from unpainted steel surfaces in accordance with AISC’s Code of Standard Practice.

B. Shop Priming:
   1. Surface Preparation:
      a. Clean the surfaces in accordance with the requirements of SSPC-SP 3 Power Tool Cleaning following the SSPC Painting Manual.
   2. Primer:
      a. Immediately after surface preparation, apply the fabricator’s standard rust-inhibiting primer according to the manufacturer’s instructions at a rate as recommended in the SSPC Painting Manual to provide a dry film thickness of not less than 1.5 mils.
      b. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
      c. For members to receive intumescent paint, apply a primer compatible with the finish coat.
   3. Refer to additional requirements specified in Section 07 81 00 and Section 09 90 00.

C. Finish Coat:
   1. Apply finish coats of paint to structural steel in accordance with the requirements of Section 09 90 0.

D. Below Grade Coating:
   1. Where structural steel is placed below grade, apply a coal tar epoxy coating to a total thickness of 20 mils.

E. Galvanizing:
   1. For structural steel specified to be galvanized, hot-dip galvanize the steel members and fabrications in accordance with ASTM A123 and to the thicknesses specified therein.
   2. Repair galvanized areas damaged by welding and flame cutting and during handling, transport, and erection by using an approved repair method in accordance with ASTM A780.

F. Do not paint the following surfaces of structural steel members:
   1. Connection plates and members where slip-critical connections are required.
   2. Surfaces in contact with fireproofing as specified in Section 07 81 00.
   3. Surfaces to be encased in concrete, except for the initial two (2) inches of the length embedded.
   4. Top flanges of beams to which metal grating or shear connectors are to be attached.
   5. Surfaces that are within ½ inch of the toe of a weld prior to welding.

2.4 SOURCE QUALITY CONTROL

A. Materials and fabrication procedures are subject to inspection and tests by an Independent Testing and Inspection Agency (Approved Agency) in the mill and shop.
1. Provide the Approved Agency with access to the places where structural steel work is being fabricated or produced so the required inspections and testing can be performed before the work is shipped.

B. Shop-Bolted Connections:
1. The Approved Agency will inspect and test the shop-bolted structural steel connections in accordance with the AISC specifications listed in Paragraph 1.03A.
   a. Verify proper fastening components were used and the connected elements were fabricated properly.
   b. For slip-critical and pretension connections, test 2 bolts per connection.

2. Acceptance Criteria:
   a. Verify proper fastening component used.
   b. Verify proper fabrication of connected elements.

C. Shop Welding:
1. The Approved Agency will verify all welders and welding materials being supplied under this Contract are properly certified and will conduct the inspections and tests specified.
   a. Inspect and test shop welds made during fabrication of structural steel assemblies by performing a visual inspection of the full length of all welds and inspecting and testing shop-welded connections in accordance with the requirements of ASTM E164 and the following:
      1) Ultrasonically inspect and test the entire length of all full penetration welds in accordance with the requirements of ASTM E164.
      2) Inspect the entire length of fillet welds in accordance with the requirements for the Magnetic Particle Method specified in ASTM E709 and the following:
         a) For gusset plates welded to steel members, test 20 percent of fillet weld locations.
         b) For all other fillet weld locations, test a minimum of 5 percent of the welds.
   b. Record both the type and location of all defects found in the work, and record the work required and the work performed to correct deficiencies.

2. Acceptance Criteria:
   a. Verify weld materials, locations, and types agree with Construction Documents.
   b. Verify welds comply with AWS D1.1.

D. Submit mill test reports certifying the material provided conforms to the appropriate ASTM specification.

E. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Before proceeding to erect the structural steel, verify the elevations of concrete and masonry bearing surfaces and locations of anchorages are in compliance with the Contract Documents and ready to receive the work of this Section.

B. Ensure anchor rods and other embedded items, that vary in location from the dimensions shown on the Contract Drawings, are positioned within the tolerances listed in the AISC Code of Standard Practice for Steel Buildings and Bridges.

C. Do not proceed with erection until unsatisfactory conditions have been corrected.
1. Immediately report errors in the structural steel, whether resulting from shop fabrication or deformation resulting from handling or transportation, which will prevent the proper erection and fitting of parts.

3.2 ERECTION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads.
   1. Leave temporary bracing in place as long as required for safety.

B. Erect steel structures plumb in the location and at the elevations shown on the Contract Drawings and in accordance with the match marks, pertinent regulations, and the AISC standards referenced in Paragraph 1.03A.
   1. Align column bases and bearing plates for beams and similar structural members using steel wedges or shims.
   2. Do not field cut or alter structural members without the approval of the Engineer.
   3. Allow concrete foundations to cure for a minimum of 14 days before tightening anchor rod hardware.
      a. Do not tighten anchor rod hardware using impact torque wrenches.
   4. Apply a coal tar epoxy coating to steel below grade.

C. Bolted Connections:
   1. For connections using high-strength steel bolts, conform to requirements of the AISC Specifications referenced in Paragraph 1.03A.
      a. Assemble high-strength bolted parts so they fit solidly together when assembled.
         1) Remove scale, dirt, and other defects liable to prevent proper seating when joint surfaces are assembled, including joint surfaces adjacent to washers.
         2) Do not use gaskets or any other interposed compressible materials.
         3) Only use drift pins for bringing members into position, not to enlarge or distort holes.
   2. Ensure holes are not enlarged and the metal in the vicinity of the holes is not disturbed by drifting during assembly.
      a. Enlarge holes to admit bolts for connections only if approved by the Engineer.
         1) Make the enlargement by reaming and not by burning.
         2) Avoid hand reaming.
   3. As erection progresses, install sufficient bolts in the work to resist dead loads, wind loads, and erection loads.
      a. Arrange and insert the bolts so bolt heads show in areas exposed to view.
      b. Perform permanent bolting when sufficient alignment has been completed to ensure as much of the structure as possible will be supported by such fastening work.
   4. For bearing-type (snug-tightened) connections, tighten the ASTM A325 bolts to a snug tight condition by either applying a few impacts from an impact wrench or the full effort of an ironworker using an ordinary spud wrench so all plies of the connected material have been brought into snug contact.
   5. For slip-critical and pretension connections, tighten the ASTM A325 bolts, nuts, and direct tension indicators or twist-off-type tension control bolt in accordance with the AISC specifications listed in Paragraph 1.03A.
      a. Clean oil, paint, or lacquer from the contact surfaces of slip-critical joints.
      b. Place direct tension indicators under either the bolt head or the hardened washer.
         1) If direct tension indicators are placed under the turned element, place a hardened round steel washer between the direct tension indicator and the turned element.
      c. To ensure proper tensioning of these connections is achieved, have a representative from the direct tension indicator supplier on site during their initial tightening to witness and approve of the degree of tightening.
D. Field Welding:
1. Provide only where approved by the Engineer or as indicated in the approved shop drawings.
   a. Securely tighten erection bolts used in welded construction and leave them in place.
   b. Field welding rigid frame flange connection plates on columns may only be performed if required for ease of erection and must be clearly indicated on the approved shop drawings and approved by the Engineer.

E. After the supported members have been aligned, properly positioned, and the anchor nuts have been tightened, dry-pack the entire area under bearing plates with non-shrink non-metallic grout.
1. Do not place concrete on steel structure until the grout is in place and anchor bolts have been tightened.

F. Prior to installing metal grating, clean all heavy rust, mill scale, dirt, or other material from the unpainted top flanges of supporting beams.

3.3 FIELD QUALITY CONTROL

A. An Independent Testing and Inspection Agency (Approved Agency) shall be engaged to inspect high-strength bolted connections and welded connections, to perform the specified tests, and interpret the test results; to confirm that the structure is square, plumb, and level in accordance with AISC tolerances; and to prepare and submit test reports for this work.

B. Field-Bolted Connections:
1. The Approved Agency will inspect and test the field-bolted structural steel connections in accordance with the AISC specifications listed in Paragraph 1.03A and as specified.
   a. Verify proper fastening components were used and the connected elements were fabricated properly.
   b. Slip-critical and pretension connections, test 2 bolts per connection.
2. Acceptance Criteria:
   a. Verify connections comply with the requirements specified in AISC and RCSC specifications.

C. Field Welding:
1. The Approved Agency will verify all welders and welding materials in the field are properly certified and will conduct the inspections and tests specified.
   a. Inspect and test field welds, in accordance with the requirements of AWS D1.1, made during erection of structural steel assemblies by performing a visual inspection of the full length of all welds and the following:
      1) Ultrasonically inspect and test the entire length of full penetration welds in accordance with the requirements of ASTM E164:
      2) Inspect the entire length of fillet welds in accordance with the requirements for the Magnetic Particle Method specified in ASTM E709 and the following:
         a) For beam connection plates (angles) welded to plates embedded in concrete, test all welds.
         b) For diagonal bracing members welded to gusset plates, test 40 percent of fillet weld locations.
         c) For gusset plates welded to steel members, test 40 percent of fillet weld locations.
         d) For all other fillet weld locations, test a minimum of 10 percent of the welds.
   b. Record both the type and location of all defects found in the work, and record the work required and the work performed to correct deficiencies.
2. Acceptance Criteria:
   a. Verify welds comply with the requirements specified in AWS and ASTM specifications will be acceptable.
   b. Verify welders and welding materials are properly certified.

D. Verification of Conditions
   1. Have the Professional Land Surveyor survey each elevated framed level to determine the top of steel elevations and the edge of slab locations, and verify that the structure is square, plumb, and level in accordance with AISC tolerances.
      a. Submit a certified copy of the Professional Land Surveyor’s survey denoting top of steel elevations and the edge of slab locations for approval.
   2. Verify only erectors qualified as specified herein erect the structural steel.

3.4 REPAIR/RESTORATION

A. Remove and replace work that does not comply with specified requirements.
   1. Correct deficiencies in structural steel work that inspections and test reports have indicated to be not in compliance with requirements.
   2. Additional tests performed by the Approved Agency to reconfirm any noncompliant original work and verify compliance of corrected work will be performed at no additional cost to the Owner.

B. Immediately after erection, clean field welds, bolted connections, and areas where shop paint is abraded; prime them with paint of the same quality as that used for the shop coat in accordance with the requirements specified in Section 09 90 00.
   1. Repair galvanized areas damaged by welding and flame cutting and during handling, transport, and erection by using an approved repair method in accordance with ASTM A780.

C. Apply touch-up paint to exposed areas using material as specified in Section 09 90 00.
   1. Completely blend touch-up paint with adjacent surfaces on all steel members.

D. Repair galvanized areas damaged by welding and flame cutting and during handling, transport, and erection by using an approved repair method in accordance with ASTM A780.

3.5 NON-CONFORMING WORK

A. Non-Conforming Work
   1. Promptly remove and replace Work that does not comply with specified requirements.
      a. Correct deficiencies in the Work that inspections and test reports have indicated to be not in compliance with requirements.
   2. Record the work required and the work performed to correct deficiencies in field welding.
   3. Depending on the amount of non-conforming work encountered, the amount of testing required may be modified.
PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The structural steel framing work of this Section shall not be measured for payment.

4.2 PAYMENTS

A. Payment for the work provided under this Section shall not be measured for payment, but shall be incidental to roof top access at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 05 50 00
META L FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90—New Carrollton Maintenance Facility (NC)
   2. K90—West Falls Church Maintenance Facility (WFC)

B. All specialty metal items required to complete the Work in accordance with the intent of the Drawings and Specifications shall be furnished and installed, regardless of whether or not specifically shown or described. Such items include loose or embedded items of structural shapes, plates and bars, welded plate inserts, fabrications, and similar items. Bolts, expansion anchors, and other fastening devices, which may or may not be provided with the indicated or specified items, shall also be furnished and installed as required for attachment and support.

1.2 SECTION INCLUDES

A. Miscellaneous fabrications include, but are not limited to the following:
   1. Pipe supports, hangers, and brackets.
   2. Prefabricated ship ladder.
   3. Shop fabricated steel items, including: fixed vertical access ladders.

1.3 REFERENCES

H. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
I. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2013.
J. ASTM A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.


O. ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.


R. AWS A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society.

S. AWS D1.1/D1.1M, Structural Welding Code - Steel; American Welding Society; American Welding Society; 2010


V. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).


X. SSPC-SP 2, Hand Tool Cleaning; Society for Protective Coatings (Ed. 2004).

1.4 RELATED SECTIONS

A. Section 05 12 00 – Structural Steel Framing.

B. Section 05 52 13 – Pipe and Tube Railings: Coordination with railing locations.

C. Section 05 53 00 – Metal Grating

D. Section 09 90 00 – Painting and Coating: Paint finish.

1.5 SUBMITTALS

A. Shop Drawings:
   1. Ladders:
      a. Letters of Certification of Compliance on materials, equipment, etc.
b. Final Certified Drawings showing outline dimensions, foundation layout or mounting information, and other pertinent dimensions.

c. Field erection instructions, assembly drawings and/or diagrams, detailed reference drawing lists, lists of erection details, and list of spare parts supplied with equipment.

d. Shop Detail Drawings showing individual sub-assemblies and fabricated pieces with material specifications and other applicable data.

2. Shop Drawings shall be provided for all metal fabrications and shall indicate all profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

a. All welds, both shop and field, shall be indicated by AWS Welding Symbols.

b. Show all types of paints.

c. Submit certified copies of the qualifications records of each welder prepared within six months of time of Contract award.

3. Contractor shall include with each shop drawing submittal structural calculations for all post-installed anchors that will be used in that submittal; unless those anchors have been specified in the contract documents. Calculation shall be signed and sealed by a Professional Engineer licensed in the state where the project is located and the shop drawings shall have a statement by that Registered Engineer; that they have reviewed the drawings and that the post-installed anchors listed are in accordance with the supplied calculations.

4. The Contractor shall submit Shop Drawings for all proposed pipe supports, hangers, and brackets.

B. Welders' Certificates:

1. Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

C. Fabricator's Qualification Statement:

1. Provide documentation showing the steel fabricator conforms to at least one of the following:

   a. Be accredited under IAS Fabricator Inspection Program for Structural Steel (AC172).

   b. Participate in the AISC Quality Certification Program and is designated an AISC Certified Plant with Category STD at time of bid.

   c. Employ an independent inspection or quality control agency, approved by the Authority's Representative, to conduct periodic, in plant inspections at the fabricator's plant at a frequency that will assure the fabricator's conformance to the requirements of the inspection agency's approved quality control program.

D. Certification of Compliance:

1. 49 C.F.R. Part 661 Buy America Requirements.

1.6 QUALITY ASSURANCE

A. Design fabricated under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State where the project is located.

B. Fabricator Qualifications: the steel fabricator shall conform to at least one of the following.

1. Be accredited under IAS Fabricator Inspection Program for Structure Steel (AC172).

2. Participate in the AISC Quality Certification Program and is designated an AISC Certified Plant with Category STD at time of bid.

3. Employ an independent inspection or quality control agency, approved by the Authority's Representative, to conduct periodic, in plant inspections at the fabricator's plant at a frequency that will assure the fabricator's conformance to the requirements of the inspection agency's approved quality control program.
2.1 PIPE SUPPORTS, HANGERS, AND BRACKETS

A. Process Piping:
1. All process piping shall be supported as detailed on the Drawings and specified herein. Process piping includes, but is not limited to, the following:
   a. Ductile iron pipe.
   b. PVC pipe.
   c. Steel pipe.
   d. Fiberglass reinforced plastic (FRP) pipe.
2. All process pipe supports, hangers, and brackets shall be as manufactured by B-Line Systems, Grinnell, or Unistrut, as detailed on the Drawings. Supports for stainless steel piping shall be Type 316 stainless steel.
3. All appurtenances required for proper installation of the pipe supports, brackets, and hangers shall be supplied by the manufacturer.
4. Anchor bolts for pipe supports, hangers, and brackets shall be of the sizes as recommended by the manufacturers of the pipe supports, hangers, and brackets. Anchor bolt type and materials shall be as specified under Section 2.02 and 2.03 of this Specification.

2.2 ANCHOR BOLTS

A. Adhesive (Epoxy) Anchors:
   1. Adhesive anchors shall consist of all-thread anchor rod, nut, washer, and adhesive capsule. Anchor rods shall be manufactured from ASTM A666 AISI Type 316 stainless steel, which meets the requirements of ASTM F593.
   2. Do not use post-installed adhesive anchors or dowel systems to resist gravity loads in direct tension or in a fire rated construction.
   3. Anchors shall be installed per manufacturer’s recommendations and printed Manufacturer’s Printed Installation Instructions (MPII).

2.3 STAINLESS STEEL RODS, NUTS, BOLTS, AND WASHERS

A. Stainless steel rods, nuts, bolts, and washers shall be ASTM A666, Type 316. Only non-gall lubricants shall be used on stainless steel rods, nuts, and bolts.

2.4 FASTENERS

A. Unless otherwise specified or required, all fasteners provided for this Project shall be at a minimum Grade 5, ASTM A449, Type 1, SAE J429. Grade marking shall appear on all bolts and nuts.

2.5 LADDERS

A. General: Fabricate ladders of steel, for the locations shown, with dimensions, spacings, details, and anchorages as indicated. Comply with requirements of ANSI A14.3, local, State, and Occupational Safety and Health Administration Standards as minimum.

B. Siderails: 1-1/2 inches nominal diameter, round, schedule 80, formed from steel, spaced 24-inches apart, minimum.

C. Rungs: Shall be 3/4” diameter steel bars, unless otherwise shown, spaced 12” o.c. maximum with nonslip surface to provide maximum grip and foot traction. Rungs shall be able to withstand a 1,000 lb load without failure, spaced 12-inches on centers, maximum.

D. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung by a proprietary process.

E. Paint ladders, including brackets and fasteners, in interior locations and in areas with non-corrosive environments.

F. Finish: Color OSHA safety yellow as selected by Engineer from manufacturer’s standard range.

G. Support each ladder at top and bottom and at intermediate points spaced not more than 4 feet o.c. by means of welded or bolted steel wall brackets. Use welded or bolted brackets, designed for adequate support and anchorage, and to hold the ladder clear of wall surface with a minimum 7-inch clearance from wall to centerline of rungs. Extend siderails 48-inches.
above platform finished elevation and return siderails to wall or structure unless other secure handholds are provided. If the ladder exceeds 12-inches from grade, provide steel rungs 12-inches on center, maximum, to platform of ladder. If the adjacent structure does not extend above the top rung, goose-neck the extended siderails back to the structure to provide secure ladder access.

1. Provide ladder manufacturer's wall mounted, bottom support, configured for anchorage to and compatibility with siderail and so that lowest ends of siderails are required to be anchored to the finish floor.

H. All welds shall be full penetration inert gas heliarc type. All surfaces to be clean, smooth, and burr-free. Remove all sharp edges.

I. Prefabricated Ship Ladder: Welded metal unit complying with ANSI A14.3; factory fabricated to greatest degree practical and in the largest components possible.

1. Components: Manufacturer's standard rails, treads, handrails. Return, platforms and safety devices complying with the requirements of the MATERIALS article of this section.
3. Incline: 70 degrees, unless noted otherwise.
4. Landing Height: 17'-3" maximum ship ladder height.
5. Treads. Steel safety grating to match platform grating.
6. Finish: Powder coat; color OSHA safety yellow as selected by Engineer from manufacturer's standard range.
7. Manufacturers:
   b. Bluff Manufacturing, Inc.
   c. Or approved equal

2.6 MISCELLANEOUS STEEL SHAPES

A. Materials - Steel:
1. Structural Steel: ASTM A36, ASTM A572 Grade 50, ASTM A992; as noted on drawings.
2. Steel Tubing: ASTM A500, Grade B, cold-formed structural tubing.
3. Structural Bars and plates: ASTM A36/A36M.

B. Finishes - Steel:
1. Prime paint all steel items.
   a. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
2. Prepare surfaces to be primed in accordance with SSPC-SP2.
3. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
   a. Provide shop primer compatible with specified field-applied topcoats.

2.7 METAL STRUT FRAMING MATERIALS

A. Metal Strut Framing System: Structural support system with capability to sustain, without failure, imposed loads consisting of channels, angles, tubes, and accessories as recommended by manufacturer for application indicated.
1. Channels: Cold formed from structural grade steel conforming to ASTM A570, Grade 33, or ASTM A653, Grade 33.
2. Fittings: Fabricated from steel conforming to ASTM A36, ASTM A575, ASTM A576, or ASTM A635.
3. Accessories: Manufacturer’s standard nuts, bolts, washers, clamps, hangers, plates, fittings, brackets, threaded rod, inserts, splices, and other fabrications as recommended by manufacturer.

B. Finish components in accordance with one of the following:
1. Rust-inhibiting acrylic enamel paint, thoroughly baked; conforming to ASTM B117.
2. Zinc-coated by the hot-dipped process prior to roll-forming, G90 conforming to ASTM A653.
3. Zinc-coated after all manufacturing, conforming to ASTM A123 or ASTM A153.

C. Product and Manufacturer: Unistrut Metal Framing, Unistrut Corporation, Division of Tyco International, Ltd.: www.unistrut.com or equal.

2.8 CHEMICAL AND EXPANSION ANCHORS

A. Post-Installed Anchors with capability to sustain, without failure, load imposed as determined by testing per an ICC Evaluation Service Report or other approved Evaluation Service, conducted by a qualified independent testing agency; designed for use in cracked concrete and masonry.
1. Expansion Anchors: HILTI KWIK Bolt TZ; SIMPSON Strong-Bolt or equal.
   a. Location: Provide only at locations specifically indicated to receive expansion anchors.
2. Chemical Anchors: Two-component injectable adhesive type HILTI HIT-HY 200; SIMPSON AT-XP; HILTI HIT-RE 500-SD; SIMPSON SET-XP or equal.

2.9 GROUT AND ANCHORING CEMENT

A. Non-shrink, Non-metallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.10 FABRICATION

A. Fit and shop assemble items in largest practical sections for delivery to site.
B. Fabricate items with joints tightly fitted and secured.
C. Continuously seal joined members by continuous welds.
D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
2.11 FABRICATION TOLERANCES

A. Squareness: 1/8-inch maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16-inch.

C. Maximum Misalignment of Adjacent Members: 1/16-inch.

D. Maximum Bow: 1/8-inch in 48-inches.

E. Maximum Deviation From Plane: 1/16-inch in 48-inches.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable to receive work.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. All bolting holes provided in equipment, valves, gates, pipe supports and hangers, handrails, ladders, and other items which require mounting shall be used as specified and intended.

C. Allow for erection loads and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Field weld components indicated on Drawings.

E. Perform field welding in accordance with AWS D1.1.

F. The Engineer's approval prior to site cutting or making adjustments not scheduled.

G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.4 SPECIAL INSPECTION

A. All Field welding shall be Special Inspected.

B. All post-install anchors shall be Special Inspected.
PART 4  MEASUREMENTS AND PAYMENTS

4.1  MEASUREMENTS

A. The metal fabrications work of this Section shall be measured for payment.

4.2  PAYMENTS

A. Payment for the work provided under this Section shall not be measured, but shall be incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 05 52 13

PIPE AND TUBE RAILINGS

PART 1  GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
1. D90—New Carrollton Maintenance Facility (NC)
2. K90—West Falls Church Maintenance Facility (WFC)

B. Section includes specifications for steel pipe handrails.

1.2 RELATED SECTIONS

A. General and Special Provisions
B. Section 04 20 00 - Unit Masonry: Placement of anchors in masonry.
C. Section 05 12 00 - Structural Steel Framing.
D. Section 05 52 13 - Pipe and Tube Railings.
E. Section 09 90 00 - Painting and Coating: Paint finish.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
3. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.

B. Federal transit Administration (FTA):
1. 49 CFR 661 Buy America Requirements

C. Steel Structures Painting council (SSPC):
1. SSPC Paint 15 - Type 1, Red Oxide.
2. SSPC-Paint 15 - Steel Joist Shop Paint.
3. SSPC Paint 20 - Type 1 Inorganic Zinc Rich.

1.4 SUBMITTALS

A. Pursuant to the provisions of the General and Special Provisions:
1. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, paint products and accessories.
2. Assurance/Control Submittals:
a. Certificates: Manufacturer’s certificate that Products meet or exceed specified requirements.

B. Certifications:
   1. That submitted products comply with 49 CFR 661 Buy America Requirements.

C. Samples:
   1. Submit two, 6 inch long samples of handrail. Submit two samples of elbow, Tee, wall bracket, end stop, and fascia mounting bracket.

1.5 QUALITY CONTROL

A. Regulatory Agency Sustainability Approvals:
   1. District of Columbia Construction Code:
      a. Perform the Work of this Section in accordance with requirements of the WMATA guidelines.
   2. Testing and Inspection Agency:
      a. To perform approval testing and inspections not considered Special Inspections by the ICC International Building Code (IBC) as Amended by the District of Columbia will employ independent Testing and Inspection Agencies, including the City Building Official and the WMATA Testing Laboratory.

B. Qualifications:
   1. Professional Engineer Qualifications:
      a. Have the pipe and tube railing manufacturer employ a licensed Professional Engineer, registered in the District of Columbia, who has experience performing design calculations for standard pipe and tube railing units and preparing Shop Drawings. Submit the Professional Engineer’s qualifications to the Program Manager for approval.
   2. Welding Qualifications:
      a. Welding Procedure Specifications (WPS):
         1) Prior to beginning work that requires welding, submit the pre-qualifying welding procedures to the Program/Project Manager for approval.
         2) For all procedures, other than those set forth in AWS D1.1/D1.1M or AWS D1.6, submit a copy of the welding procedure specifications (WPS) test records to the Program/Project Manager for approval.
      b. Welder Qualifications:
         1) Prior to beginning work that requires welding, submit the procedures to be used for pre-qualifying welders to the Program/Project Manager for approval.
         2) Only use welders, tackers, and welding operators demonstrating they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1/D1.1M and AWS D1.6, for the procedures to be used.
         3) Submit Welding Certificates certifying the welders employed to fabricate and to install the Work of this Section have been certified by the American Welding Society (AWS) within the previous 12 months to the Program/Project Manager for approval.
         4) Include certified copies of qualification test records and photographic identification indicating each welder, welding operator, and tacker employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures and, if pertinent, has undergone recertification.
   3. Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field by an Independent Testing and Inspection Agency (Approved Agency).
   4. Such inspections and tests will not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
a. Promptly remove and replace materials or fabricated components that do not comply.
b. Requirements for code-related Special Inspections are defined in General and Special Provisions.

C. Qualification Statements:
   1. Professional Engineer qualifications.
   2. Welding procedure specifications (WPS) test records.
   3. Welding Certificates.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:
   1. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Storage and Handling Requirements:
   1. Protect fastener products from dirt and corrosion by placing them in closed containers.
   2. Store fastener products in a protected shelter, remove fastener components only as necessary, and promptly return unused fasteners to protected storage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Handrails, Railings, and gates:
   1. OMEGA Industrial Products, Inc. www.omegaindl.com
   2. Standvik Designs, inc. nordvikdesigns.com
   3. Or Approved equal.

2.2 RAILINGS – GENERAL REQUIREMENTS

A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E985 and applicable local code.

B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 50 pounds per linear foot applied to the top of the assembly and in any direction, 50 pounds per linear foot of non-concurrent down force on the top rail, all forces without damage or permanent set. Test in accordance with ASTM E935.

C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935.

D. Allow for expansion and contraction of members and building movement without damage to connections or members.

E. Dimensions: See drawings for configurations and heights.
   1. Top Rails and Intermediate Rails: 1-1/2 inches nominal diameter, round, schedule 40.
   2. Posts: 1-1/2 inches nominal diameter round, schedule 80.

F. Provide anchors and other components as required to attach to structure, made of same material as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
G. Provide mechanical and welding fittings where indicated to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

2.3 STEEL RAILING SYSTEM

A. Steel Pipe: ASTM A53/A53M, Type E, Grade A, 1-1/2 inch nominal O.D., Schedule 40 horizontal rails, schedule 80 vertical posts, black finish.

B. Non-Weld Mechanical Fittings: Slip-on, galvanized malleable iron castings, for Schedule 80 pipe, with hex bolts for tightening, no screw fasteners.

C. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.

D. Exposed Fasteners: No exposed screws.

E. Straight Splice Connectors: Steel concealed spigots.

F. Painted Handrail, Guardrail, and Posts Finish: Field painted in accordance with section 09900 Paints and Coatings.
   1. Color(s): OSHA safety yellow or as selected by the Engineer at submittal review.

G. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

H. Fascia Flanges (side mount flanges): Steel, painted to match railing color. Flange design shall be similar to the flange details shown on the Drawings.

I. Toeboard: Fabricate from steel plate or angle; height 4 inches above walking surface. Attachment shall be mechanically secured to railing structure conform to OSHA standards. Posts with clamps that will allow for expansion and contraction

J. Openings in the railing shall be guarded by a self-closing gates (OSHA 1910.23).

K. Safety chains shall not be used unless specifically shown on the drawings. Where shown guard chains shall be individually welded straight link AISC 316 steel.

L. Gates: Posts and handrails and intermediate rails manufactured of the same materials as the handrails components.
   1. Sliding Gates: Manufactured of the same materials as the handrails. Attach gate roller to pipe frame and latch assembly to fixed supports. Provide and secure toeboard per OSHA standards.
   2. Swinging Gates: Manufactured of the same materials as the handrails. Weld gate latch and keeper assembly to railings on mezzanine platform side. Lock-out relay at gate latch locations with vehicle lift equipment as indicated on drawings provided by electrical contract work surfaces in accordance with AISC’s Code of Standard Practice.

2.4 FABRICATION

A. Accurately form components to suit specific project conditions and for proper connection to building structure and components.

B. Fit and shop assemble components in largest practical sizes for delivery to site.
C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

D. Welded Joints:
   1. Interior Components: Continuously seal joined pieces by continuous welds.
   2. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Materials and fabrication procedures are subject to inspection and tests by an Independent Testing and Inspection Agency (Approved Agency) in the mill and shop.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.
   1. Verify field dimensions prior to shop fabrication.

B. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply items required to be cast into concrete with setting templates, for installation as work of other sections.

C. Apply one coat of bituminous paint to concealed aluminum surfaces that will be in contact with cementitious or dissimilar materials.

D. Furnish items required to be cast into concrete, embedded in masonry, placed in partitions with setting templates, to appropriate Sections.

3.3 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.

C. Anchor railings securely to structure with anchors in accordance with ASTM E 985.

D. Field weld anchors as indicated in Drawings. Touch-up welds with primer. Grind welds smooth.

E. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

3.4 SITE QUALITY CONTROL

A. Site Tests and Inspections:
1. Inspect the bolted and welded connections.
2. Confirm the pipe and tube railings are square, plumb, and level.
3. Verify that the welders and welding materials in the field are properly certified.

B. Refer to the General and Special Provisions.

C. Inspect railings and handrail installation and attachment to structure.

D. Inspect paint finish applied to surfaces.

E. Remove and replace work that does not comply with specified requirements.
   1. Correct deficiencies in structural steel work that inspections and test reports have indicated to be not in compliance with requirements.
   2. Additional tests performed by the Approved Agency to reconfirm any noncompliant original work and verify compliance of corrected work will be performed at no additional cost to the Owner.

F. Immediately after erection, clean field welds, bolted connections, and areas where shop paint is abraded; prime them with paint of the same quality as that used for the shop coat in accordance with the requirements specified in Section 09 90 00.

G. Apply touch-up paint to exposed areas using material as specified in Section 09 90 00.
   1. Completely blend touch-up paint with adjacent surfaces on all steel members.

H. Repair painted areas damaged by welding and flame cutting and during handling, transport, and erection by using an approved repair method in accordance with Section 09 90 00.

3.5 NON-CONFORMING WORK

A. Non-Conforming Work
   1. Promptly remove and replace materials or fabricated components that do not comply with specified requirements.

3.6 TOLERANCES

A. Site Tolerances:
   1. Maximum Variation From Plumb: 1/4 inch.
PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The pipe and tube railings work of this Section shall be measured for payment.

4.2 PAYMENTS

A. Payment for the work provided under this Section shall not be measured for payment, but shall be incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 05 53 00

METAL GRATINGS

PART 1  GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90—New Carrollton Maintenance Facility (NC)
   2. K90—West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. Metal bar gratings.
   2. Metal frames and supports for gratings.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design gratings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
   1. Floors: Uniform load of 60 lb/sq. ft. or concentrated load of 300 lb, whichever produces the greater stress.

1.3 SUBMITTALS

A. Product Data: For the following:
   2. Paint products.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Certification of Compliance:
   1. 29 C.F.R. Part 661 Buy America Requirements

1.4 QUALITY ASSURANCE

A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."

PART 2  PRODUCTS

2.1 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A 510 (ASTM A 510M).

D. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30.
E. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33, with G90 (Z275) coating.

2.2 MISCELLANEOUS MATERIALS

A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.3 FABRICATION

A. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

C. Fit exposed connections accurately together to form hairline joints.

2.4 METAL BAR GRATINGS

A. Welded Steel Grating:
   4. Crossbar Spacing: 4 inches o.c.
   5. Traffic Surface: Provide nonslip surfaces with abrasive material metallically bonded by a proprietary process.
   6. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

B. Removable Grating Sections: Fabricate 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.

C. 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 same size and material as bearing bars.

D. Do not notch bearing bars at supports to maintain elevation.

2.5 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal 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.
   1. Unless otherwise indicated, fabricate from same basic metal as gratings.

B. Galvanize steel frames.
2.6 STEEL FINISHES

A. Finish gratings, frames, and supports after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. 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 of rack.

B. Fit exposed connections accurately together to form hairline joints.
   1. 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.

3.2 INSTALLING METAL BAR 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. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The metal grating work of this Section provided complete in place as shown on the Contract Drawings, including required fasteners and other hardware, and approved by the Engineer shall not be measured for payment.

4.2 PAYMENTS

A. Payment for the work provided under this Section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 09 90 00

PAINT AND COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Surface preparation.

C. Field application of paints other coatings.

1.2 REFERENCE STANDARDS


C. GreenSeal GS-11 - Paints; 1993.

1.3 SUBMITTALS

A. Submit the following for approval in accordance with the General Requirements and the additional requirements as specified for each:

3. Product Data: For each type of product. Include preparation requirements and application instructions

4. Samples:
   a. Submit three paper chip samples, 3”x3” in size, illustrating range of colors available for each surface finishing product scheduled.
   b. Submit two painted samples, illustrating selected colors for each color and system selected with specified coats cascaded. Submit on tempered hardboard, minimum 12”x12” in size.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.

B. Applicator Qualifications: Company specializing in performing the type of work specified approved by manufacturer.

C. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. The Owner will select one surface to represent surfaces and conditions for application of each paint system specified in Part 2.
2. Final approval of color selections will be based on mockups. If preliminary color selections are not approved, apply additional mockups of additional colors selected by the Owner at no added cost to the Owner.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 7 degrees C (45 degrees F) and a maximum of 32 degrees C (90 degrees F), in ventilated area, and as required by manufacturer's instructions.

1.6 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

D. Minimum Application Temperatures for Latex Paints: 7 degrees C (45 degrees F) for interiors; 10 degrees C (50 degrees F) for exterior; unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 860 lx (80 ft candles) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.

B. Paints:
   9. Or approved equal.

C. Primer Sealers: Same manufacturer as top coats.
2.2 PAINTS AND COATINGS - GENERAL

A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
   1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
   2. Supply each coating material in quantity required to complete entire project's work from a single production run.
   3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.

B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.

C. Volatile Organic Compound (VOC) Content:
   1. Provide coatings that comply with the most stringent requirements specified in the following:
      b. Ozone Transport Commission (OTC) Model Rule, Architectural, Industrial, and Maintenance Coatings; www.otcair.org; specifically:
         1) Opaque, Flat: 50 g/L, maximum.
         2) Opaque, Nonflat: 150 g/L, maximum.
         3) Opaque, High Gloss: 250 g/L, maximum.
         4) Varnishes: 350 g/L, maximum.
   2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

D. Chemical Content: The following compounds are prohibited:
   1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
   2. Acrolein, acrylonitrile, antimony, benzene, butyl benzyl phthalate, cadmium, di(2-ethylhexyl) phthalate, di-n-butyl phthalate, di-n-octyl phthalate, 1,2-dichlorobenzene, diethyl phthalate, dimethyl phthalate, ethylbenzene, formaldehyde, hexavalent chromium, isophorone, lead, mercury, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, naphthalene, toluene (methylbenzene), 1,1,1-trichloroethane, vinyl chloride.

E. Colors: To be selected from manufacturer's full range of available colors.
   1. Selection to be made by Owner after award of contract.
   2. Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.

2.3 PAINT SYSTEMS - INTERIOR

A. Paint CI-OP-3L – Concrete Floor, Opaque, Latex, 3 Coat:
   1. One coat of latex primer sealer.
   2. Gloss: Two coats of latex enamel; Chemical and Water Resistant Epoxy Enamel with anti-slip aggregate.

B. Paint MI-OP-2A - Ferrous Metals, Primed, Silicone-Alkyd, 2 Coat:
   1. Touch-up with alkyd primer.
   2. Semi-gloss: Two coats of silicone-alkyd enamel; Minimum of 30% silicone content meeting the qualitative requirements of FS TT-E-490.
C. Paint MgI-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
   1. One coat galvanize primer.
   2. Semi-gloss: Two coats of alkyd enamel; Odorless alkyd enamel made for use over a
      primer and undercoat on zinc-coated (galvanized) metal surfaces (FS TT-E-509).

2.4 ACCESSORY MATERIALS

A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding
   materials, and clean-up materials required to achieve the finishes specified whether
   specifically indicated or not; commercial quality.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any
   condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with subsequent cover materials.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply
   finishes unless moisture content of surfaces are below the following maximums:
   1. Concrete Floors and Traffic Surfaces: 8 percent.

3.2 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to coating application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best
   result for the substrate under the project conditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture
   trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

D. Seal surfaces that might cause bleed through or staining of topcoat.

E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium
   phosphate and bleach. Rinse with clean water and allow surface to dry.

F. Concrete Floors and Traffic Surfaces to be painted: Remove contamination, acid etch, and
   rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.

G. Galvanized Surfaces to be painted: Remove surface contamination and oils and wash with
   solvent. Apply coat of etching primer.

H. Corroded Steel and Iron Surfaces to be painted: Prepare using at least SSPC-PC 2 (hand tool
   cleaning) or SSPC-SP 3 (power tool cleaning) followed by SSPC-SP 1 (solvent cleaning).
I. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

3.3 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance.

D. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

3.4 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.5 PROTECTION

A. Protect finished coatings until completion of project.

B. Touch-up damaged coatings after Substantial Completion.

3.6 WASTE MANAGEMENT

A. Do not use kerosene or any such organic solvents to thin or clean up water based paints.

B. Do not dispose of paints or solvents by pouring on the ground. Place in designated containers for proper disposal.

C. Where paint recycling is available, collect all waste by paint type and provide for delivery to recycling or collection facility.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENT

A. No measurement will be made of the work in this section.

4.2 PAYMENT

A. Payment for the work of this Section shall not be measured for payment, but shall be incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum Price.

END OF SECTION
SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes
   1. Fire extinguishers.
   2. Accessories.

C. Related Sections

1.2 REFERENCE STANDARDS


1.3 SUBMITTALS

A. Refer to the General and Special Provisions for submittal procedures.

B. Shop Drawings: Indicate cabinet physical dimensions, rough-in measurements for recessed cabinets, wall bracket mounted measurements, and location.

C. Product Data: Provide extinguisher operational features, color and finish, and anchorage details.

D. Manufacturer’s Installation Instructions: Indicate special criteria and wall opening coordination requirements.

E. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.

F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.4 FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.1 FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.

B. Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gage.
2. Class: A:B:C.
3. Size: 10 pound (4.54 kg).
4. Finish: Baked polyester powder coat, red color.
5. Temperature range: -65 degrees F (-54 degrees C) to 120 degrees F (49 degrees C).

2.2 ACCESSORIES

A. Extinguisher Brackets: Formed steel, galvanized and enamel finished.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install cabinets plumb and level in wall openings, 24 inches (600 mm) from finished floor to inside bottom of cabinet.

C. Secure rigidly in place.

D. Place extinguishers and accessories in cabinets and on wall brackets.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. Locations of the Fire Extinguishers are shown on the contract drawings. No Measurement will be made of the work in this system.

4.2 PAYMENTS

A. Payment for the work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 11 05 00
COMMON WORK RESULTS FOR EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY:

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. The requirements of this Section shall apply to Divisions 09, 10, 11 and 41
      Equipment Specifications.
   2. Furnish and install as directed by the Authority Representative 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.
   3. Equipment shall be suitable for installation in the Maintenance Facility as shown and
      required by the Contract Documents. Any modification or redesign to the building
      structure or utilities because of an alternate equipment selection by the Contractor
      shall be provided by the Contractor at no additional cost to WMATA and shall be as
      approved by the Authority Representative. All alternate equipment selections or
      proposed substitutions must be submitted and approved in accordance with the
      provisions of the Special Provisions and this section
   4. 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.
   5. There will be no separate payment for the work of this Section.

C. Related Sections:
   b. Section 09 90 00 Paint and Coatings
   c. Section 10 44 00 Fire Protection Specialties
   e. Section 41 62 23 Forklifts
   f. Section 41 64 16 Mobile Railcar Mover
   g. Division 22 Plumbing
   h. Division 26 Electrical

1.2 REFERENCES:

A. Work shall conform to Federal, State and local governing rules and regulations and
   ordinances, including OSHA and NFPA requirements, and shall pass inspection by the
   authorities having jurisdiction.

B. Federal Transit Administration (FTA)
   1. 49 CFR 661 Buy America Requirements

1.3 QUALITY ASSURANCE:

A. General:
1. All articles, materials, fittings, equipment and appurtenances incorporated in the work shall be new and unused, free from defects and imperfections, of first grade commercial quality, and shall, as far as practicable, be manufacturer's standard make. Manufacturers shall have proven experience in the design and manufacture of specified items, suitable for the purpose intended and subject to approval by the Authority Representative.

2. When two or more items of equipment are required, they shall be products of a single manufacturer.

3. 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.

4. 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.

5. For purposes of designating type and quality of work for the Division 09, 10, 11 and 41 Equipment, the Specifications are based on the requirements listed in Part 2 - Products.

B. Substitutions: Requests for approval of equipment items other than those specified herein shall be made in accordance with the Special Provisions, General Requirements and this section.

C. Permits and Tests: Obtain all necessary permits from the State and other authorities having jurisdiction, make application and file all drawings required for such permits, and pay all fees. Arrange for inspections and tests required by governing authorities and by the Owner, and pay all costs connected therewith. Obtain and file with the Owner written evidence that all the above requirements have been met.

D. Furnish proof that the Installing Contractor is licensed in Maryland and Virginia.

E. Certifications: Obtain all necessary certifications from suppliers and testing agencies as required by the Contract and pay all fees related to obtaining them.

1.4 SUBMITTALS:

A. Pursuant to the provisions of the General and Special Provisions; the Contractor shall submit:

1. Material and Equipment List

2. Product data (e.g., catalog cuts, manufacturer’s data, and manufacturer’s certificate of conformance or compliance, certified test report, samples).

3. Shop Drawings and Installation Instructions including the following:
   a. Layout drawings showing equipment, elevations, conduit runs, utilities, and hook-ups, and all required dimensions. Drawings shall show plan and elevation views of all required conduit and piping runs. Equipment drawings shall clearly indicate all maintenance access points.
   b. Foundation and structural support drawings including anchor bolt plan and elevation.
   c. Utility connection plan.
   d. Electrical equipment layout, with all motors, limit switches, solenoid valves, disconnects, control panels, emergency shut off switches, interlocks, accessories, all located and labeled.
   e. Piping systems including pipe routing, pipe and fittings, sizing, valving, lubricators, regulators, pumps, nozzles and accessories, fully noted and scheduled.
f. 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.

4. Schedule of Work.

5. Operations Maintenance (O&M) Manuals as required by this section and the Special Provisions.
   a. The Contractor shall provide two (2) sets of Operation and Maintenance Manuals, per location for all equipment specified.
   b. The Contractor shall provide an electronic copy of the O&M Manual as specified below.
   c. Manuals shall contain 8½ inch x 11 inch pages. The binders shall not exceed 3 inches overall thickness. Punched holes shall be on ¾ inch centers. Folding pages will be permitted (11 inch x 17 inch, “Z” folded) where the information to be conveyed cannot be presented clearly on single pages. Manuals for 8½ inch x 11 inch pages may be divided into Book 1, Book 2, etc., if the required material cannot be accommodated within the maximum binder thickness. Table of Contents shall be provided in each book.
   d. Format Manuals as follows:
      1) Title page: Include the name and function of the equipment, manufacturer's identification number, and the project Specification number and title.
      2) Table of contents, in numerical order listing each section and subsection title of the O&M 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 O&M Manual.
      5) Manufacturer's literature describing each piece of equipment, including major assemblies and subassemblies, and giving manufacturer's model number and drawing number.
      6) Operation instructions including step-by-step preparation for starting, safe operation, shutdown and draining, and emergency requirements.
      7) Control diagrams, as-installed by the manufacturer.
      8) Sequence of operation by the control manufacturer.
      9) Wiring diagrams, as-installed and color codes, of electrical motor controllers, connections and interlock connections.
     10) Diagrammatic location, function and tag numbers of each valve.
     11) Maintenance instructions: Include step-by-step procedures for inspection, operation checks, cleaning, lubrication, adjustments, repair, overhaul, disassembly, and reassembly of the equipment for proper safe operation of the equipment. Include list of special tools which are required for maintenance with the maintenance information.
     12) Possible breakdowns and repairs.
     13) Manufacturer's parts list of functional components, control diagrams and wiring diagrams, giving manufacturer's model number and manufacturer's part number.
     14) “Long-Lead-Time” spare parts list for spare parts not readily available on the local open market or for which it is anticipated ordering and delivery time will exceed 10 days.
15) List of nearest local suppliers of all equipment parts.
16) Lubrication schedule indicating type and frequency of lubrication.
17) Manufacturer’s warranty and guarantee data.
18) Spare parts data as follows:
   a) Complete list of parts and supplies, with current unit prices and sources of supply.
   b) List of parts and supplies that are either normally furnished at no extra cost with purchase of equipment, or specified herein to be furnished as part of Contract.
   c) List of additional items recommended by manufacturer to assure efficient operation for period of 120 days.
19) Complete sufficient copies of manufacturer’s preventive maintenance forms to properly address each equipment item and all major equipment components installed under this section.
20) 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.
21) Delete information on material or equipment not used in the work from the O&M Manual.

6. Training Program as required by this section and the General and Special Provisions.
   a. General Requirements: Provide training as outlined in this section.
      1) Maintenance management classes are to take place prior to substantial completion of the facility. Mechanics training will commence only after installation of machine is complete at the garage.
      2) Training shall be conducted at the existing facility
      3) Hours for training are to be between 6:00 am and 2:30 pm unless specifically permitted otherwise.

7. Sequence of Approval:
   a. Tentative Approval of Equipment: Before submittal of shop drawings, submit to the Authority Representative 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.
   b. Final Approval of Equipment: After receiving tentative approval of the equipment lists, submit shop drawings, product data and installation instructions for final approval.
   c. Equipment substitutions must conform to the requirements of the Special Provisions and this section.

8. Certificates:
   a. Furnish an affidavit certifying that all materials and workmanship comply with the applicable code requirements.
   b. Before final acceptance, furnish certificates of the authorities having jurisdiction.
   c. Furnish factory certificates stating that all specification requirements relating to load capacities, pump capacities and fan capacities are provided.
   d. Certify that the design of equipment items and systems complies with Seismic Site Classification D, Seismic Design Category – B criteria.
1) Certification must be by a Professional Engineer registered in the states of Maryland and Virginia.
2) Supporting calculations must be submitted for review by the Authority Representative.
   e. Certificates stating equipment items comply with the FTA’s 49 CFR Part 661 Buy America Requirements.

1.5 JOB CONDITIONS:

A. 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.

B. General Design and Fabrication Requirements:
   1. 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.
   2. It is not the intent of these Specifications to detail the design and fabrication of the several parts of the equipment, but it is expected that 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 Authority Representative 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.
   3. The Authority Representative may permit variations from the requirements of these Specifications to permit the use of the manufacturer’s standard equipment, provided in his opinion 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 Authority Representative in writing and shall be made only if approved in writing. All proposed substitutions must conform to the requirements of the Special Provisions.
   4. 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.

C. Remove, relocate and repair any items that are necessary for the installation of the equipment, at no additional cost to WMATA.
1.6 GUARANTEE:

A. Warranty: All equipment shall be warranted as a minimum 2 years in accordance with Special Provisions and the following provisions:
   1. The Contractor shall furnish a warranty covering all parts of the work performed, and all materials and equipment furnished hereunder by Contractor or his subcontractors or suppliers will be free from defects in design, material, workmanship, and operation for a period of two years from the date of acceptance of the work.
   2. Warranty shall provide for 24 hour parts availability and 24 hour response time. Supplier shall maintain an adequate parts stock such that equipment down times attributable to unavailable typical repair parts shall be 48 hours or less during the first five year period.
   3. The Contractor shall repair or pay for the repair of any such defect at his own expense.
   4. Work which has been abused or neglected is excluded from this warranty.
   5. Furnish written warranties required by the respective sections of the Specifications for time stipulated therein. These warranties shall be in writing, on the Contractor's or supplier's letterhead and shall be included in the operations and maintenance manual(s) as specified in 1.04 of this section.
   6. Major equipment components, (as required by the respective sections of the specifications) specifically those manufactured by other than the primary equipment supplier, shall be covered by their own respective warranties, which shall not be less than the suppliers mandated two year warranty. These warranties shall also be included in the operations and maintenance manual(s).
   7. Nothing in these requirements, conditions or specifications including WMATA's right to a complete inspection shall constitute a disclaimer to or limit, negate, exclude or modify in any way any warranty created hereunder.

1.7 NOISE AND VIBRATION ISOLATION:

A. Operation of the equipment shall not exceed noise and vibration limits established by OSHA, local code or other regulatory requirements. Where required, provide approved type noise and vibration isolation pads equipped with necessary bearing plates and bolts. Pads 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 bedplates.

B. Bolts and other fastenings in connection with these pads shall also be isolated.

1.8 SHOP PAINTING:

A. Equipment shall be given one shop prime coat of approved rust-inhibitive paint containing at least 50 percent rust-inhibitive pigments and manufacturer's standard finish coat system. Shop drawings shall indicate brand and type of paint for both the prime coat and finish coat systems, as well as the color of all finish coats. All color selections must be approved by the Authority Representative.

B. Special equipment painting requirements are outlined in the respective sections of Divisions 09, 10, 11 and 41.
1.9 ELECTRICAL REQUIREMENTS:

A. Electrical materials and devices shall conform to the standard of Underwriters’ Laboratories, Inc. (UL). Where material standards have not been established by UL, standards of quality and performance shall be those of the specified manufacturers, subject to approval of the agencies having jurisdiction. Products that are not UL listed shall be tested in place to demonstrate that the item complies with FEP (Field Evaluated Product) UL requirements. The Contractor is responsible to include the costs for all such testing in his bid price and no additional compensation related to this testing will be provided.

B. Power supply for equipment shall be 480 volts, 3-phase, 60 hertz unless otherwise specified.

C. Provide transformers 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.

D. Wiring shall be provided for complete installation of all equipment and accessories and shall be adequate for proper operation of equipment. Disconnect switch shall be provided for each equipment item requiring electric power. Disconnect switch shall meet the requirements of the respective equipment item manufacturer and these Specifications. Permanently label each disconnect switch to identify corresponding equipment item; labeling method shall conform to Division 26 and be subject to approval of the Authority Representative. Contractor shall provide 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, 230 volt and 208 volt equipment, as required, with electric fusible disconnecting means, sized and fused as required for each equipment item. 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 carried 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 26.

E. 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 104°F ambient temperature for open motors, with a service factor of 1.15 for open motors and unity service factor for totally enclosed or drip-proof 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 25 horsepower and over shall be designed for reduced voltage starting.

F. 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.
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. Bolts shall comply with applicable SAE requirements including manufacturer's identification and certification of testing.

1.11 EQUIPMENT:

A. Equipment, machinery and materials shall be as specified in Division 09, 10, 11 and 41.

B. Starters, controllers, disconnect switches and start-stop stations shall be provided for all equipment. Correct sizing of starters and disconnect switches shall be the joint responsibility of the Contractor and the equipment or apparatus manufacturer.
   1. Electrical enclosures shall be NEMA 12 for indoor units and NEMA 4 for outdoor units unless otherwise noted by the Authority Representative.
   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.
   4. Provide labels for all disconnects for the equipment furnished under respective section of work.

C. 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 the Specifications.

D. Switches, lights and control functions shall be identified with commercially available touch pads. The touch pads shall be industrial type oil resistant, etc. that are used on CNC control panels. No decals will be accepted.

E. Piped services for equipment shall be 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 connections.

F. Provide piping, fittings, valves, connections, etc., of a type and size as recommended by the equipment manufacturer that will properly interface with the existing piped services.

G. All piping, valves, fittings, conduits and wiring required for the equipment installation shall be in accordance with the applicable portions of these Specifications.
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 indicated in the Contract Documents. Equipment Manufacturer shall provide onsite representative during equipment installation.

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 the Authority Representative.

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 Authority Representative.

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 as approved by the Authority Representative.

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 applicable codes and standards of practice employed by these trades.

1.13 HOLES, OPENINGS, AND INSERTS:

A. Provide holes and openings in floors, walls, ceilings, and roofs as required. Coordinate all holes and openings with reinforcement and sleeves as required by Structural Contract Drawings.
B. Core drill holes in existing work using dustless method. Grout 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 manufacturer’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. Retighten 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. Provide concrete foundations for equipment as required for proper installation and operation. Contractor shall be responsible for all foundation modifications required because of submitting substitute or as equal equipment.

B. Provide anchor bolts as required for equipment to be mounted. Size anchors for embedding in concrete and expansions anchors as recommended by the equipment manufacturer, in accordance with specified seismic criteria.

C. Provide grouting as necessary to stabilize equipment bases to concrete foundations.

D. Provide hard rubber shims and dampening pads as recommended by the equipment manufacturer for leveling of equipment and dampening of equipment vibration transmission.

1.17 EQUIPMENT TEST AND CHECK-OUT:

A. Before Final Acceptance, the Contractor-furnished building equipment and systems shall be tested in accordance with the General Provisions (by a testing agency when required) in the presence of the Authority Representative to his satisfaction and demonstrated to be correctly connected and installed. Submit a testing schedule to the Authority Representative 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. 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 as described in Division 09, 10, 11 and 41 Equipment Specifications.

D. Tested equipment found to be defective or inoperable to any extent shall be reported to the Authority Representative immediately.

E. 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 Owner.

F. Protect equipment and surrounding areas from damage resulting from testing operations. Clean-up spills or leakage from testing.

G. The Contractor shall bear all expenses of all tests, including the furnishing of all necessary instruments, lubricant, hydraulic fluids, supplies, data recorders, certificates and operating personnel. Provide and bear all expenses for fuel/power required to operate the equipment during the tests.

H. At the sole discretion of the Authority Representative, the Contractor will be required to repeat any test at no additional cost to the Owner.

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 Authority Representative.

1.19 INSPECTION:

A. Work will be inspected by the Authority Representative periodically during the course of construction.

B. Provide for inspections by all those having jurisdiction over the work performed under Division 09, 10, 11 and 41 during the progress of the work.

C. At time of final inspection, furnish certificate or certificates of final approval by all those having jurisdiction as applicable.

1.20 FIELD PAINTING:

A. Field painting equipment, including touch-up painting, if any, is included in Section 09 90 00 Paint and Coatings. Normally, equipment shall be factory-finished as previously specified.

B. Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection.
1.21 EQUIPMENT START-UP:
   A. Unless otherwise specified in other Sections of these Specifications, all lubricants, cleaning compounds and similar operating materials will be furnished by the Contractor during start-up and testing.
   B. After all equipment and systems have been installed, connected, and tested, proceed with start-up.

1.22 TRAINING:
   A. General: The Contractor is responsible for providing training on equipment in accordance with requirements of the General and Special Provisions, Section 11 11 39.13 Vertical Swing Vehicle Rooftop Access Platform, Section 41 62 23 Forklifts, and Section 41 64 16 Mobile Railcar Mover.

PART 2 PRODUCTS
Not Required

PART 3 EXECUTION
Not Required

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS
   A. No Measurement will be made of the work of this section.

4.2 PAYMENTS
   A. Payment for the work of this Section shall not be measured, but shall be considered incidental to rooftop access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 11 11 39.13

VERTICAL SWING VEHICLE ROOFTOP ACCESS PLATFORM

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
      a. Maintenance Bay only

B. Section Includes:
   1. The work in this section includes furnishing and installing a Vertical Swing Vehicle Rooftop Access Platform that connects to the NC maintenance bay platform. The manufactured item bridges the gap between the constructed platform and the rooftop of the railcar.

C. Related Sections:
   2. Section 11 05 00 Common Work Results for Equipment
   3. Section 05 53 00 Metal Gratings
   4. Division 26 Electrical

1.2 DEFINITIONS


B. Installer: General Contractor.

1.3 REFERENCES

A. Federal Transit Administration (FTA)
   1. 49 CFR 661 Buy America Requirements

1.4 QUALITY ASSURANCE

A. Refer to the General Provisions, Special Provisions and Section 11 05 00 Common Work Results for Equipment and comply with the provisions herein.

B. Experience: Equipment shall be produced by a manufacturer of established reputation with a minimum of 5 years’ experience supplying specified equipment.

C. Manufacturer's Representative:
   1. Training: Provide technical representative to train WMATA’s maintenance personnel in operation and maintenance of specified equipment.

1.5 SUBMITTALS

A. Comply with the requirements of the General and Special Provisions, Section 11 05 00 Common Work Results for Equipment and as specified herein.

B. Shop Drawings:
   1. Submit complete catalog information and dimensioned shop drawings. Tolerances, clearances, and dimensions shall follow the system of ounces, pounds, gallons, inches, and feet, as used in the United States (metric conversions may be provided
parenthetically). Shop drawings shall include, but not necessarily be limited to, the following:

a. Outline dimensions of equipment.
b. Equipment and component layout.
c. Details of equipment and controls.
d. Complete and detailed foundation requirements with embedded items completely detailed.
e. Other necessary installation details, including infrastructure items furnished by others.
f. Catalog cuts of all purchased components.
g. Certification of Compliance: 49 C.F.R. Part 661 Buy America Requirements

C. Operation and Maintenance Manuals:
1. Submit Operation and Maintenance Manuals in accordance with the General Provisions, Special Provisions and Section 11 05 00 Common Work Results for Equipment.

D. Parts Catalog:
1. Enumerate and describe every component and its related parts, including identifying numbers and commercial equivalents where applicable.
2. Include cut-away and exploded view drawings for identification of all parts.

E. Spare Parts List:
1. Submit recommendations for spare parts inventory including types and quantities considered normal for routine maintenance of the equipment for one year.
2. Submit recommendations for spare parts inventory for approval by WMATA. Spare parts Inventory must include types and quantities considered critical and for which extended acquisition time would create excessive downtime.

F. Contractor's certification that proposed equipment meets or exceeds Specification requirements submitted with Shop Drawings.

G. Detailed information regarding location where fabrication assembly and testing operations are to be performed, submitted to the Authority Representative within 30 calendar days of Notice to Proceed.

H. Submit Acceptance Test Program including field testing procedures minimum 30 calendar days prior to installation and testing.

I. Submit proposed training program 90 calendar days prior to training.

1.6 PRODUCT SUBSTITUTIONS

A. Requests for approval of equipment items other than those specified herein shall be made in accordance with the General and Special Provisions.

B. Additional costs resulting from substitution of products other than those specified, including drawing changes and construction will be at the expense of the Contractor.

1.7 GUARANTEE

A. Vertical Swing Vehicle Rooftop Access Platform written warranty against defects in material, function, or workmanship from the date of acceptance by the owner, for a period of two (2) years.

B. Warranty shall include materials and labor necessary to correct defects.
C. Defects shall include, but not be limited to noisy, rough, or substandard operation; loose, damaged, and missing parts; and abnormal deterioration of finish.

D. All parts shall be readily available to the project site.

PART 2 PRODUCTS

2.1 VERTICAL SWING VEHICLE ROOFTOP ACCESS PLATFORM

A. Quantity: Full length of the NC Maintenance Bay; both sides of the platform.

B. Acceptable Manufacturer; provided compliance with Buy America 49 CFR Part 661 is certified:
   1. The products of the following manufacturer are specified as the standard of quality for the Vertical Swing Vehicle Rooftop Access Platform
      a. Western Sierras
         314 North Park Street
         Reno, Nevada 89512
         Phone: 775-324-2444
   2. Products of equal quality and utility of other approved manufacturers will be accepted.

C. General Description:
   1. Vertical Swing Vehicle Rooftop Access Platform is to be fabricated to provide a full length, married pair, bridge between the roof of the vehicle and the platform.
   2. Design the system outside of the dynamic envelope and to roll along the railcar as it is raised with the hoist without marking the railcar.

D. Construction Features:
   1. Each flap of the vertical swing vehicle rooftop access platform shall be approximately 4 feet in length and consist of the following items:
      a. 1 ea. frame, steel profile construction include counter weights
      b. 1 ea. aluminum plate with anti-slip surface, 48 inches x 17 inches
      c. 2 ea. hinges with integrated adaptor plate to connect the flaps to the steel structure.
      d. 2 ea. dampers that act as a stop for the flap in the horizontal position and are adjusted to reduce the lifting force of the flap.
      e. 2 ea. mounting brackets for dampers
      f. 2 ea. 2 inch (approx.) diameter non-marking, skid resistant rollers
         1) Rollers shall be constructed of a thermoplastic rubber or similar material, requiring minimum maintenance.

E. Dimensions and Capacities:
   1. Span: 150 feet
   2. Capacity: meet or exceed the requirements specified in specification Section 05 53 00 Metal Grating

F. Spares
   1. 20% spares for the hydraulic dampers and wheels.

PART 3 EXECUTION

3.1 INSPECTION

A. 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. Report defects to the Authority’s Representative. Commencement of Work means acceptance of existing conditions.

3.2 INSTALLATION

A. Vertical Swing Vehicle Rooftop Access Platform including all appurtenances in accordance with approved shop drawings and manufacturer's instructions.

B. Install equipment in accordance with Design Plans, accepted Shop Drawings, and manufacturer's written installation instructions.
   1. Upon completion of work, finished surfaces shall be free of tool marks, scratches, blemishes, and stains.

C. Retouch surface where the shop finishes is damaged, using the same materials and dry film thickness as the original shop finish.

3.3 CLEANUP

A. Touch-up damage to painted finishes

B. Wipe and clean equipment of oil, grease, and solvents, and make ready for use.

C. Clean area around equipment and remove packing or installation debris from job site.

D. Notify WMATA for acceptance inspection.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Provide an operation and maintenance manual in accordance with the requirements specified in Section 11 05 00 Common Work Results for Equipment.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. Locations of the Vertical Swing Vehicle Rooftop Access Platform are shown on the contract drawings. No Measurement will be made of the work in this system.

4.2 PAYMENTS

A. Payment for the work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes pipe, fittings, valves, and connections for wet-pipe sprinkler systems.

B. Related Sections:
   1. Section 09 90 00 - Painting and Coating: Execution requirements for piping painting specified by this section.
   2. Section 21 13 13 - Wet Pipe Sprinkler System.
   3. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
   4. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

C. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

1.2 REFERENCES

A. Reference Standards:
   1. U. S. Government:
      a) Federal Transit Administration (FTA):
      b) 49 CFR 661 Buy America Requirements.

B. American Society of Mechanical Engineers (ASME):
   2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
   4. ASME B16.3 - Malleable Iron Threaded Fittings.
   5. ASME B16.4 - Gray Iron Threaded Fittings.
   6. ASME B16.5 - Pipe Flanges and Flanged Fittings.
   8. ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

C. ASTM International (ASTM):

D. American Welding Society (AWS):
   1. AWS D1.1 - Structural Welding Code - Steel.

E. National Fire Protection Association: (NFPA)
1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Certificates: Buy America Act Certification

C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections. Indicate pipe sizes and nodes as related to sprinkler system hydraulic calculations.

D. Product Data: Submit manufacturer’s catalogue information. Indicate pipe materials. Indicate valve data and ratings. Indicate all sprinkler head types, temperature ratings and usage classifications

E. Manufacturer’s Certificate: Certify products meet or exceed specified requirements.

F. Submit Contractor’s Material and Test Certificates for Aboveground and Underground Piping.

1.4 CLOSEOUT SUBMITTALS

A. Closeout Requirements: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of components and tag numbering.

C. Operation and Maintenance Data: Submit spare parts lists.

1.5 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
   1. Buy America Act:
      a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.

B. Certifications: Buy America Act Certification; Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

C. Provide fire sprinkler piping located in plenums with the peak optical density not greater than 0.5, the average optical density not greater than 0.15, and flame spread not greater than 5 feet when tested in accordance with UL 1887.

D. Perform Work in accordance with current NFPA 13 standard.

E. All products must be stamped UL Listed and/or FM Approved.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.
1.7 PRE-INSTALLATION MEETINGS
A. Pre Installation Meetings: Refer to Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Delivery, Storage and Handling: Refer to Contract Documents.
B. Deliver and store valves in shipping containers, with labeling in place.
C. Furnish cast iron and steel valves with temporary protective coating.
D. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
E. Sprinkler heads shall remain in shipping cartons until installed.

1.9 WARRANTY
A. Warranty Requirements: Refer to Contract Documents.
B. Furnish five year manufacturer warranty for basic fire suppression materials and methods.

1.10 EXTRA MATERIALS
A. Extra Materials, Spare parts and maintenance products: Refer to Contract Documents.
B. Furnish two sets of valve stem packing for each size and type of valve installed.

1.11 BASIS OF DESIGN AND ACCEPTABLE MANUFACTURERS
A. Where a specific manufacturer or product is identified as the Basis of Design or listed first in a list of acceptable manufacturers, the overall project design is based on the identified manufacturer or product. If the Contractor elects to utilize a manufacturer or product which differs from the identified Basis of Design, the Contractor shall bear all efforts and costs of any design changes necessary in order to achieve finished work which is equal in character, performance, and quality to the original design depicted in the Contract Documents. Such changes shall include, but not necessarily be limited to: changes to ratings and/or features of other equipment, changes to material sizes and/or types, new material and/or equipment, and changes to structural and/or architectural features (including room sizes). Approval by the Engineer of a proposed item shall not relieve the Contractor of this responsibility.

B. The listing of specific manufacturers is solely intended to identify reputable manufacturers who are known to provide quality products of the general type specified. Such listing is in no way intended to imply that the identified manufacturer’s product(s) have been verified to satisfy the specified requirements, or to be equivalent to any identified Basis of Design manufacturer. Nor does such a listing imply acceptance of products which do not meet the specified requirements, ratings, features, dimensions, and functions as indicated.
PART 2 PRODUCTS

2.1 VALVES

A. Manufacturers:
   1. Conbraco Industries
   2. Nibco.
   3. Stockham

B. Ball Valves:
   1. Over 2 inches: Manufacturers: Cast steel body, chrome plated steel ball, Teflon seat and stuffing box seals, lever handle, flanged.

C. Drain Valves:
   1. Compression Stop: Bronze with hose thread nipple and cap.
   2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

2.2 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A53, Grade B; ASTM A135 UL listed, threadable, light wall; ASTM A795 or ASME B36.10; Schedule 40 black.
   4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
   5. Mechanical Formed Fittings: Carbon-steel housing with integral pipe stop and O-ring pocked and O-ring uniformly compressed into permanent mechanical engagement onto pipe.

2.3 PIPE HANGERS AND SUPPORTS

A. Conform to NFPA 13.

B. Refer to Section 22 05 29 Hangers and Supports for Plumbing Equipment.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material from inside and outside before assembly

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Install piping in accordance with NFPA 13 for sprinkler systems.
B. Route all piping in orderly manner. Run plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping at common elevations, whenever practical.

E. Install pipe sleeve at piping penetrations through partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Pipe Hangers and Supports:
   1. Install in accordance with NFPA 13.
   2. Install hangers to within minimum 1/2 inch space between finished covering and adjacent work.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
   6. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

H. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding, paint piping RED. Refer to Section 09 90 00.

J. Do not penetrate building structural members unless indicated.

K. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.

L. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

M. Install valves with stems upright or horizontal, not inverted. Remove protective coatings after installation.

N. Install ball valves for shut-off or isolating service.

O. Install drain valves at main shut-off valves, low points of piping and apparatus.

P. Where inserts are omitted, drill through concrete slab from below, and install through-bolt with recessed square steel plate and nut flush with top of slab.
3.3 INTERFACE WITH OTHER PRODUCTS

A. Inserts:
   1. Install inserts for placement in concrete forms.
   2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.4 CLEANING AND FLUSHING

A. Execution and Closeout Requirements: Refer to Contract Documents.
B. Clean entire system after other construction is complete.
C. Flush underground and above ground piping in accordance with NFPA 13.

3.5 TESTING

A. Perform all testing in accordance with NFPA 13

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured, but shall be incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Domestic water piping, above grade.
   2. Unions and flanges.
   3. Valves.
   4. Hose bibs.

B. Related Sections:
   1. Section 21 05 00 – Common Work results for Fire Suppression.
   2. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.

C. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

1.2 REFERENCES

A. Reference Standards:
   1. U. S. Government:
      a. Federal Transit Administration (FTA):
         1) 49 CFR 661 Buy America Requirements.

B. National Fire Protection Association (NFPA):

1.3 SYSTEM DESCRIPTION

a. system to provide coverage for the entire building.

A. provide hydraulically designed system to NFPA 13 ordinary hazard, group 2 occupancy requirements.

B. Determine volume and pressure of incoming water supply from water flow test data.

C. Interface system with building control system.

D. Provide fire department connections as indicated on Drawings. Coordinate with local Fire Department.

1.2 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.
B. Certificates: Buy America Act Certification

C. Shop Drawings: Indicate layout of finished ceiling areas indicating sprinkler locations coordinated with ceiling installation. Indicate detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.

D. Product Data: Submit data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

E. Design Data: Submit design calculations; signed and sealed by professional engineer.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Execution and Closeout Requirements: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings, indicate drain and test locations.

C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.4 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
   1. Buy America Act:
      a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.

B. Certifications: Buy America Act Certification; Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

C. Perform Work in accordance with NFPA 13 and the local Fire Department.

D. All products must bear the markings of UL listed and/or FM Approved.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.

B. Installer: Company specializing in performing Work of this section with minimum three years of experience approved by manufacturer.

C. Design system under direct supervision of Professional Engineer experienced in design of this Work and licensed in the site location State.
1.6 PRE-INSTALLATION MEETINGS
A. Pre-installation meeting: Refer to Contract Documents.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Delivery, Storage and Handling: Refer to Contract Documents.
B. Store products in shipping containers until installed.
C. Furnish piping with temporary inlet and outlet caps until installation.

1.8 WARRANTY
A. Warranty Execution and Closeout Requirements: Refer to Contract Documents.

1.9 BASIS OF DESIGN AND ACCEPTABLE MANUFACTURERS
A. Where a specific manufacturer or product is identified as the Basis of Design or listed first in a list of acceptable manufacturers, the overall project design is based on the identified manufacturer or product. If the Contractor elects to utilize a manufacturer or product which differs from the identified Basis of Design, the Contractor shall bear all efforts and costs of any design changes necessary in order to achieve finished work which is equal in character, performance, and quality to the original design depicted in the Contract Documents. Such changes shall include, but not necessarily be limited to: changes to ratings and/or features of other equipment, changes to material sizes and/or types, new material and/or equipment, and changes to structural and/or architectural features (including room sizes). Approval by the Engineer of a proposed item shall not relieve the Contractor of this responsibility.

B. The listing of specific manufacturers is solely intended to identify reputable manufacturers who are known to provide quality products of the general type specified. Such listing is in no way intended to imply that the identified manufacturer’s product(s) have been verified to satisfy the specified requirements, or to be equivalent to any identified Basis of Design manufacturer. Nor does such a listing imply acceptance of products which do not meet the specified requirements, ratings, features, dimensions, and functions as indicated.

1.10 EXTRA MATERIALS
A. Extra Materials: Refer to Contract Documents.
B. Furnish extra sprinklers under provisions of NFPA 1.
C. Furnish suitable wrenches for each sprinkler type.
D. Furnish metal storage cabinet located adjacent to alarm valve.

PART 2 PRODUCTS

2.1 SPRINKLERS
A. Manufacturers:
1. Tyco Fire Systems.
2. Grinnell Corp.
B. Exposed Area Type:
   1. Type: Standard upright type.
   2. Finish: Brass.
   3. Fusible Link: Fusible-solder link type or Glass bulb type temperature rated for specific area hazard.

C. Acceptable Manufacturers (Reserve Sprinkler Cabinet and Sprinkler Guards):
   1. Tyco Fire Systems.
   2. Viking Corporation
   3. Grinnell Corp.

D. Reserve Sprinkler Cabinet: Cabinet construction shall conform to NFPA requirements and shall have storage capacity in accordance with NFPA 13 for storing spare sprinkler heads of each type installed plus a sprinkler head wrench.

E. Sprinkler Guards: UL listed and FM Approved; for use with standard and large orifice, standard and quick response, upright and pendant style sprinklers. Hard steel wire cage designed to encase and protect sprinkler, clear chromate over zinc plating. Model D-1

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 13.

B. Install buried shut-off valves in valve box. Furnish post indicator.

C. Install approved double check valve back-flow preventer assembly at sprinkler system water source connection.

D. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of fire department wrench handle.

E. Locate outside alarm-gong on building wall as indicated on Drawings.

F. Place pipe runs to minimize obstruction to other work.

G. Install piping in concealed spaces above finished ceilings.

H. Center sprinklers in two directions in ceiling tile and install piping offsets.

I. Hydrostatically test entire system.

J. Require tests to be witnessed by Fire Marshall and/or the Owner’s insurance underwriter.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Verify signal devices are installed and connected to fire alarm system.

3.3 CLEANING

A. Cleaning Requirements: Refer to Contract Documents.
B. Flush entire piping system of foreign matter, in accordance with NFPA 13.

3.4 TESTING

A. Test entire system in accordance with NFPA.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Protecting installed construction: Refer to Contract Documents.

B. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be incidental to roof top platform at New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe hangers and supports.
   2. Hanger rods.
   3. Inserts.
   4. Sleeves.
   5. Formed steel channel.
   6. Firestopping relating to plumbing work.
   7. Firestopping accessories.

B. Related Sections:
   1. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
   2. Section 22 05 53 – Identification of Plumbing Piping and Equipment.
   3. Section 22 07 00 – Plumbing Insulation.
   4. Section 22 11 00 - Facility Water Distribution

C. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

1.2 REFERENCES

A. American Society of Mechanical Engineers:
   1. ASME B31.1 - Power Piping.
   2. ASME B31.9 - Building Services Piping.

B. ASTM International:

C. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:
1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction in accordance with FM/UL Design Numbers.

B. Surface Burning: ASTM E84 or UL 723 with maximum flame spread / smoke developed rating of 25/450.

C. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

A. General and Special Provisions: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
   2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

H. Certificates: Buy America Act Certification
1.7 QUALITY ASSURANCE

A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 1.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
   1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
   2. Floor Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
      a. Floor Penetrations within Wall Cavities: T-Rating is not required.

B. Through Penetration Firestopping of Non-Fire Rated Floor [and Roof] Assemblies: Materials to resist free passage of flame and products of combustion.
   2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.

D. Fire Resistant Joints between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage (24.9 Pa) minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.

E. Surface Burning Characteristics: 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

F. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

G. Perform Work in accordance with WMATA standards.

H. Regulatory Agency Sustainability Approvals:
   1. Buy America Act:
      a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.

I. Certifications: Buy America Act Certification; Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years of experience.

B. Installer: Company specializing in performing Work of this section with minimum five years of experience.

C. Installer: Certified by product manufacturer.

D. Firestopping Installer: Certified by the firestopping manufacturer with 1 years of experience.
1.9 PRE-INSTALLATION MEETINGS
   A. Section 01312 - Administrative Requirements: Pre-installation meeting.

1.10 DELIVERY, STORAGE, AND HANDLING
   A. Section 01610 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
   B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
   C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS
   A. Environmental Requirements: Refer to Contract Documents.
   B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
   C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
   D. Provide ventilation in areas to receive solvent cured materials.

1.12 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.13 BASIS OF DESIGN AND ACCEPTABLE MANUFACTURERS
   A. Where a specific manufacturer or product is identified as the Basis of Design or listed first in a list of acceptable manufacturers, the overall project design is based on the identified manufacturer or product. If the Contractor elects to utilize a manufacturer or product which differs from the identified Basis of Design, the Contractor shall bear all efforts and costs of any design changes necessary in order to achieve finished work which is equal in character, performance, and quality to the original design depicted in the Contract Documents. Such changes shall include, but not necessarily be limited to: changes to ratings and/or features of other equipment, changes to material sizes and/or types, new material and/or equipment, and changes to structural and/or architectural features (including room sizes). Approval by the Engineer of a proposed item shall not relieve the Contractor of this responsibility.
   B. The listing of specific manufacturers is solely intended to identify reputable manufacturers who are known to provide quality products of the general type specified. Such listing is in no way intended to imply that the identified manufacturer's product(s) have been verified to satisfy the specified requirements, or to be equivalent to any identified Basis of Design manufacturer. Nor does such a listing imply acceptance of products which do not meet the specified requirements, ratings, features, dimensions, and functions as indicated.

1.14 WARRANTY
   A. Warranty Requirements: Refer to Contract Documents.
PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Anvil Inc.
   2. Carpenter & Paterson Inc.

B. Plumbing Piping Compressed Air:
   1. Conform to ASME B31.9, MSS SP58, MSS SP69, MSS SP89.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Galvanized Carbon steel, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 inches and Larger: Galvanized Carbon steel, adjustable, clevis.
   4. Wall Support for Pipe Sizes 3 inches and Smaller: Galvanized Iron or Steel hook.
   5. Vertical Support: Galvanized Steel riser clamp.

C. Plumbing Piping - Water:
   1. Conform to ASME B31.9, MSS SP58, MSS SP69, MSS SP89.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Galvanized Carbon steel, adjustable swivel, split ring.

2.2 HANGER RODS

A. Manufacturers:
   1. Anvil Inc.
   2. Carpenter & Paterson Inc.

B. Hanger Rods: Galvanized mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors:
   Galvanized steel pipe or 18 gage thick galvanized steel.

B. Sealant: Refer to Manufacturer’s Instructions

2.4 FORMED STEEL CHANNEL

A. Manufacturers:
   2. Unistrut Corp.

B. Product Description: Galvanized 12 gage thick steel, with holes 1-1/2 inches on center.

2.5 FIRESTOPPING

A. Manufacturers:
   1. Dow Corning Corp.
2. Fire Trak Corp.
3. Hilti Corp.
4. 3M fire Protection Products.

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
   1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
   2. Foam Firestopping Compounds: Single component foam compound.
   3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
   4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
   5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
   6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
   7. Firestop Pillows: Formed mineral fiber pillows.

C. Color: Dark gray.

2.6 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01711 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing or damming materials to arrest liquid material leakage.

D. Obtain permission from Architect/Engineer before using powder-actuated anchors.

E. Do not drill or cut structural members.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as scheduled.
B. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

L. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

3.4 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1-inch above finished floor level. Caulk sleeves.

E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with stuffing or firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel escutcheons at finished surfaces.

3.5 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.
D. Remove dam material after firestopping material has cured.

E. Fire Rated Surface:
   1. Seal opening at floor, wall, partition, and ceiling as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch on both
         sides of building element.
      b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
      c. Pack void with backing material.
      d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating
         of structure penetrated.

F. Non-Rated Surfaces:
   1. Seal opening through non-fire rated wall, partition and floor as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch on both
         sides of building element.
      b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied
      spaces. Occupied spaces include rooms with finished ceilings and where penetration
      occurs below finished ceiling.
   3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device
      to size of piping and tighten in place, in accordance with manufacturer's instructions.

3.6 FIELD QUALITY CONTROL

A. Section 01470 - Quality Requirements 01775 - Execution and Closeout Requirements: Field
   inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.7 CLEANING

A. Section 01775 - Execution and Closeout Requirements: Requirements for cleaning.

B. Clean adjacent surfaces of firestopping materials.

3.8 PROTECTION OF FINISHED WORK

A. Section 01775 - Execution and Closeout Requirements: Requirements for protecting finished
   Work.

B. Protect adjacent surfaces from damage by material installation.

3.9 SCHEDULES

<table>
<thead>
<tr>
<th>PIPE MATERIAL</th>
<th>MAXIMUM HANGER SPACING</th>
<th>HANGER ROD DIAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feet</td>
<td>Inches</td>
</tr>
<tr>
<td>Cast Iron (All Sizes)</td>
<td>5</td>
<td>5/8</td>
</tr>
<tr>
<td>Cast Iron (All Sizes) with 10 foot length of pipe</td>
<td>10</td>
<td>5/8</td>
</tr>
<tr>
<td>Copper Tube, 1-1/4 inches and smaller</td>
<td>6</td>
<td>1/2</td>
</tr>
<tr>
<td>Copper Tube, 1-1/2 inches and larger</td>
<td>10</td>
<td>1/2</td>
</tr>
<tr>
<td>PVC (All Sizes)</td>
<td>4</td>
<td>3/8</td>
</tr>
</tbody>
</table>
### PART 4 MEASUREMENTS AND PAYMENTS

#### 4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

#### 4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1  GENERAL

1.01 SUMMARY

A. This section specifies providing nameplates and tags on mechanical equipment and apparatus.

B. Related Sections:
   1. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
   2. Section 22 11 00 - Facility Water Distribution
   3. Section 22 15 00 – General Services Compressed Air Systems

C. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1.03 SUBMITTALS

A. Submittal Procedure: Refer to Contract Documents.

B. Product Data: Submit manufacturer’s catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer’s name and model number.

D. Manufacturer’s Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer’s Certificate: Certify products meet or exceed specified requirements.

F. Certificates: Buy America Act Certification

1.04 CLOSEOUT SUBMITTALS

A. General and Special Provisions - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.05 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
B. Regulatory Agency Sustainability Approvals:
   1. Buy America Act:
      a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.

C. Certifications: Buy America Act Certification; Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

PART 2 - PRODUCTS

2.01 TAGS

A. Plastic Nameplate Manufacturers:
   1. Seton Identification Products Model
   2. Craftmark Identification Systems.
   3. Safety Sign Co.

B. Laminated three-layer plastic with engraved black letters on light contrasting background color. Nameplate size minimum 1-1/2 inches (38 mm) diameter.

C. Valve Tag Securing Device: Number 6 brass bead chain; provide one securing device for each tag in accepted schedule, secure with brass S-hooks.

D. Terminology: Match identifying Number from drawings and schedules.

E. Metal Tags Manufacturers:
   1. Seton Identification Products Model
   2. Craftmark Identification Systems.
   3. Safety Sign Co.

F. 18 Gauge Stainless Steel with stamped letters; tag size minimum 1-1/2 inches (38 mm) diameter with finished edges.

G. Valve Tag Securing Device: Number 6 brass bead chain; provide one securing device for each tag in accepted schedule, secure with brass S-hooks.

H. Terminology: Match identifying Number from drawings and schedules.

I. Identification Plates: Bronze, Authority-furnished.

2.02 VALVE TAG CHART

A. Tag Chart: Typewritten letter size in anodized aluminum frame, list of applied tags and location. Provide mounting device.

2.03 PIPE MARKERS


B. Plastic Pipe Markers Manufacturers:
   1. Seton Identification Products; Model
   2. Craftmark Identification Systems.
3. Safety Sign Co.

C. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering, minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers Manufacturers:
   1. Seton Identification Products; Model
   2. Craftmark Identification Systems.
   3. Safety Sign Co.

E. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum information indicating flow direction arrow and identification of fluid being conveyed.

PART 3 EXECUTION

3.01 PREPARATION

   A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

   A. Install identifying devices after completion of coverings and painting.
   B. Install all pipe markers in accordance with accepted shop drawings and manufacturer’s instructions.
   C. Install valve tags in accordance with accepted shop drawings and manufacturer’s instructions.
   D. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
   E. Install tags with corrosion resistant chain.
   F. Mount valve charts in aluminum frames with clear Lucite front cover in locations as directed.

PART 4 MEASUREMENTS AND PAYMENTS

4.01 MEASUREMENTS

   A. The work of this section will not be measured for separate payment.

4.02 PAYMENTS

   A. The payment for work of this section shall not be measured, but shall be incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.:
SECTION 22 07 00

PLUMBING INSULATION

PART 1  GENERAL

1.1  SUMMARY

A. Section Includes:
   1. Manufacturers
   2. Common Insulation Characteristics
   3. Insulation Types
   4. Field-Applied Jackets
   5. Accessories and Attachments
   6. Vapor Retarders

B. Related Sections:
   1. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
   2. Section 22 05 53 – Identification of Plumbing Piping and Equipment.
   3. Section 22 11 00 - Facility Water Distribution

C. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

1.2  REFERENCES

A. The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic definition only.

B. American Society of Heating, Ventilating and Air Conditioning Engineers (ASHRAE):
   1. ASHRAE 90.1; Energy Standard for Buildings except Low-Rise Residential Buildings (inch).

C. American Society for Testing and Materials (ASTM):
   1. ASTM A 666; Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet Strip, Plate, and Flat Bar.
   2. ASTM B 209; Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   5. ASTM C 423; Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
   7. ASTM C533; Calcium Silicate Block and Pipe Thermal Insulation.
   8. ASTM C534; Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   9. ASTM C547; Mineral Fiber Performed Pipe Insulation.
   10. ASTM C553; Mineral Fiber Blanket and Felt Insulation.
   11. ASTM C612; Mineral Fiber Block and Board Thermal Insulation.
   12. ASTM C919; Practice for Use of Sealants in Acoustical Applications.
14. ASTM C 1071; Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
15. ASTM D 635; Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
17. ASTM E 136; Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C.
18. ASTM G 21; Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
19. ASTM G 22; Determining Resistance of Plastics to Bacteria.

D. Underwriters Laboratories, Inc. (UL):

1.3 SUBMITTALS

A. General: Submit in accordance with General and Special Provisions requirements. Submit in sufficient detail to show full compliance with Contract Documents.

B. Product Data:
   1. Submit manufacturer's product data for each product and material
   2. Indicate manufacturer, trade names, and model numbers, components, arrangement, and accessories being provided.
   3. Include applicable literature, catalog material or technical brochures.
   4. Certified test reports indicating compliance with specified performance requirements.
   5. Certificates: Buy America Act Certification

C. Closeout Submittals:
   1. Record Documents

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section with a minimum of 5 years of experience.

B. Installer Qualifications: Experience on at least 5 projects of a similar nature in past 5 years, and acceptable to the Owner.

C. Pre-Installation Meetings:
   1. Conduct pre-installation meetings in accordance with General and Special Provisions.

D. Regulatory Agency Sustainability Approvals:
   1. Buy America Act:
      a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.

E. Certifications: Buy America Act Certification; Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

1.5 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with requirements of General and Special Provisions.

B. Packing, Shipping, Handling, and Unloading:
1. Accept equipment, materials, and other Products on site in factory containers, bundles, and shipping skids.

C. Delivery and Acceptance at Site:
1. Deliver material in original packages, containers, skid loads, or bundles bearing brand names and identification of source of manufacture or supply.
2. Inspect deliveries for damage.

D. Storage and Protection:
1. Store all materials inside under cover and in a dry location.
2. Protect from weather, direct sunlight, surface damage, corrosion, and construction traffic and activity.
3. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Handling:
1. Handle material to prevent damage to edges, ends, surfaces, and finishes.

1.6 PROJECT/SITE CONDITIONS

A. Project Conditions:
1. Sequence installation to insure utility connections are made in an orderly and timely manner.

1.7 BASIS OF DESIGN AND ACCEPTABLE MANUFACTURERS

A. Where a specific manufacturer or product is identified as the Basis of Design or listed first in a list of acceptable manufacturers, the overall project design is based on the identified manufacturer or product. If the Contractor elects to utilize a manufacturer or product which differs from the identified Basis of Design, the Contractor shall bear all efforts and costs of any design changes necessary in order to achieve finished work which is equal in character, performance, and quality to the original design depicted in the Contract Documents. Such changes shall include, but not necessarily be limited to: changes to ratings and/or features of other equipment, changes to material sizes and/or types, new material and/or equipment, and changes to structural and/or architectural features (including room sizes). Approval by the Engineer of a proposed item shall not relieve the Contractor of this responsibility.

B. The listing of specific manufacturers is solely intended to identify reputable manufacturers who are known to provide quality products of the general type specified. Such listing is in no way intended to imply that the identified manufacturer’s product(s) have been verified to satisfy the specified requirements, or to be equivalent to any identified Basis of Design manufacturer. Nor does such a listing imply acceptance of products which do not meet the specified requirements, ratings, features, dimensions, and functions as indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Use of Trade Names: The use of trade names on the drawings or other documents is to establish a basis of design, constructability, and level of quality. It is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with contract requirements.
B. Acceptable 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. Manville Corporation.
   2. Owens-Corning Fiberglass.

C. Acceptable Manufacturers for Closed Cell Elastomeric or Polyolefin Insulation Materials:
   1. Armstrong AP.
   2. IMCOA.
   3. Rubatex.

D. Acceptable Manufacturers for Metal Jackets:
   1. Manville Metal-Loc.
   2. Childers.

2.2 COMMON INSULATION CHARACTERISTICS

A. Specified insulation thickness based on R-values ranging from 4.0 to 4.6 per inch at 75 degrees F. mean temperature.
   1. If insulation R-value is less than 4.0, increase indicated insulation thickness by ratio of 4.0/R-value.
   2. If insulation R-value is greater than 4.6, decrease indicated insulation thickness by ratio of 4.6/R-value.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread rating of 25 or less and smoke-developed rating of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread rating of 75 or less and smoke-developed rating of 150 or less.

2.3 INSULATION TYPES

A. Type 1: Fiberglass (molded for pipe).
   1. Material: 1 or 2 piece fiberglass molded to pipe size and conforming to ASTM C547 Type I; rigid molded, noncombustible.
   3. ‘K’ ('ksi') Value: 0.23 at 75 degrees F Mean Temperature.
   4. Maximum Service Temperature: 0 degrees F to 850 degrees F.

B. Type 2: Closed Cell Elastomeric or Polyolefin (molded for pipe).
   1. Material: Expanded, flexible, molded to pipe size and conforming to ASTM C534.
   2. Pre-slit and pre-glued longitudinal seam.
   3. ‘K’ ('ksi') Value: 0.30 at 75 degrees F Mean Temperature.
   4. Maximum Service Temperature of 220 degrees F.
   5. Adhesive: As recommended by insulation material manufacturer.
   6. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.4 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.
B. Aluminum Jacket: Sheets manufactured from aluminum alloy complying with ASTM B209, and having an integrally bonded moisture barrier over entire surface in contact with insulation, 0.016 inch thick No. 5005 tempered aluminum secured with machine drawn 0.020-inch stainless steel bands.
   1. Finish: Stucco finish

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
   1. Coordinate installation of insulation with Section 221100.
   2. Extend piping insulations through walls, floor, and similar penetrations without interruption, unless noted otherwise.
   3. Clean and dry pipe surfaces prior to insulating.
   4. Maintain integrity of vapor barrier jackets on piping insulation and protect to prevent puncture or other damage.
   5. Protect exposed insulated interior vertical piping with protective 0.02 inch minimum thickness rigid aluminum jacket
   6. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
   7. Install vapor-retarder mastic on equipment scheduled to receive vapor retarders. Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
   8. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
   9. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
  10. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
  11. Apply insulation with the least number of joints practical.
  12. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
  13. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
  14. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

B. Cold Piping - Type 1:
   1. Wrap with type 1 segments.
   2. Seal tabs and joints with lagging adhesive or self-sealing system without using staples.
   3. Seal exposed insulation ends at valves, fittings, and flanges with vapor barrier mastic.
   4. Wrap fittings, valves, and flanges with mitered Type 1 segments of same thickness as adjacent insulation or; for 2 inch and smaller, wrap with 3/4 pound density fiberglass blanket compressed to adjacent pipe insulation thickness.
   5. Cover fittings, valves, and flanges with PVC pre-molded fitting covers using adhesive or coat wrap using mineral fiber cement technique.
3.2 PROTECTION AND REPLACEMENT

A. Replace damaged insulation, including vapor barrier damage and moisture saturated insulation, prior to acceptance of work.

B. Advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.3 SCHEDULES

<table>
<thead>
<tr>
<th>COLD PIPING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
</tr>
<tr>
<td>Domestic cold water</td>
</tr>
</tbody>
</table>

3.4 PIPING MINIMUM INSULATION SCHEDULE (ASHRAE 90.1-89)¹

A. Fiber Glass Insulation

<table>
<thead>
<tr>
<th>Fluid Temp</th>
<th>Runouts up To 2 inches</th>
<th>1 and Less</th>
<th>1 to 2</th>
<th>2-1/2 to 4</th>
<th>5 &amp; 6</th>
<th>8 &amp; up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>.5</td>
<td>1</td>
<td>1</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

¹The required minimum insulation thickness does not consider condensation.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.2 PAYMENTS

A. The payment for work of this section shall be not measured for payment, but shall be incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 22 11 00

FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Domestic water piping, above grade.
   2. Unions and flanges.
   3. Valves.
   4. Hose bibs.

B. Related Sections:
   1. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
   2. Section 22 05 53 – Identification of Plumbing Piping and Equipment.
   3. Section 22 07 00 – Plumbing Insulation.

C. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

1.2 REFERENCES

A. American National Standards Institute:

B. American Society of Mechanical Engineers:
   1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   3. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
   4. ASME B31.9 - Building Services Piping.
   5. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
   6. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. American Society of Sanitary Engineering:
   1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
   2. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
   3. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type.

D. ASTM International:

E. American Welding Society:
   1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
F. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
   4. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
   5. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

G. National Sanitary Foundation:
   1. NSF/ANSI 61; Standard 61 Drinking Water System Components

H. Plumbing and Drainage Institute:

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturer's catalog information.
   2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
   3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
   4. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
   5. Certificates: Buy America Act Certification

C. Manufacturer's Installation Instructions: Submit installation instructions for valves and accessories.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Closeout Submittals: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of valves and equipment.

C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

D. Regulatory Agency Sustainability Approvals:
   1. Buy America Act:
      a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.

E. Certifications: Buy America Act Certification; Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

F. Certifications: Buy America Act Certification; Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.
1.5 QUALIFICATIONS
   
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years of experience.
   
   B. Installer: Company specializing in performing Work of this section with minimum three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING
   
   A. Delivery, storage and handling requirements: Refer to Contract Documents.
   
   B. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.
   
   C. Provide temporary protective coating on cast iron and steel valves.
   
   D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
   
   E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.7 ENVIRONMENTAL REQUIREMENTS
   
   A. Environmental Requirements: Refer to Contract Documents.

1.8 FIELD MEASUREMENTS
   
   A. Verify field measurements prior to fabrication.

1.9 WARRANTY
   
   A. Warranty Requirements: Refer to Contract Documents.

1.10 EXTRA MATERIALS
   
   A. Extra Materials: Refer to Contract Documents.
   
   B. Furnish two packing kits for each size valve.

1.11 BASIS OF DESIGN AND ACCEPTABLE MANUFACTURERS
   
   A. Where a specific manufacturer or product is identified as the Basis of Design or listed first in a list of acceptable manufacturers, the overall project design is based on the identified manufacturer or product. If the Contractor elects to utilize a manufacturer or product which differs from the identified Basis of Design, the Contractor shall bear all efforts and costs of any design changes necessary in order to achieve finished work which is equal in character, performance, and quality to the original design depicted in the Contract Documents. Such changes shall include, but not necessarily be limited to: changes to ratings and/or features of other equipment, changes to material sizes and/or types, new material and/or equipment, and changes to structural and/or architectural features (including room sizes). Approval by the Engineer of a proposed item shall not relieve the Contractor of this responsibility.
B. The listing of specific manufacturers is solely intended to identify reputable manufacturers who are known to provide quality products of the general type specified. Such listing is in no way intended to imply that the identified manufacturer’s product(s) have been verified to satisfy the specified requirements, or to be equivalent to any identified Basis of Design manufacturer. Nor does such a listing imply acceptance of products which do not meet the specified requirements, ratings, features, dimensions, and functions as indicated.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L, hard drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

2.2 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
   1. Copper Piping: Class 150, bronze unions with soldered or brazed joints.
   2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.3 VALVES – DOMESTIC WATER

A. Valves: Valve ends may either be threaded or soldered, but mixtures of end types in a system is not acceptable

2.4 BALL VALVES

A. Acceptable Manufacturers:
   1. Apollo Valve Co
   2. Nibco.
   3. Stockham

B. Ball Valve (4-inch and smaller): MSS SP-110, ANSI/NSF 61-8; Blowout proof stem, 600 PSI CWP maximum pressure, 500°F maximum temperature, chrome plated ball, adjustable packing gland, in-line disassembly design, stem extensions, bronze body and trim, PTFE Seat, lead free, lead free hang tag, zinc plated steel lever handle with vinyl grip, threaded ends; 70LF-100-03.

C. Ball Valve (4-inch and smaller): MSS SP-110, ANSI/NSF 61-8; Blowout proof stem, 600 PSI CWP maximum pressure, 500°F maximum temperature, chrome plated ball, adjustable packing gland, in-line disassembly design, stem extensions, bronze body and trim, PTFE Seat, lead free, lead free hang tag, zinc plated steel lever handle and nut and vinyl grip, solder ends; 70LF-200-03.

2.5 HOSE BIBS

A. Acceptable Manufacturers:
   1. Nibco Incorporated; Series QT63X

B. Hose Bibb (Interior): NSF/ANSI 61; ASTM B283; brass body, rough brass finish, angle pattern, renewable Nitril “O” ring, PTFE seat, zinc handle, sweat or threaded inlet, standard 3/4 inch male hose end outlet.
2.6 VACUUM BREAKERS

A. Acceptable Manufacturers (Vacuum Breakers):
   1. Watts Regulator Company, Model 8A.
   2. Wilkins

B. Vacuum Breakers: ASSE 1011/ANSI A112.1.3; Lead-free brass body, non-removable, stainless steel internal working parts, rubber diaphragm and disc.

PART 3 EXECUTION

3.1 EXAMINATION

A. Administrative Requirements: Refer to Contract Documents.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with Section 22 05 29.

3.4 INSTALLATION - ABOVE GROUND PIPING

A. Install non-conducting dielectric connections wherever jointing dissimilar metals.
B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
C. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
D. Group piping whenever practical at common elevations.
E. Slope piping and arrange systems to drain at low points.
F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.
G. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
H. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
I. Install domestic water piping in accordance with ASME B31.9.
J. Sleeve pipes passing through partitions, walls and floors.
K. Install unions downstream of valves and at equipment or apparatus connections.

L. Install valves with stems upright or horizontal, not inverted.

M. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

N. Install ball valves for shut-off.

3.5 TESTING, CLEANING AND DISINFECTION

A. Testing (Underground outside structure and under on-grade slab): Hydrostatic at 50 percent over system operating pressure but not less than 100 psig.
   1. General: Conduct testing and disinfecting in accordance with the Water Service utility requirements, or in accordance with the following requirements, whichever is more stringent.
   2. Prior to testing, allow those installed sections of water piping protected by concrete reaction blocking to stand undisturbed for at least seven days from concrete pour. Provide temporary blocking as required.
   3. The Contractor may, at his option, completely backfill the trench or partially backfill the trench over the center section of each pipe length prior to performing the pressure test.
   4. Fill the section of installed water piping being tested with water a minimum of twenty-four hours prior to testing. During filling insure the piping is free of air. Use potable water for filling.
   5. Line Acceptance Test:
      a. After the water line is constructed, backfilled (as stated above), and successfully cleaned, perform a hydrostatic line acceptance test as follows:
         1) Seal water line at downstream end with a suitable pipe plug.
         2) Fill water line with potable water (as stated above).
         3) Raise hydrostatic pressure to 150 psig.
         4) Maintain test pressure for a period of not less than one hour.
      b. Also conduct a leakage test for a duration of two uninterrupted hours at the same pressure specified for the hydrostatic test and provide a means for measuring leakage. Piping being tested will not be accepted if leakage is greater than that determined by the formula \( L = ND(\sqrt{P}) \) in which \( L \) is the allowable leakage 7400 in gallons per hour; \( N \) is the number of joints in the length of pipeline tested; \( D \) is the nominal diameter of the pipe in inches; and \( P \) is the average test pressure in pounds per square inch (based on test pressure indicated above, measured at the low point).
      c. The leakage test may be conducted simultaneously with the pressure test, provided a suitable means of measuring leakage is provided and a record of water added to the piping being tested is kept for the two-hour test period.

B. Cleaning: After testing flush entire system until free of sediment and other foreign matter.

C. Disinfection: After system flushing perform system disinfection from source of supply through entire system.
   1. Fill system with disinfection solution of calcium hypochlorite or sodium hypochlorite at a concentration of 50 parts available chlorine per million parts of water. Proof test solution concentration of system outlet.
   2. Retain solution in system for a minimum of 24 continuous hours, then drain and thoroughly flush system until potable water is test proven comparable to water quality from supply source.
3.6 FIELD QUALITY CONTROL

A. General Provisions: Refer to Contract Documents. Conduct tests specified under Part 3 Execution, Testing, Cleaning and Disinfection, so that each piping system installed in the Project is tested to the Engineer's satisfaction.
   1. Provide tools, materials (including clean water), apparatus and instruments necessary for piping system testing.
   2. Conduct tests of every kind in the presence of and to the satisfaction of the Engineer.
   3. Free piping systems of trapped air for tests involving water.
   4. Perform tests involving water in the test only when there is no danger of water freezing during the test time period.
   5. Repair and Retest: When a piping system fails to meet test requirements specified herein, conform to the following:
      a. Determine source or sources of leakage.
      b. Repair or replace defective material and if a result of improper workmanship, correct such.
      c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
      d. Perform repair and retest work at no increase in Contract Price.

   6. Accuracy Proof: Furnish acceptable proof to the Engineer that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Project.

   B. Notification: Give the Engineer a minimum of three days advance notice of the times when piping system acceptance testing will be conducted.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 22 15 00

GENERAL SERVICE COMPRESSED-AIR SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Project Includes:
   1. Piping inside the Building
   2. Valves
   3. Strainers
   4. Piping Specialties
   5. Quick Disconnects
   6. Point of Use Filters/Regulator/Lubricators

B. Related Section:
   1. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment.
   2. Section 22 05 53 – Identification of Plumbing Piping and Equipment.

C. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

1.2 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI A13.1; Scheme for the Identification of Piping Systems.
   2. ANSI B16.1; Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
   3. ANSI B16.3; Malleable Iron Screwed Fittings Class 150 and 300 lb.
   4. ANSI B16.9; Factory-Made Wrought Steel Butt-welding Fittings.
   5. ANSI B16.21; Nonmetallic Flat Gaskets for Pipe Flanges.
   6. ANSI B16.26; Cast Copper Alloy Fittings for Flared Copper Tubes.

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 47; Specification for Malleable Iron Castings.
   2. ASTM A 53; Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   3. ASTM A 181; Specification for Forgings, Carbon Steel, for General-Purpose Piping.
   4. ASTM A 234; Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
5. ASTM A 278; Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 Degrees F (345 Degrees C).
8. ASTM A 536; Specification for Ductile Iron Castings.
9. ASTM B 61; Specification for Steam or Valve Bronze Castings.
10. ASTM B 62; Specification for Composition Bronze or Ounce Metal Castings.
11. ASTM B 88; Specification for Seamless Copper Water Tube.
12. ASTM B 584; Specification for Copper Alloy Sand Castings for General Applications.

C. Manufacturer's Standardization Society (MSS) of the Valve and Fittings Industry:
13. MSS-SP-70; Cast Iron Gate Valves, Flanged and Threaded Ends.
14. MSS-SP-71; Cast Iron Swing Check Valves, Flanged and Threaded Ends.
15. MSS SP-80; Bronze Gate, Globe, Angle and Check Valves.
16. MSS SP-110; Ball Valves Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends.

1.2 SUBMITTALS

A. Product Data: As specified in Section 15010; submittals required for the following items:
1. Pipe and Pipe Fitting
2. Valves.
3. Combination Filter/Regulator/Lubricator
4. Certificates: Buy America Act Certification

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing compressors and receivers, specified in this section, with a minimum of three years of experience.
1. Pressure Vessels: Conform to applicable code for construction and installation of pressure vessels.
2. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
3. Regulatory Agency Sustainability Approvals:
   a. Buy America Act:
      1) Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this Section must comply with the requirements of the Buy America Act.

PART 2 PRODUCTS

2.1 PIPE, FITTINGS AND VALVES (ABOVEGROUND INSIDE STRUCTURE)

A. Service Requirements: Maximum operating pressure of 200 psig and maximum operating temperature of 110 degrees F.
B. Pipe: (¾-inch up to 3-inch): ASTM A53; Black Steel Schedule 40.
   1. Fittings: ASTM A47 and ANSI B16.3; Malleable Iron 150lb. Threaded.
   3. Nipples: Same as pipe except Schedule 80.
   4. Unions: Malleable Iron 150 lb. Threaded, ground joint bronze to iron
   5. Thread Lubricant: Graphite/Oil compound or polytetrafluoroethylene (PTFE) tape. Apply to male threads ONLY.

2.2 VALVES

A. Acceptable Manufacturers:
   1. Nibco.
   2. Stockham

B. Ball Valves (Black steel pipe: ¼-inch up to 1-inch): ASTM A-108; Blowout Proof Stem 2000 PSI WOG, Two-piece carbon steel phosphate coated body, Zinc plated steel handle, handle nut; reinforced TFE seats; nickel plated carbon steel stem, chrome plated carbon steel ball, threaded ends.

C. Ball Valves (Black steel pipe: 1 ¼-inch up to 2-inch): ASTM A-216; Blowout Proof Stem 2000 PSI WOG, Two-piece carbon steel phosphate coated body, Zinc plated steel handle, handle nut; reinforced TFE seats; nickel plated carbon steel stem, chrome plated carbon steel ball, threaded ends.

2.3 PIPING SPECIALTIES

A. Acceptable Manufacturers (Drain Valve):
   1. Apollo
   2. Nibco

B. Drain Valves: Ball valves, blowout proof stem, 600 WOG/150 PSI S-steam, bronze two-piece body and trim ASTM B584 C84400; chrome plated ball, full port, PTFE seat.

2.4 QUICK DISCONNECTS

A. Acceptable Manufacturers (Quick Disconnect):
   2. AMFLO
   3. Legris

B. Quick Disconnect:
   1. One-way shut-off design; automatic push to connect design with automatic shut-off socket end, anti-snag design, 360 degree swivel.
   5. Plug: Brass construction with knurled grasp, designed to mate with socket.

2.5 COMBINATION FILTER/REGULATOR/LUBRICATORS

A. Acceptable Manufacturer (Filter/Regulator/Lubricators):
1. Wilkerson
2. Norgren
3. Ingersol-Rand

B. General: Space-saving integral design. Wall mounted assembly. (Up to 40 CFM); Model C08-FLG0
1. Filter: 5 micron rated particulate element, quick disconnect bowl and bowl guard, metal bowl with manual drain, 150 psig maximum operating pressure and 150 degree F. maximum operating temperature. Zinc body, zinc bowl with nylon bowl guard, nitrile bowl seal.
4. Regulator: Balanced valve design, relieving type, two ¼-inch gauge ports, flush mounted gauge with 0-to 125 psig range, diaphragm operated, 300 psi maximum supply pressure and 150 degree F. maximum operating temperature. Zinc body, brass/nitrile diaphragm assembly and valve assembly, steel spring.
5. Lubricator: Mist type, fill under pressure design, adjustable oil feed, clear sight glass, quick-disconnect bowl, plastic bowl and bowl guard, 150 psig. maximum operating pressure and 125 degree F. maximum operating temperature, 4.1 oz. oil retention, manual drain; zinc body, zinc bowl, nitrile seals.

2.6 COMPRESSED AIR REEL ASSEMBLY

A. Acceptable Manufacturers:
1. GRACO; Model # HSL65B
2. Lincoln
3. ARO

B. Minimum capacity of 50 feet of 1/2" ID hose, heavy-duty double pedestal frame with welded joints and formed ribs, fully ported axle, dual, sealed roller bearings, dual arms hose guide supports, ball stop, "slide-in" mounting ability and anti-sparking ratchet assembly, sealed rewind spring with an external tensioning mechanism.
1. Hose length: 50’ x 1/2” ID
4. Reel outlet: 1/2” npsm
5. Reel inlet: 1/2” npsm
6. Pressure rating: 300 psi for reel assembly
7. Weight: 59 lbs, approx.

C. Provide the following for each reel:
1. Hose Inlet Kit Model # 218549
8. 1/2” Air Shut-Off Valve Model # 107142
9. Air Coupler Model # 110199

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify connections to existing piping systems.
3.2 PREPARATION
   A. Ream pipe and tube ends, remove burrs. Bevel plain end ferrous pipe.
   B. Remove scale and dirt on inside and outside of pipe before assembly.
   C. Prepare piping connections to equipment with flanges or unions.
   D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION – INSERTS
   A. Install inserts in accordance with Section 22 05 29.

3.4 INSTALLATION - HANGERS AND SUPPORTS
   A. Install hangers and supports in accordance with Section 22 05 29.

3.5 INSTALLATION - ABOVE GROUND PIPING - COMPRESSED AIR SYSTEMS
   A. Install drip connections with valves at low points of piping system.
   B. Install take-off to outlets from top of main, install shut off valve after take-off, slope take-off piping to outlets.
   C. Install compressed air couplings and female quick connectors where outlets are indicated.
   D. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.
   E. Cut pipe and tubing accurately and install without springing or forcing.
   F. Slope all piping in direction of flow.
   G. Install pipe identification in accordance with Section 22 05 53.

3.6 FIELD QUALITY CONTROL
   A. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1 and ASME B31.9.
   B. Verify for atmospheric pressure in piping systems, other than system under test.
   C. Test system with dry compressed air or dry nitrogen with test pressure in piping system at 50 psi.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS
   A. The work of this section will not be measured for separate payment.
4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1  GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. Requirements for basic electrical studies and reports, material handling, and other
      basic electrical materials and methods.

C. Related Sections:
   2. Section 09 90 00 - Paints and Coatings.
   3. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
   4. Section 26 05 28 – Hangers and Supports Systems for Electrical Systems
   5. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   6. Section 26 05 33.13 – Conduits for Electrical Systems.
   7. Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

A. National Electric Manufacturer’s Association (NEMA).
   1. ANSI/NEMA MG 1, Motors and Generators.
   2. NEMA ICS 6, Industrial Control and Systems: Enclosures.

B. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).
   2. NFPA 70E, Standard for Electrical Safety Requirements for Employee
      Workplaces.

1.3 DEFINITIONS

A. Not Used.

1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of
   the General and Special Provisions:
   1. Product Data:
      a. Submit Product Data, including catalog cuts, for all products provided for the
         electrical work of this Contract and as specified in other Sections.
         1) Clearly indicate the usage of each product on each submittal.
2. Shop Drawings:
   a. Submit Shop Drawings for the electrical work of this Contract as specified in other Sections.

3. Quality Assurance/Control Submittals:
   a. Certificates:
      1) Testing agency quality verification that all products meet requirements or manufacturer disclaimer statements.
   b. Qualification Statements:
      1) Testing agency qualifications.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Perform all electrical work in conformance with the requirements of NFPA 70, the National Electrical Code.

B. Certifications:
   1. Submit evidence with all Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
      a. Such evidence may consist of either a printed mark on the data or a separate listing card.
      b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
         1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and equipment to the work site in accordance with the requirements of Section 26 05 00.
   1. Deliver materials and equipment in a clean condition.
      a. Provide packaging that plugs, caps, or otherwise seals openings both during shipping and temporary storage.
   2. Provide equipment needed for unloading operations, and have such equipment on the work site to perform unloading work when the material and equipment is delivered.
      a. If possible, clearly identify pick-points or lift-points on electrical equipment crating and packaging.
      b. In the absence pick-points or lift-points on equipment crating and packaging, identify pick-points or lift-points on the equipment itself.

B. Handle materials and equipment in accordance with the requirements of Section 01660.
1. Handle materials and equipment in accordance with manufacturer’s written instructions.
2. When unloading materials and equipment, provide special lifting harnesses or apparatus as required by manufacturers.

C. Store electrical materials and equipment, whether on-site or off-site, in accordance with General and Special Provisions and the following:
   1. Follow the manufacturer’s written instructions for storing the items.
   2. Store electrical equipment and products under cover.
      a. Except for electrical conduit, store electrical equipment and products in heated warehouses or enclosed buildings with auxiliary heat and that provide protection from the weather on all sides.

PART 2 PRODUCTS

2.1 MATERIALS

A. Grounding and Bonding Materials:
   1. Provide grounding and bonding materials in accordance with the requirements of Section 26 05 26.

B. Hangers and Supports:
   1. Provide hangers and supports for electrical equipment in accordance with the requirements of Section 26 05 28.

C. Wire and Cable:
   1. Provide low-voltage electrical wire, cable, and accessories in accordance with the requirements of Section 26 05 19.

D. Conduit and Raceway:
   1. Provide conduit and raceway as indicated, as appropriate for the application per NFPA 70, and in accordance with the following:
      a. Conduit and Tubing: Provide electrical conduit and tubing in accordance with the requirements of Section 26 05 33.13.

E. Wiring Devices:
   1. Provide electrical wiring devices in accordance with the requirements of Section 26 27 26.

2.2 SHOP FINISHING

A. For electrical equipment, factory-apply paint and coating systems that at a minimum meet the requirements of the NEMA ICS 6 corrosion-resistance test and the additional requirements specified in individual Specification Sections.
PART 3 EXECUTION

3.1 INSTALLATION

A. Field-Applied Finishes:
   1. Except for factory-finished items that have been completely finished with factory-applied primer and final finish coatings, finish installed electrical materials, equipment, apparatus, and items in the field in accordance with the requirements of Section 09 90 00.
      a. Apply paint material matching the composition of the factory-applied products.
         1) Obtain factory-supplied paint for this work whenever available.
      b. Comply with the paint manufacturer’s instructions for mixing, thinning, surface preparation, application, spreading rate, drying time, and environmental limitations concerning application of the paint.
      c. Apply paint in such a manner so that the finished appearance will match as nearly as possible the factory finish.
         1) Poorly applied paint may be required to be repaired and re-applied by the Contractor in accordance with Article 3.02 at no additional cost to the Owner.
   2. Coordinate the painting of large areas with the Engineer to minimize the duration of exposure of other workers to toxic paint fumes.

3.2 REPAIR/RESTORATION

A. If the factory finish of factory-finished items is damaged for any reason, refinish the item.
   1. If an item that has several surfaces has damage on one surface, refinish the entire damaged surface.
      a. Surface Preparation:
         1) Outside the damaged area, lightly sand the entire surface and perform additional sanding to profile the damaged paint edge.
         2) Prepare the surfaces of damaged areas in accordance with SSPC-SP 2.

3.3 FIELD QUALITY CONTROL

A. Perform electrical testing as detailed in Section 26 05 63 and in each Specification Section.

B. Have electrical work inspected as required by the local Authority Having Jurisdiction (AHJ).
   1. Submit a copy of the certification of inspection with the final project closeout documents, and post the original in the electrical room on-site protected by a metal frame with a protective plate glass cover.

C. The quality of finishing and refinishing work is subject to approval by the Engineer.
3.4 MANUFACTURERS’ FIELD SERVICES

A. Provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the Final Project Report of the power system study.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. Requirements for furnishing, installing, connecting, energizing, testing, cleaning, and protecting low voltage cable, shielded cable, and accessories.

C. Related Sections:
   2. Section 26 05 00 – Common Work Results for Electrical
   3. Section 26 05 26 – Grounding and Bonding for Electrical Systems
   4. Section 26 05 33.23 – Boxes for Electrical Systems

1.2 REFERENCES

A. American Society for Testing Materials (ASTM):

B. National Electrical Manufacturer’s Association (NEMA):
   1. NEMA WC 26/EEMAC 201 - Binational Wire and Cable Packaging Standard.

C. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).

D. Underwriter’s Laboratories, Inc. (UL):
   1. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.3 DESIGN REQUIREMENTS

A. Conductors in Raceway and Conduit Systems:
   1. Provide conduit systems for installing the wiring that is outside of equipment.
   2. Except for raceway or conduit for control wires or where otherwise indicated on the Contract Drawings, design raceway and conduit systems so that the maximum number of low-voltage current carrying conductors (per NFPA 70, Article 310) in each raceway or conduit does not exceed three, plus a ground.

B. Product Data and Catalog Cuts:
1. Submit low-voltage ground, power, and control wiring product data as listed below for the products provided as the Work of this Section; and clearly indicate the usage of each product on the data submitted.
   a. Wires and cables.
   b. Lugs.
   c. Connectors.
   d. Tapes.
   e. Pulling lubricant.

C. Use of Trade Names:
1. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
   a. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with Contract requirements.

1.4 SUBMITTALS
1. Submit the following information to the Engineer for approval in accordance with the requirements of General and Special Provisions.
2. Product Data:
   a. Wires and cables.
   b. Lugs
   c. Connectors.
   d. Tape.
   e. Pulling lubricant.
3. Quality Assurance/Control Submittals:
   a. Certificates.
      1) Testing agency/quality verification.
   b. Manufacturer’s Instructions.
      1) Cable manufacturer’s recommendations.
   c. Qualification Statements.
      1) Documented experience of the installing firm.
      2) Qualifications of the licensed electricians supervising the Work.

1.5 QUALITY ASSURANCE
A. Qualifications:
1. Installer Qualifications:
   a. To install the Work of this Section, employ the services of a firm specializing in installing wire, cable, and accessories, and that has a minimum of 3 years’ experience doing so.
      1) Submit the documented experience of the firm installing the wire, cable, and accessories.
b. To supervise installation of the Work of this Section, employ licensed electricians.
   1) Submit the qualifications of the licensed electricians supervising the Work of this Section.

B. Regulatory Requirements:
   1. Perform the Work of this Section in accordance with the requirements specified in NFPA 70, and to all other applicable state, local, and national governing codes and regulatory requirements.

C. Certifications:
   1. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and the application intended, unless products meeting the requirements of these testing laboratories are not available or unless standards do not exist for the products.
      a. Provide copper conductors listed and labeled by UL for all wiring.
   2. Submit evidence of testing agency/quality verification, listing, and labeling for each product with the submitted product data either by providing a printed mark on the data or by attaching a separate listing card.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Imprint insulated conductors with the date of manufacture, the wire type, and the manufacturer.
   2. Package wire and cable in conformance with the requirements of NEMA WC 26/EEMAC 201.
   3. Protect items from damage during delivery, handling, and installation.
      a. Comply with the cable manufacturer’s recommendations for inspection, handling, storage, temperature conditioning, bending and training limits, pulling limits, and calculation parameters for installing cable.
      b. Submit the cable manufacturer’s recommendations for inspection, handling, storage, temperature conditioning, bending and training limits, pulling limits, and calculation parameters for installing cable.

B. Acceptance at Site:
   1. Wire and cable manufactured more than 12 months before delivery to the Site is unacceptable for use under this Contract, and will be rejected.

C. Storage and Protection:
   1. Store products indoors on blocking or pallets.
   2. Protect items from damage during storage.
1.7 PROJECT ENVIRONMENTAL REQUIREMENTS

A. Install armored instrumentation cable only when the temperature is above -40 degrees Celsius.

PART 2 PRODUCTS

2.1 LOW VOLTAGE CONDUCTORS

A. Conductor Design Requirements:
   1. Provide conductors of the proper size and ampacity ratings based on Article 310 of NFPA 70.
      a. Provide copper conductors that have 98 percent conductivity.
      b. Unless otherwise indicated on the Contract Drawings, at a minimum provide conductors of the following American Wire Gauge (AWG) sizes:
         1) For power and branch feeder circuits: 12 AWG.
            a) For power and branch feeders, provide solid or stranded copper low-voltage conductors for sizes up to and including 10 AWG, provide stranded copper low-voltage conductors for 8 AWG and larger sizes.
         2) For control circuits: 14 AWG.

B. Insulation Design Requirements:
   1. Provide low voltage ground, power, and control wiring having the proper insulation types as follows:
      a. All conductors shall be XHHW-2; low smoke, zero halogen, 90 degree celsius insulation and tested by independent nationally recognized testing agency for flame retardancy and low-smoke generation. Single and multiple-conductor cables shall pass the vertical wire flame test in accordance with UL 1581 or ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692. Single and multiple-conductor cables demonstrate low-smoke generation in accordance with ASTM E662. Values not to exceed the following:
         1) Chlorosulfonated Polyethylene
            a) Flame Mode
               (1) Uncorrected maximum specified optical density (msod) during the first four minutes of test; 325
               (2) Uncorrected msod for entire 20 minutes of test; 400.
            b) Non-flaming Mode
               (1) Uncorrected msod during first four minutes of test; 325
               (2) Uncorrected msod during 20 minutes of test; 480.
         2) Cross-Linked Polyolefin
            a) Flaming And Nonflaming Modes
               (1) Uncorrected msod during first four minutes of test; 150
               (2) Uncorrected msod for 20 minutes of test; 300.
   2. Color Coding of Wires
a. Insulation shall be factory colored per Tables 26 05 19-1 below. The use of tape for color coding is prohibited.

C. Manufacturers
1. Acceptable Manufacturers:
   a. Continental Wire & Cable Company
   b. SouthWire
   c. General Cable
   d. Okonite Co.
   e. CME Wire & Cable Inc.
   f. Or Approved Equal

2.2 ACCESSORIES

A. Tapes:
1. Vinyl Insulating Tape:
   a. Provide UL-listed flexible polyvinyl chloride (PVC) backed insulating tape with a pressure sensitive adhesive, such as black Scotch® 33+ Vinyl Electrical Tape, that is resistant to abrasion, acids, alkalis, and copper corrosion; resistant to, hot, cold and wet weather; and resistant to damage from UV sunlight exposure.

2. Manufacturers:
   a. 3M, Scotch
   b. Plymouth
   c. Permacel
   d. Approved equal.

B. Wire and Cable Connections:
1. Grounding Connectors:
   a. Provide grounding connectors conforming to the requirements of Section 26 05 26 Grounding and Bonding for Electrical Systems.

2. Connectors for Service Wires and Cables, and for Wires and Cables Larger Than Number 6:
   a. Split Bolt Connectors or Compression Type Connectors:
      1) Provide UL-listed split bolt connectors or compression type connectors for making parallel or butt splices of stranded copper wire.
      2) Use companion preformed plastic insulating covers or tape insulation conforming to NFPA 70 (NEC) requirements.
   b. Mechanical compression connectors:
      1) Provide mechanical compression connectors that are capable of connecting single or multiple conductors, and of being installed with one wrench.
         a) Type: Compact, two-hole mechanical compression connectors having two clamping bolts.
            (1) Connector Body: Provide a high copper bronze or brass alloy body.
(2) Bolts: Provide brass or bronze bolts; plated steel screws are unacceptable.

(3) Fasteners: Provide silicon-bronze fasteners for bolting connectors to connections.

3. Control Wiring Connections:
   a. For control wiring connections at terminal boards, provide crimped nylon-insulated ring terminals.
   b. For control wiring splices, provide nylon insulated butt splices with insulation grips.
   c. For joining more than two control wires, provide junction boxes with terminal boards.

4. Connectors for Other Conductors:
   a. Any of the applicable types listed for larger wire may be provided.
   b. Screw Terminal Connections:
      1) For making terminal connections of stranded copper wire to screw terminals, provide nylon insulated crimped compression terminals with copper barrel on the wire.
      2) For making terminal connections of solid copper wire to screw terminals, provide screw lock connectors.
   c. Wire Nuts:
      1) For making splices of copper wire, provide pre-insulated, UL-listed, solderless connectors of the spring-lock or compression type that can be installed by hand or using tools.
      2) For site lighting, wire nuts used in underground or below grade locations is prohibited. There only permitted use for site lighting is within a pole base.
   d. Manufacturers:
      1) Thomas & Betts Corp.
      2) Tyco Electronics, AMP Inc.
      3) Ilsco Corp.
      4) FCI-Burndy® Products
      5) Approved equal.

PART 3 EXECUTION

3.1 INSTALLERS
   A. Install the work of this Section only under the supervision of licensed electricians.

3.2 EXAMINATION
   A. Inspect all conduits, junction boxes, to verify that they are clean, that they do not have burrs, that conduits are properly aligned, and that they are complete.
      1. Ensure that on all conduits without threaded hubs, two locknuts are installed.
      2. Ensure that in all conduits with wires larger than No. 10, bushings are installed.
3. Ensure that grounding bushings and fittings are installed at all places specified in Section 26 05 26, Grounding and Bonding.
4. Verify that proper sized boxes are installed.

B. Verify that boxes and conduit fittings conform to the bending requirements specified in Article 314 of NFPA 70 (NEC).

3.3 PREPARATION

A. Verify that pulling calculations have been made and are available for long conduit runs and pulls as indicated in this Section.

B. Do not begin installing wiring until other work which might cause damage to the wires, cables, or conduits has been completed.
   1. Correct deficiencies in conduits, junction boxes, that have been discovered by the inspection required in Paragraph 3.02.A.

C. Prepare conduits to receive wire and cable.
   1. Swab the conduits with a nylon brush and steel mandrel.

D. Take the necessary precautions to prevent water, dirt, or other foreign material from accumulating in the conduits during the execution of wiring work.

3.4 INSTALLATION

A. Low Voltage Ground, Power, and Control Wiring:
   1. Install Type CL2P, FPLP, or CMP cable as required by the application in accordance with the requirements of NFPA 70 (NEC).
      a. For exposed low voltage wiring, use plenum cable.
      b. For low voltage wiring concealed from view, only install wiring in the accessible locations permitted by the Contract Drawings.
   2. Neutral Conductors:
      a. For each single-phase and each multi-phase feeder, provide separate neutrals.
      b. For branch circuits, except at three-phase wye-connected panelboards, provide separate neutral conductors.
         1) For the three-phase wye-connected panelboards, provide common neutrals from 3 adjacent single-pole circuit breakers or from the poles of the same multi-pole circuit breaker.
      c. Except for feeders with a small unbalanced and single-phase load, size each neutral the same as the largest phase conductor.
         1) For feeders with a small unbalanced and single-phase load, size the feeders to the largest of the following:
            a) The size of any three-phase load connected to the neutral, which contains lighting, computer power outlets, instrumentation, or other electric loads.
            b) The size required for 125 percent of the maximum unbalanced load.
3. Equipment Ground Conductors:
   a. Provide a green equipment ground conductor with all runs.
      1) Provide the equipment ground conductor wire type as specified in Section 26 05 26, Grounding and Bonding.

B. Terminating Cable:
   1. Terminate cable using materials and methods indicated or specified herein, or in accordance with the written instructions of the cable manufacturer or termination kit manufacturer.
      a. For equipment connections, provide split bolt or compression type connectors, mechanical compression connectors, or crimped compression type connectors as specified and approved by the equipment manufacturer; for all other types of connections provide connectors of one of the types specified:
   2. Protect insulated power and lighting cable terminations from accidental contact, deterioration of coverings, and moisture by using proper terminating devices and materials.

C. Splicing Wire and Cable:
   1. All new conductors shall be continuous from end to end without splices, except where indicated on the drawings or with the special written permission of the Engineer on a case-by-case basis where the Contractor can demonstrate that installation without splices is not practical.
   2. If permitted as noted above, splice cables in accessible locations.
   3. Within outlet or junction boxes, make wire and cable splices that conform to the requirements of NFPA 70 (NEC).
      a. Install these outlet or junction boxes in accessible locations.

D. Wiring Identification:
   1. Color code all feeder wires and cables as indicated in Table 26 05 19-1 and Table 26 05 19-2.

<table>
<thead>
<tr>
<th>Table 16122-1 Feeder Wire and Cable Color Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase</td>
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<tr>
<td>------------------</td>
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<tr>
<td>A</td>
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<tr>
<td>B</td>
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<tr>
<td>C</td>
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<tr>
<td>Neutral</td>
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<tr>
<td></td>
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<tr>
<td>Electrical Ground Conductor</td>
</tr>
</tbody>
</table>

   2. Identify all power wiring by circuit and panelboard, switchboard, and motor control center numbers.
   3. Identify all control wiring with wire numbers.
   4. Provide additional electrical identification of cabling and wiring as specified in Section 26 05 53, Identification for Electrical Systems.
3.5 FIELD QUALITY CONTROL

A. Site Tests:
   1. Prior to energizing wire and cable, field test the wire and cable as specified in this Section.

B. Inspection:
   1. Record the actual installed elevations and locations of grounding cables and rods, both concealed and exposed, on the record drawings specified in Section 01757, Closeout.
      a. Verify that the control wiring wire numbers correspond to the numbers indicated in the record drawings.

PART 4 MEASUREMENTS AND PAYMENTS

4.01 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.02 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. Requirements for connecting, energizing, testing, cleaning, and protecting
      grounding and bonding systems.

C. Related Sections:
   2. Section 26 05 00 – Common Work Results for Electrical.
   3. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
   4. Section 26 05 33.13 – Conduits for Electrical Systems.

1.2 REFERENCES

A. American Society for Testing Materials (ASTM):
   1. ASTM B 3; Standard Specification for Soft-Drawn Copper Wire.

B. InterNational Electrical Testing Association, Inc. (NETA):

C. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).

D. National Electrical Manufacturing Association (NEMA):
   1. NEMA WC-7; Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and
      Cable for the Transmission and Distribution of Electrical Energy.

1.3 DESIGN REQUIREMENTS

A. Design the electrical system installation to conform to Article 300 of NFPA 70,
   Wiring Methods, and to other applicable articles of NFPA 70 governing methods of
   wiring.

B. Ground the conduit systems, metal enclosures, equipment frames, motors, and
   receptacles in accordance with Article 250 of NFPA 70, Grounding.
   1. Ground all metallic conduits, wiring channels, and armored cables continuously
      from outlet to outlet, and from outlets to cabinets, junction boxes, or pull boxes.
26 05 26  
Grounding and Bonding for Electrical Systems

a. Bond each run of raceways to form a continuous path for ground faults from end to end.
b. When liquid tight flexible metal conduit sizes larger than 1-inch or flexible metal conduit are installed, provide external bond wires.

2. Grounding Bushings:
   a. Provide all 1-inch or larger metallic conduits with grounding bushings unless they enter metallic enclosures via integral threaded hubs.
   b. Provide grounding bushings for conduits entering the bottom of freestanding equipment.
   c. Bond wire from every grounding bushing to the equipment ground stud or ground bus in the enclosure.
   d. Bond the grounding bushings to ground studs or ground buses in the enclosures.

3. Provide insulated, internal equipment ground wire in all conduits.
   a. Bond the internal wire to all pullboxes, junction boxes, equipment enclosures, and other enclosures as required by NFPA 70.

C. Equipment Grounds:
   1. Design all feeders and branch circuits to include an equipment grounding conductor consisting of a copper wire within a raceway or cable and sized as specified herein.
      a. Where conductors are run in parallel in multiple raceways, run the equipment grounding conductor in parallel to the related conductors.
      b. Size each of the parallel equipment grounding conductors on the basis of the ampere rating of the circuit overcurrent protecting device.
   2. Ground enclosing cases, mounting frames, rack mounted components, rack struts, switches, breakers, control panels, motors, and other electrical or electrically operated equipment by providing an equipment grounding conductor with phase conductors from an established equipment ground source.

D. Ground Wire Sizes:
   1. The minimum size for bonding jumpers, equipment ground conductors, grounding electrode conductors, and ground grid conductors is as follows:
      a. Under 600 volts:
         1) Provide #6 AWG, minimum.
         2) Control power circuits, Provide #6 AWG, minimum.
   2. When the ground wire size is not specified or indicated on the Contract Drawings, provide wire sized in accordance with the requirements of NFPA 70.

E. Within 60 days of the Contract award, submit the following:
   1. The Submittals required by Section 26 05 00.
      a. Include Product Data and Catalog Cuts for all products provided, and describe the usage of each product.

F. Project Closeout:
   1. Follow closeout procedures in accordance with General and Special Provisions.
1.4 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of
   General and Special Provisions.
   1. Product Data:
      a. Manufacturer’s product data
   2. Quality Assurance/Quality Control Submittals:
      a. Certificates:
         1) Testing agency product certification.
         2) Certification of Compliance: 49 C.F.R Part 661 Buy America
            Requirements.
      b. Qualification Statements:
         1) System installers’ qualifications
         2) Installation supervisors’ resumes
   3. Closeout Submittals:

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Installer Qualifications:
      a. Employ installers who specialize in the work of this Section, and who can
         demonstrate a minimum of three years documented experience.
      b. Submit the system installers’ qualifications.
   2. Supervisor’s Qualifications:
      a. Employ supervisor to supervise the installation work who are skilled licensed
         electricians.
      b. Submit the installation supervisors’ resumes.
   3. All products are to be certified by Underwriters Laboratories, Inc. (UL),

B. Regulatory Requirements:
   1. All grounding and bonding Work must comply with the requirements of NFPA 70,
      the National Electrical Code.

C. Certifications:
   1. Testing Agency Product Certification:
      a. Verify product quality by certifying products as meeting the requirements of
         one of the following:
         1) Underwriters Laboratories, Inc. (UL).
            a) Provide products listed and labeled by UL.
      b. Testing agency product certification must include agency listing and labeling,
         either by a printed mark on the data or by a separate listing card.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Transport materials, both on site and from Contractor's storage to site, in accordance with the recommendations of the respective manufacturers.

B. Storage and Protection:
   1. Store materials, both on and off site, in accordance with manufacturer's written instructions.
   2. Store products indoors on blocking or pallets.

PART 2 PRODUCTS

2.1 MATERIALS

A. Wire:
   1. Bare Ground Wire:
      a. Soft drawn copper, Class A or Class B stranded, meeting the requirements of ASTM B3 for sizes #6 or larger.
      b. Soft drawn solid copper, meeting the requirements of ASTM B3 for sizes #8 or smaller.
   2. Insulated Ground Wire:
      a. Provide insulated Class B copper stranded wire rated for 600 volts that conforms to the requirements of NEMA WC-7, and is green in color. Insulation type shall be as specified in Section 26 05 19.
   3. Acceptable Manufacturers:
      a. Continental Wire & Cable Company www.continentalwire.com
      b. SouthWire www.southwire.com
      c. General Cable www.generalcable.com
      d. Okonite Co. www.okonite.com
      e. Or Approved Equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:
   1. The Contract Drawings are generally indicative of the Work, but due to their small scale, it is not possible to indicate some offsets and fittings required nor the minor structural obstructions that may be encountered.
      a. Perform field measurements to discover offsets and fitting requirements not shown.

3.2 PREPARATION

A. Layout electrical work to suit actual field conditions and in accordance with accepted standard practice.
3.3 INSTALLATION

A. Construct each ground system and connection so it is mechanically secure and electrically continuous.
   1. Secure grounds to boxes in such a manner that each system is electrically continuous from the point of service to each outlet.
   2. Terminate conduits using double locknuts and bushings.
      a. Unless a conduit run enters a metallic enclosure via integral threaded hubs, provide the conduit run with two locknuts.
   3. Clean paint, grease and such other insulating materials from the contact points of grounds.

   B. Equipment Grounds:
      1. Install equipment grounds in spaces accessible to authorized personnel only.
      2. Equipment Grounding Connectors:
         a. Only use approved grounding connectors.
            1) Terminate grounds with closed lugs with star washers on both sides and a 1/4-20 bolt and nut, minimum; spade lugs are not allowed.
            2) For portable electrical equipment, provide electric cords having an equipment grounding conductor and a NEMA and UL approved cord cap.
            b. Do not install grounding lugs on flanges, mounting screws, or standoffs in switches, distribution boxes, or panels.
            c. Cover or coat grounding clamps and connectors with coating compound.
      3. Equipment Grounding Conductors:
         a. Do not use a system neutral or a current carrying conductor as the equipment grounding conductor.
            1) Do not ground the electrical and electronic equipment neutral to chassis, racks, equipment ground conductor, or any non-current carrying conductor on the equipment.

4. Grounding Lighting Fixtures:
   a. Provide the housing of each lighting fixture with a separate, factory-installed grounding device and ground conductor.
   b. Use the factory-installed grounding device for connecting a separate grounding conductor meeting applicable grounding requirements of the NEC to the fixture.
      1) Provide a green covered grounding conductor of the same wire gauge as the two power feed wires.
      2) Provide a continuous ground for the fixture construction.

3.4 REPAIR/RESTORATION

A. Replace any finished exothermic welded splice connections that inspections find to be defective.
3.5 FIELD QUALITY CONTROL

A. Inspection:
   1. Prior to completion of the Work of this Section, inspect the items provided for conformity to the Contract Drawings and Specifications.
      a. Leave in-place "made grounds" open until they have been inspected and approved by the Engineer.
      b. Clean the surfaces involved in "made grounds" before connecting the grounds, and finish the installation with touch up painting or another protective coating to prevent corrosion.

3.6 PROTECTION

A. Protect finished insulated wires from being painted.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to rooftop access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 26 05 28
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. Requirements for furnishing, installing, cleaning, and protecting hanger and
      support systems for electrical wiring, conduit boxes, and equipment.

C. Related Section:
   2. Section 26 05 00 – Common Work Results for Electrical.

1.2 REFERENCES

A. American Iron and Steel Institute (AISI):
   1. AISI Standard Steels (Handbook).

B. American Society for Testing Materials (ASTM):
   1. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized)
      Coatings on Iron and Steel Products.
   2. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on
      Iron and Steel Hardware.
   3. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated,
      120/105 ksi, Minimum Tensile Strength.
   5. ASTM A 575 - Standard Specification for Steel Bars, Carbon, Merchant Quality,
      M-Grades.
   6. ASTM A 576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought,
      Special Quality.
   7. ASTM A 635/A 635M - Standard Specification for Steel, Sheet and Strip, Heavy-
      Thickness Coils, Carbon, Hot-Rolled.
   8. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on
      Iron and Steel.

C. American Welding Society (AWS):
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

D. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts maximum).
E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).

F. Society of Automotive Engineers International (SAE):
   1. SAE J 429 - Mechanical and Material Requirements for Externally Threaded Fasteners.

G. The Society for Protective Coatings (SSPC):
   1. SSPC Painting Manual.
      a. SSPC-SP 2 - Hand Tool Cleaning.
      b. SSPC-Paint 15 - Paint Specification No. 15, Steel Joist Shop Paint, Type I,
         Red Oxide Paint, Type II, Asphalt Coating.
      c. SSPC-Paint 20 - Paint Specification No. 20, Zinc-Rich Primers (Type I,

H. Underwriters Laboratory, Inc. (UL):
   1. UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.
   2. UL 2239 - Hardware for the Support of Conduit, Tubing, and Cable.

I. U. S. General Services Administration (GSA)
   1. Federal Specifications:
      b. FF-S-107C(2) - Screws, Tapping and Drive.

1.3 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the
   requirements of General and Special Provisions and Section 26 05 00, Common Work
   Results for Electrical:
   1. Product Data:
      a. Provide product data and catalog cuts for the products provided under this
         Section.
   2. Shop Drawings:
      a. Provide Shop Drawings.
      b. Provide Shop Drawings of hanging supports for conduit.
   3. Quality Assurance/Control Submittals:
      a. Certificates:
         1) Testing Agency/Quality Verification:
            a) With the product data for electrical hangers and supports, provide
               evidence of quality verification, listing, and labeling by the
               Electrical Testing Agency (ETA); either by a printed mark on the
               data, or by a separate listing card.
         2) Certification of Compliance: 49 C.F.R Part 661 Buy America
            Requirements.
         3) Manufacturers’ Certificate of Compliance.
      b. Qualification Statements:
         1) Manufacturers’ qualifications.
1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturers’ Qualifications:
      a. Provide electrical support framing made by manufacturers that have been
         manufacturing support framing for a minimum of 5 years, and who carefully
         controls their operations to ensure that excellent product engineering, quality,
         safety, and reliability are achieved.
      b. Submit the manufacturer’s qualifications to the Engineer for approval.

B. Certifications:
   1. Manufacturers Certificate of Compliance:
      a. Submit a manufacturer’s Certificate of Compliance certifying that both the
galvanizing and the products meet the requirements of the ASTM standards.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packaging, Shipping, Handling, and Unloading:
   1. Deliver, store, and handle the hangers and supports in accordance with Section 26
      05 00 Common Work Results for Electrical, and as specified herein.
   2. Deliver material to Site in the original factory packaging.

B. Storage and Protection:
   1. Shelter and store the components under cover, and supported off the ground and
      floors on blocking.

PART 2 PRODUCTS

2.1 MATERIALS

2.2 MANUFACTURED UNITS

A. Metal U-Channel Electrical Support Framing Systems and Fittings:
   1. Carbon Steel U-Channel Support Framing Systems:
      a. Provide 1-5/8-inch nominal size U-channel supports fabricated from 12
         gauge carbon steel electrolytically galvanized with a zinc-coating thickness
         commensurate with Service Condition SC 1 (mild) in conformance with the
         requirements of ASTM B 633.
         1) For Type II ASTM B 633 galvanized finishes, fabricate the framing from
            steel complying with the requirements for Grade 33 specified in
            ASTM A 1011/A 1011M.
         2) For Type III ASTM B 633 galvanized finishes, fabricate the framing
            from steel complying with the requirements of ASTM A 575,
            ASTM A 576, ASTM A 635/A 635M, or ASTM A 36/A 36M.
      b. Where combination members are required, spot-weld the members on 3-inch
         centers.
      c. Provide 1-3/8-inch or larger depths, except where supports are mounted
         directly to walls 13/16-inch or larger depths may be provided.
d. Provide metal framing systems and fittings for metal framing systems from a single manufacturer.

e. Manufacturers:

B. Conduit Supports:
   1. Malleable Iron Conduit Supports:
      a. Provide one-hole style galvanized malleable iron fasteners with pipe straps similar to those as manufactured by Thomas & Betts.
      b. Provide support devices consisting of threaded rods, channel supports, and conduit straps/fasteners.
   2. Manufacturers:
      b. Approved equal.

C. Bolts, Nuts, and Washers:
   1. For bolts, nuts, and washers smaller than 1/4-inch trade size, provide 316 stainless steel fasteners complying with the requirements of ASTM A 325.

D. Anchors and Fasteners:
   1. Drive (Deep-Pitch) Screws:
      a. Provide Type 316 stainless steel self-tapping type drive (deep-pitch) screws that comply with the requirements of FF-S-107C(2).
   2. Drilled-In Anchors and Fasteners:
      a. Provide drilled-in anchors and fasteners that comply with the requirements of FF-S-107C(2).
      b. Masonry Anchors:
         1) Provide masonry anchors designed to accept both machine bolts and threaded rods as fasteners.
            a) Provide SAE J 429 Grade 2 machine bolt fasteners fabricated from AISI Type 316 stainless steel.
            b) Provide nuts and washers conforming to the requirements of ASTM A 563.
         2) Provide masonry anchors consisting of an expansion shield and expander nut contained inside the shield.
            a) Expander Nuts:
               (1) Fabricate square expander nuts with their sides tapered inward from the bottom to the top.
               (2) Design the expander nuts to simultaneously climb the bolt or rod thread and expand the shield as soon as the threaded expander nut reaches and bears against the shield bottom when being tightened.
            b) Expansion Shields:
(1) Provide expansion shield bodies consisting of four legs, the inside of each tapered toward the shield bottom, or nut end.

(2) The end of one leg shall be elongated and turned across shield bottom. Outer surface of shield body shall be ribbed for grip-action.

3) Masonry Anchor Material:
   a) Provide die cast Zamac No. 3 zinc alloy having a 43,000 psi minimum tensile strength.

4) Manufacturers:

   c. Concrete Anchors:
      1) Carbon Steel Anchor/Fastener:
         a) Provide UL listed one-piece studs (bolts) with integral expansion wedges, nuts, and washers.
         b) Provide carbon steel anchor/fasteners complying with the physical requirements specified in FF-S-325 for Group II, Type 4, Class 1.
      2) Stainless Steel Anchor/Fastener:
         a) Provide one-piece AISI Type 303 or 304 stainless steel studs (bolts) with integral expansion wedges, AISI Type 316 stainless steel nuts, and AISI Type 316 stainless steel washers.
         b) Provide stainless steel anchor/fasteners complying with the physical requirements of FF-S-325 for Group II, Type 4, Class 1.

3) Acceptable Manufacturers:
   c) Molly Fastener Group; PARABOLT.

3. Hammer drive-type explosive charge drive-type anchors and fastener systems are unacceptable.

4. Lead shields, plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems are unacceptable.

2.3 ACCESSORIES

A. Fire Seals:
   1. Where conduit penetrates fire-rated walls, floors, partitions, and ceiling, provide approved fire seals to ensure that the fire rating is maintained.
   2. Provide a fire seal system which is UL-listed for the application.
      a. Provide fire seal compound or a mechanical seal for fire rating of 2 hours or less.
   3. Manufacturers:
      a. Compound Fire Seals:
      b. Mechanical Fire Seals:
      c. Through-Wall Barrier Fire Seals:

2.4 FABRICATION

A. Fit and shop assemble items in the largest sections practical for delivery to the Site.

2.5 FINISHES

A. Prime paint non-galvanized steel items.
   1. Prepare surfaces to be primed in accordance with the requirements of SSPC-SP 2.
      a. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
   2. Prime Painting: Apply one coat of primer.

B. Galvanizing items specified above as galvanized.
   1. Galvanize the items after fabrication in accordance with the requirements of ASTM A 123/A 123M.
   2. Provide a minimum galvanized coating of 1.25 ounces per square foot (380 grams per square meter).

C. Touch-Up Primer:
   1. For un-galvanized metal surfaces: Provide primer complying with the requirements of SSPC-Paint 15 for Type I, Red Iron Oxide.
   2. For galvanized surfaces: Provide primer complying with the requirements of SSPC-Paint 20 for Type I, Inorganic Zinc-Rich Primer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Field Measurement:
   1. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
      a. Due to the small scale of the Contract Drawings it is not possible to indicate all offsets, fittings, and apparatus required or the minor structural obstructions that may be encountered during the Work.
   2. Carefully investigate the structural and finish conditions, and other construction work, at the Site which may affect the work of this Section.

3.2 PREPARATION

A. After carefully investigating structural and finish conditions and other in-place construction work, produce detailed Shop Drawings showing proposed departures from the original design due to field conditions or other causes.
   1. Layout the electrical work according to accepted standard electrical trade practice to suit actual field measurements.
   2. Arrange the electrical work to consider existing conditions and to preserve access to other equipment, rooms, areas, and similar features of the construction.
3. Provide plan and profile views of duct banks, and show equipment backboards and support structures not directly fastened to the walls on the Shop Drawings.
4. Indicate the location and details of conflicting utility construction and slopes on the Shop Drawings.
5. Submit the Shop Drawings to the Engineer for approval prior to performing the Work of this Section.

B. Obtain roughing-in dimensions of electrically operated equipment, including equipment being installed by both electrical and other construction trades.
   1. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.
   2. Arrange electrical Work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment, rooms, areas, and similar spaces.

3.3 INSTALLATION

A. Install electrical Work in conformance to the requirements of NFPA 70 for wiring methods general requirements, and to other applicable Articles of the NEC governing methods of wiring.

B. Installing Anchors and Fasteners:
   1. For anchoring or fastening applications in masonry and hollow-core precast concrete structural elements, provide masonry anchors as specified herein.
   2. For anchoring or fastening applications in cast-in-place concrete and solid precast concrete structural elements, provide concrete anchors as specified herein.
   3. Threaded Bolts:
      a. Draw threaded bolted connections up tight using 316 stainless steel lock washers to prevent the bolt or nut from loosening.
   4. Drilled-In Expansion Anchors:
      a. Install expansion anchors in strict accordance with manufacturer’s instructions and the following.
         1) Drill holes to the required diameter and depth in accordance with anchor manufacturer’s instructions for the size of anchor being installed.
         2) Minimum Embedment:
            a) Embed expansion anchors to four and one-half bolt diameters minimum unless otherwise indicated on the Contract Drawings.

C. Installation of U-Channel Support Framing Systems in accordance with Table 26 05 28-1 below:

<table>
<thead>
<tr>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aboveground</td>
<td>Interior</td>
<td>Carbon steel</td>
</tr>
</tbody>
</table>

D. Installing Conduit Supports
1. Provide malleable iron conduit supports.

E. Field Fabrication:
   1. Fabricated Items:
      a. Fabricate backboards, backboard supports, equipment supports, conduit supports, and the other items as detailed on the Contract Drawings.
         1) Hot-dip galvanize mild-steel fabrications in accordance with the requirements of ASTM A 153/A 153M.
      b. Fabricate backboard posts as detailed on the Contract Drawings from concrete filled steel pipe with a crowned cap; and apply a prime paint finish.
      c. Supply components required for the anchorage of fabrications.
         1) Except where specifically noted otherwise, fabricate anchors and related components from the same material as the fabrication and apply the same finish.
   2. Tightly fit and secure joints.
      a. Make exposed joints butt tight, flush, and hairline.
      b. Weld fabricated assemblies in accordance with AWS D1.1/D1.1M.
         1) Continuously seal joined members using intermittent welds and plastic filler.
         2) Dress welds smooth and free of sharp edges and corners.
      c. Grind exposed joints flush and smooth with the adjacent finish surface.
   3. Ease exposed edges to a small uniform radius.
      a. Cut all backboard corners to a 1-inch radius.
   4. For the attachment of work and for bolted connections, accurately drill or punch holes for the fasteners as required.
      a. Burned holes are unacceptable.
      b. Provide holes no more than 3/32-inch larger than the fasteners.
   5. Exposed Mechanical Fastenings:
      a. Except where specifically noted otherwise in the Contract Documents, provide flush countersunk screws or bolts; unobtrusively located, and consistent with the design of the component.
   6. Fabrication Tolerances:
      a. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
      b. Maximum offset between faces: 1/16 inch (1.5 mm).
      c. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
      d. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
      e. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

3.4 REPAIR/RESTORATION

A. Coatings:
   1. Repair damage to coatings.
      a. Touch up damaged coating surfaces using the specified primer for primed steel surfaces, and using zinc-rich primer for galvanized steel surfaces.
3.5 FIELD QUALITY CONTROL

A. Inspection:
   1. Verify the adequacy of coatings.
   2. Inspect the items provided under this Section for adherence to the fabrication tolerances specified above, and correct any discrepancies:

3.6 PROTECTION

A. Protect the items provided under this Section from damage during the work of other trades.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 26 05 33.13

CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Related Section:
   2. Section 07840 – Firestopping.
   3. Section 26 05 00 – Common Work Results for Electrical.
   4. Section 26 05 26 – Grounding and Bonding for Electrical.
   5. Section 26 05 28 – Hangers and Supports for Electrical Systems.

1.2 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
   2. ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated (GCR).
   3. ANSI C80.6 - Intermediate Metal Conduit - Zinc-Coated (IMC).

B. American Society for Testing and Materials (ASTM):

C. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).

D. Underwriters Laboratory, Inc. (UL):
   1. ANSI/UL 6 - Standard for Rigid Metallic Conduit.
   2. ANSI/UL 360 - Standard for Liquid-Tight Flexible Steel Conduit.
   4. ANSI/UL 514A - Metallic Outlet Boxes.

1.3 DESIGN REQUIREMENTS

A. Conduit Systems:
   1. Provide conduit of the type and material shown in Table 26 05 33.13-1 for the application indicated, or as indicated on the Contract Drawings.
   2. Provide conduit fittings made of material identical to that of the conduit system with which they are used.
### Table 26 05 33.13-1 Conduit System Selection

<table>
<thead>
<tr>
<th>Location</th>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Conduit Type</th>
<th>Size (Minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Ground</td>
<td>Inside</td>
<td>All Locations</td>
<td>Rigid Galvanized Steel</td>
<td>3/4 Inch</td>
</tr>
</tbody>
</table>

1.4 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of General and Special Provisions:

1. Product Data:
   a. To facilitate power utility approval of the items installed from the utility’s service poles to the main service panels, submit 4 more copies of the conduit submittals than the number required by General and Special Provisions.
   1) Liquidtight flexible metal conduit.
   2) Rigid galvanized steel conduit (RGS).
   3) Wall and floor penetration seals.

2. Shop Drawings:
   a. Proposed departures from the original design.

3. Quality Assurance/Control Submittals:
   a. Qualification Statements:
      1) Qualifications of the installer.
   b. Certificates:
      1) Testing agency/quality verification, listing, and labeling.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installer Qualifications:
   a. Employ an installation firm with a minimum of three years documented experience installing conduit and tubing similar in type and scope to that required by this Contract to install the Work of this Section.
   b. Employ skilled licensed electricians to supervise the Work of this Section.
   c. Submit information verifying the installer’s qualifications.

B. Regulatory Requirements:

1. Perform the Work of this Section in accordance with the requirements specified in NFPA 70 (NEC), and to other applicable state, local, and national governing codes and regulatory requirements.
2. All items installed from utility service poles to the main service panels must be approved by the serving utility, whether electrical service or telephone service, as listed in Section 26 05 00 Common Work Results for Electrical.

C. Certifications:
   1. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location the product is installed in, and the application intended, unless products meeting the requirements of these nationally recognized testing laboratories are not available or unless standards do not exist for the products.
      a. Submit evidence with the Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
         1) Such evidence may consist of either a printed mark on the data or a separate listing card.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Pack, ship, handle, and unload products in accordance with the requirements of Section 26 05 00 Common Work Results for Electrical, and as detailed herein.

B. Acceptance at Site:
   1. Acceptance products at the Site in accordance with the requirements of Section 26 05 00 Common Work Results for Electrical, and as detailed herein.

C. Storage and Protection:
   1. Store products in accordance with the requirements of Section 26 05 00 Common Work Results for Electrical, and as detailed herein.
      a. Store all products indoors on blocking or pallets.

PART 2 PRODUCTS

2.1 METALLIC CONDUIT

A. Liquidtight Flexible Metal Conduit:
   1. Provide PVC coated flexible metal conduit conforming to the requirements of Article 350 of NFPA 70 (NEC) for materials and uses and ANSI/UL 360.
   2. Provide conduit with interlocking spiral strip construction capable of bending to a minimum radius of five times its diameter without deforming the spiral strips both inside and outside of the conduit.
      a. Provide conduit with a flexible, galvanized, interlocking spiral strip steel core jacketed with smooth, liquid-tight polyvinyl chloride designed to withstand temperatures from minus 40 degrees Celsius to plus 60 degrees Celsius.
3. Finish the interior and exterior of flexible conduit smooth and free from burrs, sharp edges, and other defects that may injure wires; and place the manufacturer’s trademark on each length.

4. Furnish an integral continuous copper ground in 1/2-inch through 1-1/4-inch PVC coated flexible metal conduit.

5. Acceptable Manufacturers
   c. Approved equal.

B. Rigid Galvanized Steel Conduit (RGS):
   1. Provide rigid galvanized steel conduit (RGS) conforming to the requirements of Article 344 of NFPA 70 (NEC) for materials and uses, ANSI C80.1, and UL 6.
   2. Fabricate the RGS from mild steel piping, galvanized or sherardized inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating.
   3. Provide defect free conduit bearing the UL label, and furnished in 10-foot minimum lengths with both ends threaded and one end fitted with a coupling.
   4. Acceptable Manufacturers:
      c. Approved equal.

2.2 CONDUIT FITTINGS

A. Fittings for Threaded Metallic Conduit Systems:
   1. Construct conduit bodies/fittings from cast malleable iron or cast steel.
   2. Conduit Outlet Bodies:
      a. Provide malleable iron threaded entry type conduit outlet bodies with neoprene gaskets and cast steel cover.
      b. Acceptable Manufacturers:
         3) Approved equal.
   3. Conduit Expansion Joints:
      a. Provide telescoping sleeve type galvanized, weatherproof, and vapor tight conduit expansion joints designed for 4-inch maximum expansion with an insulated bushing and lead-wool packing.
      b. Acceptable Manufacturers:
         3) Approved equal.
   4. Conduit Unions:
a. Provide conduit unions capable of completing a conduit run when neither conduit end can be turned.

b. Acceptable Manufacturers:
   2) Thomas and Betts Company, Erickson® Coupling.,
      www.tnb.com/contractor/docs/tbhazardous.pdf
   3) Approved equal.

5. Conduit Outlet Boxes:
   a. Provide malleable or cast iron conduit outlet boxes conforming to the requirements of UL 886, and having a cover with O-rings to keep out moisture.

b. Acceptable Manufacturers:
   3) Approved equal.

6. Conduit Device Boxes:
   a. Provide malleable iron conduit device boxes with internal grounding screws and conforming to the requirements of UL 498 and UL 514A.

b. Acceptable Manufacturers:
   3) Approved equal.

2.3 FINISHES

A. Cold Galvanize Coating:
   1. Provide a cold galvanize coating to provide protection against corrosion by forming an insoluble zinc salt barrier from a cathodic reaction when the coating is damaged by abrasion and exposed to weather.
      a. Provide a single component pre-mixed liquid organic zinc compound producing 95 percent zinc in the dry film.
      b. Provide a coating that bonds to clean iron, steel, or aluminum through electrochemical action.

   2. Acceptable Manufacturers:
      b. Clearco
      c. Krylon
      d. Rustoleum
      e. Or Approved Equal

PART 3 EXECUTION

3.1 EXAMINATION

A. Although the Contract Drawings are generally indicative of the Work, take field measurements to verify actual conditions.
1. Due to the small scale of the Contract Drawings it is not possible to indicate all offsets, fittings, and apparatus required or the minor structural obstructions that may be encountered during the Work.

B. Inspect the condition of existing conduit that is required for the Work of this Section.

3.2 PREPARATION

A. After carefully investigating structural and finish conditions and other in-place construction work, prepare and submit detailed Shop Drawings showing proposed departures from the original design due to field conditions or other causes.
   1. Layout the electrical work according to accepted standard electrical trade practice to suit actual field measurements.
   2. Arrange the electrical work to consider existing conditions and to preserve access to other equipment, rooms, areas, and similar features of the construction.
   3. Include plan and profile views of duct banks.
   4. Indicate the location and details of conflicting utility construction and slopes.
   5. Submit these Shop Drawings to the Engineer for approval prior to performing the Work of this Section.

B. Submit Product Data and catalog cuts for all products provided under this Section.
   1. Clearly indicate the usage of each product on the submittal.

C. Obtain roughing-in dimensions of electrically operated equipment, including equipment being installed by both electrical and other construction trades.
   1. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.

D. Remove dirt, debris, and other obstructions from existing conduit required for the Work of this Section by blowing out and mandreling the conduits as applicable.

3.3 INSTALLATION

A. Perform the Work of this Section as specified in Section 26 05 00, Common Work Results for Electrical.

B. Fabricate and install conduit and wireway systems in accordance with accepted electrical trade standard practice.
   1. Layout the electrical work of this Section to suit actual field measurements.
   2. Record the actual installed elevations and locations of duct banks and the as-found locations of conflicting utility lines on the record drawings specified in General and Special Provisions, and submit the record drawings.
   3. Install the electrical Work of this Section in conformance to the wiring methods general requirements of Article 300 in NFPA 70 (NEC), and to all other applicable Articles of NFPA 70 governing wiring methods.
4. Cut conduit and wireway square, and ream the cut ends according to the requirements of NFPA 70 (NEC) to deburr the openings so that they are not restricted more than cuts made by the material manufacturer.

5. Avoid bending conduits as much as possible and practical; but if bends are made, use an approved conduit bending tool or machine to make the bends.

6. Do not install crushed or deformed conduit, and remove crushed or deformed conduit from the Site.

7. On conduit that is installed outside, provide a second equipment ground conductor and use fittings with a built-in ground lug for bonding.

8. Provide flexible conduit only to the extent permitted by NFPA 70 (NEC).
   a. In flexible conduits that do not have an integral ground wire, install a green insulated wire in addition to the neutral wire for grounding purposes.
      1) Form a ‘J’ or ‘S’ hook with a drip loop to allow flexibility.
      2) Provide a second equipment grounding conductor on outside conduit and provide fittings with built-in ground lug for bonding.
   b. In exposed areas, use PVC coated flexible metal conduit and fittings.
   c. Use flexible metal conduit or liquid tight flexible metal conduit for final connection to recessed lighting fixtures and rotating and vibrating equipment.
      1) Flexible Metal Conduit is only permitted for final connections to lighting fixtures in dry, environmentally conditioned spaces.
      2) Liquid tight flexible metal conduit, as herein specified, for final connection to recess mounted lighting fixtures in unconditioned spaces and to all rotating and vibrating equipment including transformers, motors, solenoid valves, pressure switches, limit switches, generators, engine-mounted devices and pipe-mounted devices.
      3) Flexible conduit not to exceed 18 inches in length for motor connections, 24 inches in length for equipment connections or 24-inches for lighting fixture connections.

9. Provide fittings and apparatus as required to construct the approved electrical design.
   a. Running threads on conduit are not permitted.
      1) Where couplings and connectors are required for metal conduits, use approved threaded couplings and connectors.
   b. Provide conduit unions where necessary to complete a conduit run when neither conduit end can be turned.
   c. Where conduit and raceway runs cross building expansion joints, make provision for expansion in the conduit and raceway runs.

10. Installing RGS Conduit:
    a. Installation of the RGS Conduit System shall be performed in accordance with the Manufacturer’s recommendations.
    b. Threading Conduit:
       1) Field thread the conduits per the manufacturers instructions.
2) Once the threading operation is complete, protect the newly cut threads against corrosion by applying a "sealing" compound as recommended by the manufacturer.

c. Assembling RGS Conduit Fittings:
   1) Just prior to assembling each conduit joint, apply the conduit manufacturer's touch-up compound to the end of the conduit in the area normally covered by the fitting sleeve.
   2) Use cloth or other material over strap type wrenches to protect the coating while tightening conduits.

C. Exposed Work:
   1. In exposed work, run conduit and raceway parallel to centerlines and structure surfaces; or perpendicular to centerlines where required, with right angle turns consisting of symmetrical bends or fittings.
   2. Maintain at least 6 inches clearance between conduit and raceway runs and pipes, ducts, and flues of mechanical systems.
   3. If a portion of a metallic conduit run, whether plastic-coated or not, extends above grade or is otherwise exposed to personnel, ensure that the conduit is properly bonded to an equipment grounding conductor at both ends.
      a. Install the equipment grounding conductor either inside or outside the box.

D. Hangers and Supports:
   1. Install auxiliary support structures, anchors, and fasteners as specified in Section 26 05 28, Hangers and Supports for Electrical Systems.
      a. Mount or suspend conduit and wireway systems directly on structural members of the structures and walls.
      b. Do not attach conduit or raceway systems to suspended ceiling members or to the suspending mediums.
      c. Securely attach anchors into walls.
   2. At all conduit attachments, allow space between the mounting surfaces and the conduit by providing U-channel supports, clamp-backs, or spacers.
      a. Attach wall-mounted conduit runs close to the walls following the contour of the walls, parallel to the walls and other building lines except at bends.

E. Structure Penetrations:
   1. Make penetrations in existing concrete structures by core-drilling.
      a. Drill the penetrations true, clean, and free from spalling.
      a. Seal all conduit penetrations through floor slabs on grade in buildings with a floor penetration seal.
   3. Install a wall penetration seal at all wall penetrations.
      a. Size wall penetrations to accommodate the conduit outside diameter plus either 1/4 inch or a hole allowance to allow the installation of the wall penetration seal.
4. For conduits that enter rooms from concrete floors or masonry, provide corrosion protection by using an RGS conduit that extends from 12 inches inside the concrete or masonry to at least 6 inches into the room.

F. Wiring:
   1. Install wiring in conduit as indicated.
   2. Prior to the installation of any wire, verify that the conduit is clean and free of debris.
   3. Install a separate ground conductor within every conduit.

3.4 FIELD QUALITY CONTROL

   A. Inspection:
      1. Inspect installed conduit runs for obstructions, proper support, proper grounding, and completeness.
      2. Record the actual installed elevations and locations of conduit and tubing on record drawings specified in General and Special Provisions.

PART 4 MEASUREMENTS AND PAYMENTS

4.01 MEASUREMENTS

   A. The work of this section will not be measured for separate payment.

4.02 PAYMENTS

   A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 26 05 33.23

BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. Requirements for furnishing, installing, connecting, cleaning, and protecting
electrical pull and junction boxes.

C. Related Section:
   2. Section 26 05 00 – Common Work Results for Electrical.
   3. Section 26 05 26 - Grounding and Bonding Electrical Systems.
   5. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   6. Section 26 05 33.13 – Conduits for Electrical Systems.

1.2 REFERENCES

A. National Electric Manufacturer's Association (NEMA):
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit,
      Electrical Metallic Tubing and Cable.

B. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).

C. American National Standards Institute (ANSI):
   1. ANSI Z55.1 - Gray Finishes for Industrial Apparatus & Equipment (withdrawn
      1990, no replacement).

1.3 DESIGN REQUIREMENTS

A. Product Data:
   1. Submit a list of the materials proposed to satisfy the requirements of this Section.
   2. Submit the manufacturer's comprehensive calculations used to determine size
      requirements for the boxes.
   3. Submit Product Data and catalog cuts of the materials and equipment proposed to
      be used to satisfy the requirements of this Section.
1.4 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of General and Special Provisions:

1. Product Data:
   a. List of the proposed materials.
   b. Catalog cuts of cast outlet boxes for general purpose applications used with steel conduit systems.
   c. Catalog cuts of sheet metal boxes for general purpose applications in dry locations.

2. Quality Assurance/Control Submittals:
   a. Design Data.
      1) Manufacturer's comprehensive calculations.
   b. Test Reports.
      1) Factory test reports.
   c. Certificates.
      1) Testing agency/quality verification, listing, and labeling.
   d. Qualification Statements.
      1) Qualifications of the licensed electricians.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Installer Qualifications:
      a. To supervise installation of the Work of this Section, employ licensed electricians.
      1) Submit the qualifications of the licensed electricians supervising the Work of this Section.

B. Regulatory Requirements:
   1. Perform the Work of this Section in accordance with the requirements specified in Articles 250, 300, and 370 of NFPA 70 (NEC), and to all other applicable state, local, and national governing codes and regulatory requirements.

C. Certifications:
   1. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and listed and labeled or approved for the application intended as indicated or specified, unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.
      a. Provide products that are approved, listed, and labeled for the short circuit currents, voltages, and currents indicated or specified to be applied.
      b. Provide service entrance labeled products for all service entrance equipment.
2. Submit evidence of testing agency/quality verification, listing, and labeling for each product with the submitted product data, either by providing a printed mark on the data or by attaching a separate listing card.

1.6 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Pack, ship, handle, and unload products in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

B. Acceptance at Site:
   1. Accept products at the Site in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

C. Storage and Protection:
   1. Store products in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Use of Trade Names:
   1. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
   2. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with Contract requirements.

2.2 MANUFACTURED UNITS

A. Cast Outlet Boxes for General Purpose Applications:
   1. For Use with Steel Conduit Systems:
      a. For use with steel conduit systems, provide UL Listed small cast steel or cast malleable iron outlet boxes with threaded hubs that meet the NEMA 250 requirements for Type 12 enclosures.
      b. If covers are indicated or specified, provide cast steel or cast malleable iron covers with neoprene gaskets.
         1) Provide captive Type 316 stainless steel mounting screws for the covers.
      c. If fixture hangers are indicated or specified, provide ball type cast steel or cast malleable iron fixture hangers with neoprene gaskets.
         1) Provide captive Type 316 stainless steel mounting screws for the fixture hangers.
      d. Finish:
         1) Provide outlet boxes, covers, and hangers with an electroplated zinc coating, followed first by a dichromatic prime, and then by an aluminum polymer finish coating conforming to NEMA FB 1.
e. Manufacturers:
   1) Appleton Electric
   2) O-Z/Gedney
   3) Crouse Hinds
   4) Thomas & Betts
   5) Killark
   6) Or Approved equal.

B. Sheet Metal Junction and Pull Boxes for General Purpose Applications:
   1. For general purpose applications in dry locations, provide small sheet steel pull and
terminal boxes and covers that meet the NEMA 250 requirements for Type 12
enclosures with continuously welded and ground smooth seams, and having no
holes or knockouts.
      a. Cover:
         1) Provide overlapping sheet steel screw covers with captivated screws for
each box.
         2) Provide a means of bonding on the cover.
      b. Gasket: Provide an oil resistant cover gasket for each box.
      c. Mounting Brackets:
         1) Provide 12 gauge steel wall-mounting brackets.
      d. Finish:
         1) Provide polyester powder coating applied over phosphatized surfaces.
         2) Color: ANSI Z55.1 Number 61 gray.
   2. Manufacturers:
      a. Pentair, Screw Cover SC Junction Boxes
      b. Rittal Corp
      c. Milbank Manufacturing
      d. Or Approved Equal

C. Equipment and Control Device Enclosures:
   1. For all areas except outdoor and corrosive locations, provide enclosures with
hinged doors that meet the NEMA 250 requirements for Type 4 or 12 enclosures,
depending on Contract requirements.
      a. Enclosure Cabinet:
         1) Provide sheet steel boxes having continuously welded seams, ground
smooth.
         2) Provide enclosures having no holes or knockouts.
      b. Enclosure Door:
         1) Provide overlapping sheet steel hinged doors, having a continuous hinge
with a removable heavy gauge hinge pin and door clamps with screws to
provide a watertight seal or to exclude liquids and contaminants.
         2) Provide a means of bonding on the door.
      c. Door Gasket:
         1) Provide an oil resistant door gasket for each box.
      d. Security:
         1) Provide a mechanism for padlocking the enclosure.
e. Finish:
   1) Provide polyester powder coating applied over phosphatized surfaces.
   2) Color: ANSI Z55.1 Number 61 gray.

f. Manufacturers:
   1) Pentair, Single-Door Type 4 Enclosures or Type 12 and Type 13 Enclosures
   2) Rittal Corp
   3) Milbank Manufacturing
   4) Or Approved Equal

PART 3 EXECUTION

3.1 INSTALLERS

   A. Install the work of this Section only under the supervision of licensed electricians.

3.2 EXAMINATION

   A. Verify that conduit stub-ups to be mated with electrical boxes and enclosures are the correct type and size, and are at the proper location.

3.3 INSTALLATION

   A. Junction Boxes and Pull Boxes for General Purpose Applications:
      1. For general purpose applications in dry locations, provide small sheet steel pull and terminal boxes that meet the NEMA 250 requirements for Type 12.
      2. Provide boxes that are fabricated from the same type of material as the conduit with which the boxes are used.

   B. Equipment and Control Device Enclosures:
      1. For all areas except outdoor and corrosive locations, provide enclosures that meet the NEMA 250 requirements for Type 4 or 12 enclosures, depending on Contract requirements.
      2. For outdoor locations, provide enclosures with covers that meet the NEMA 250 requirements for Type 3R enclosures.
      3. For corrosive locations, provide enclosures that meet the NEMA 250 requirements for Type 4X enclosures.

   C. Installing Boxes for Electrical Outlets and Devices:
      1. Install boxes level and plumb within 1/16-inch of vertical or horizontal over the length of the box.
      2. Unless otherwise indicated on the drawings, devices boxes for interior or exterior wiring devices of buildings shall be recessed within the wall construction. The installation of surface mounted device boxes is prohibited.
      3. Install device boxes at a uniform height as indicated on the Contract Drawings.
         a. Mount all adjacent boxes in alignment at the same mounting height.
b. Mount outlet boxes for equipment within 18-inches of the equipment power connection.

4. When installing boxes outside or to exposed conduit, provide cast boxes.
   a. For interior unfinished locations mount these boxes on spacers to be 1/8-inch from wall unless box has built-in raised pads to perform the same function.

5. When installing boxes for single devices, two devices, or wall outlets, install 4-inch square boxes with appropriate plaster rings.
   a. Space boxes on opposite sides of the wall 6 inches apart.
   b. Set plaster rings flush or to protrude less than 1/16-inch from the wall.
   c. Openings for boxes in finished walls must be within 1/16-inch of the box.
      1) Correct all oversize openings in accordance with the specifications for the wall material.

6. Outlet boxes must be of the one-piece type, the use of expandable sheet metal boxes is prohibited.

7. Support cast boxes for outlet and device using one of the following methods:
   a. Mount the boxes directly to the structure using 4 or more anchors.
      1) Attach mounting screws to feet located outside of the box interior.
      2) Provide 1/4-inch spacers behind the boxes unless the box has raised pads.
   b. Attach the box to two 1-inch or larger conduits which are supported within 12-inches of the box.
   c. Attach the box to two 1-inch or larger conduits which exit from a poured concrete floor no further than 18-inches from the box.

D. Installing Boxes for Other than Electrical Outlets and Devices:
   1. Accurately punch holes for conduit openings using a hydraulic punch and punches sized for the conduit to be installed.
   2. Install a conduit breather in the top of the box and a conduit drain fitting in the bottom of all boxes not located in bone-dry areas that are at least 100 feet from a hose-bib.
   3. Support boxes for other than electrical outlets and devices using one of the following methods:
      a. Mount the boxes directly to the structure using 4 or more anchors.
         1) Attach mounting screws to feet located outside of the box interior. or seal the screw holes to prevent water penetration.
         2) Provide 1/4-inch spacers behind the boxes unless the box has raised pads.
      b. Attach the box to two 1-inch or larger conduits which are supported within 12-inches of the box.
      c. Attach the box to two 1-inch or larger conduits which exit from a poured concrete floor no further than 18-inches from the box.
      d. Mount the box on U-channel and structural supports conforming to Section 26 05 28, Hangers and Supports.

E. Make up all conduit connections to boxes in accordance with the requirements of Section 26 05 33.13, Conduit and Tubing.
F. Install wiring in boxes in accordance with the requirements of Section 26 05 19, Low- Voltage Wire, Cable, and Accessories.

G. Ground boxes in conformance with Section 26 05 26, Grounding and Bonding.

3.4 REPAIR/RESTORATION

A. Touch up damaged coatings on electrical boxes and enclosures.

3.5 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test all boxes to verify that they are properly connected to the grounding system.

B. Inspection:
   1. Inspect flush boxes to verify that the opening between the box and the wall finish is less than 1/16-inch.
   2. Inspect flush boxes to verify that each box is flush with the wall, or protrudes less than 1/16-inch, and is not set behind the wall surface.
   3. Inspect surface mounted boxes to verify that they are level and plumb within 1/16-inch as specified.

3.6 CLEANING

A. Waste Management and Disposal:
   1. Clear and dispose of waste materials in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

3.7 PROTECTION

A. Except for surfaces to be painted, mask electrical boxes to protect them from paint overspray or over-brushing during painting operations.

B. Protect boxes against damage from other work.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will be measured for separate payment.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. Requirements for furnishing, installing, connecting, energizing, testing, cleaning, and protecting wiring devices and cover plates.

C. Related Sections:
   2. Section 26 05 00 - Common Work Results for Electrical.
   3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   5. Section 26 05 33.13 – Conduits for Electrical Systems.
   7. Section 26 05 33.23 – Boxes for Electrical Systems.

1.2 REFERENCES

A. National Electric Manufacturer's Association (NEMA):
   1. NEMA WD 1 - General Color Requirements for Wiring Devices.
   2. NEMA WD 6 - Wiring Devices - Dimensional Requirements.

B. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).

C. Underwriter’s Laboratories, Inc. (UL):
   3. UL 1681 - Standard for Safety for Wiring Device Configurations.

D. U. S. General Services Administration (GSA):
   1. Federal Specifications:
      b. W-S-896F - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
1.3 DEFINITIONS

A. Definitions for all items are as stated in NFPA 70 and the other references listed unless otherwise stated, specified, or noted.

B. SPDT: An acronym for single pole, double throw type electrical switches.

C. Wiring Devices: Yoke mounted switches and receptacles with indicated line ratings of 300 Volts and 30 Amperes or less.

1.4 DESIGN REQUIREMENTS

A. Provide electrical power outlets designed in accordance with the requirements of UL 1681.

B. Product Data:
   1. Submit a list of the products and accessories proposed to satisfy the requirements of this Section.
   2. Submit Product Data and catalog cuts of the materials and equipment proposed to be used to satisfy the requirements of this Section.
      a. Clearly indicate the usage of each product on the submittal.

1.5 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of General and Special Provisions:
   1. Product Data:
      a. List of the proposed materials.
      b. Catalog cuts of toggle handle snap switches.
      c. Catalog cuts of control switches.
      d. Catalog cuts of commercial specification grade GFCI receptacles.
      e. Catalog cuts of device plates and covers.
   2. Quality Assurance/Control Submittals:
      a. Test Reports.
         1) Test reports for Site tests.
      b. Certificates.
         1) Testing agency/quality verification, listing, and labeling.
      c. Manufacturer’s Instructions.
         1) Manufacturer’s printed installation instructions.
      d. Qualification Statements.
         1) Qualifications of the Electrical Testing Laboratory (ETL).

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Perform the Work of this Section in accordance with the requirements specified in NFPA 70, and to all other applicable state, local, and national governing codes and regulatory requirements.

B. Certifications:
   1. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and the application intended, unless products meeting the requirements of these testing laboratories are not available or unless standards do not exist for the products. Provide copper conductors listed and labeled by UL for all wiring.

1.7 MATERIAL DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Pack, ship, handle, and unload products in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

B. Acceptance at Site:
   1. Accept products at the Site in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

C. Storage and Protection:
   1. Store products in accordance with the requirements of Section 26 05 00, Common Work Results for Electrical.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Use of Trade Names:
   1. The use of trade names within the Contract Documents is intended to establish the basis of design and to illustrate the constructability and level of quality required.
   2. The use of trade names is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with Contract requirements.

B. Provide the switches and receptacles of the same kind provided under this Contract from the same manufacturer; a mixture of manufacturers= products is unacceptable.

2.2 MANUFACTURED UNITS

A. Switches:
   1. Provide UL listed specification grade switches meeting the requirements of W-S-896F, NEMA WD 1, and NEMA WD 6 for the voltage and current indicated, and having screw terminals.
   2. Toggle Handle Snap Switches:
a. Provide quiet design, 20 Amp rated, single pole, 3-way or 4-way, toggle handle snap switches as indicated in the Contract Documents.

b. Manufacturers:
      a) Heavy Duty Specification Grade Switches: HBL1220 Series.
      b) Construction Series Heavy Duty Specification Grade Switches: CS120 Series.
   4) Approved equal.

B. Receptacles:
   1. Provide UL listed specification grade receptacles complying with the requirements of W-C-596/40D, W-C-596/41D, W-C-596/107A, NEMA WD 1, and NEMA WD 6 for the voltage and current indicated, and having screw terminals.
      a. Provide receptacles complying with the terminal identification requirements of UL 498.
   2. Standard Face Design Receptacles:
      a. Heavy Duty Specification Grade Receptacles:
         1) Provide 2-pole, 3-wire, grounding type duplex receptacles rated for 125 Volts AC and 20 Amperes.
         2) Provide receptacles with terminals rated for both solid and stranded wire.
         3) Manufacturers:
            d) Or Approved equal.
   3. Ground Fault Circuit Interrupter (GFCI) Receptacles:
      a. Heavy Duty Specification Grade GFCI Receptacles:
         1) Provide 2-pole, 3-wire, grounding type duplex GFCI receptacles rated for 125 Volts AC and 20 Amperes; having solid state circuitry; and that comply with the requirements of UL 498 and UL 943.
         2) Provide receptacles with terminals rated for both solid and stranded wire.
         3) Manufacturers:
            d) Approved equal.

2.3 ACCESSORIES

A. Wall Plates:
   1. Unless otherwise indicated in the Contract Documents, provide AISI Type 302/304 stainless steel wall plates.
a. For use with exposed stamped steel boxes and cast type boxes, provide heavy cadmium-plated steel wall plates whose edges are flush with the edges of the associated boxes.

2. Thickness (Minimum): 0.040 inches thick (1mm).

3. Finish:
   a. For finished areas, provide wall plates having a satin finish.
   b. For emergency circuits, provide either a red or Type 302/304 stainless steel wall plate engraved with the word “EMERGENCY” and with the panel designation and circuit number.

4. Fasteners:
   a. For installing wiring devices and wall plates, provide the following of fastener types:
      1) For affixing wall plates, provide stainless steel hardware

5. Manufacturers:
   f. Approved equal.

B. Weatherproof While-In-Use Covers:
   1. Body, cover and plates shall be made of polycarbonate and be non-conductive and non-corrosive.
   2. A gasket shall be pre-applied that is constructed of closed-cell foam, neoprene blend regular density and UL rated HBF.
   3. Cover shall provide a water channel, which keeps water moving outside while cord flap keeps the inside dry.
   4. Cover shall be able to mount either vertically or horizontally.
   5. Must provide a NEMA 3R protection level.
   6. Manufacturers:
      f. Approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect the surfaces of concrete foundations where wiring devices will be mounted to verify that the surface is level and complete.
   1. Verify that the required number of anchors of the correct type and size have been placed in the proper locations.
2. Verify that there are no concrete spalls, honeycomb areas, or other concrete defects.

B. Verify that the pull and junction boxes installed are the correct type and size, and are at the correct location.
   1. Verify that flush boxes are plumb and level to within 1/8-inches of vertical and horizontal; and are either flush with the finish surface or protrude no more than 1/16 inch.
   2. Verify that surface mounted boxes are plumb and level to within 1/16-inch of vertical and horizontal.
   3. Verify that the size of each box conforms to the requirements of Article 370 of NFPA 70.

C. Verify that wiring pigtails within installed boxes are sufficiently long to re-terminate the wiring twice and still allow 6 inches of slack.

D. Verify that ground wires are the correct type and size, and are at the correct location.

3.2 PREPARATION

A. Correct defects discovered during the examination
   1. Remove any extraneous paint from the interior of boxes and from wiring.
   2. Clean the interior of boxes to remove dirt and debris.

B. Provide outlet boxes and supports for wiring devices in accordance with the requirements of Section 26 05 33.23, Boxes, and Section 26 05 28, Hangers and Supports.
   1. Mounting Locations and Heights:
      a. Unless otherwise specified or shown on the Contract Drawings, locate wiring devices by measuring the mounting heights from the finished floor to the centerline of the wiring device.
      1) Electrical Duplex Convenience Outlets:
         a) In Unfinished Areas:
            (1) Locate electrical duplex convenience outlets 18 inches above the catwalk, unless this interferes with equipment or another obstacle.
            (2) If locating electrical duplex convenience outlets 18 inches above the catwalk interferes with equipment or another obstacle; then install the outlet above or below the obstruction as directed by the Engineer.

3.3 INSTALLATION

A. Install wiring devices and accessories in accordance with the manufacturer's printed installation instructions.
1. Submit the manufacturer’s printed installation instructions to the Engineer for information.
2. Make connections to the devices in accordance with the requirements of Sections 26 05 19, Low-Voltage Electrical Power Conductors, and Section 26 05 33.13, Conduits for Electrical Systems.
3. Ground the devices in accordance with the requirements of Section 26 05 26.

B. Provide a wall plate for each switch, receptacle, and special purpose outlet.
   1. If the Contract Drawings show two or more switches or receptacles at the same location, gang these devices together and cover them with a single wall or cover plate.
   2. For multi-gang boxes, provide multi-gang outlet plates; sectional gang plates are unacceptable.

3.4 REPAIR/RESTORATION

A. Correct the defects that are found in wiring devices during the specified inspections and tests, and retest the devices after correcting the defects.

3.5 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test each receptacle with a plug-in tester that checks for reversed line and neutral wiring, reversed ground and neutral wiring, open ground wiring, and open neutral wiring.
   2. Verify that the GFCI receptacles work by using both the built-in integral tester and a plug-in tester which simulates a ground fault to test all receptacles.
   3. Test the last receptacle in each branch circuit to ensure that the neutral and ground wiring resistance does not exceed 1 ohm between the receptacle and its panelboard.
   4. Record and submit the results of the tests to the Engineer for approval in accordance with the requirements of General and Special Provisions.

B. Inspection:
   1. Inspect boxes to verify proper operation, for visual appearance, and to verify correct mounting height.

3.6 ADJUSTING

A. Adjust the final position of switches and devices to be plumb and level, and set the final position of the wall plates for flush boxes flush to the wall.

3.7 CLEANING

A. Waste Management and Disposal:
   1. Clear and dispose of waste materials in accordance with the requirements of Section 26 05 00 Common Work Results for Electrical.
3.8 PROTECTION

A. Mask electrical devices to protect them from paint overspray or over-brushing during painting operations.

B. Protect electrical devices against damage from other work.

3.9 SCHEDULES

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 26 50 00

LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. This Specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. Section Includes:
   1. Requirements for general and emergency egress lighting equipment, components, and related installation.

C. Related Sections:
   2. Section 26 05 26 - Grounding and Bonding.
   4. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   5. Section 26 05 33.13 – Conduits for Electrical Systems.
   6. Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

A. The Aluminum Association, Inc. (AA):
   1. DAF-45, Designation System for Aluminum Finishes.

B. Federal Communications Commission (FCC)

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. IEEE C62.41; Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

D. Illuminating Society of North America (IESNA)
   1. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products
   2. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Lighting Sources
   3. IESNA TM-15, Luminaire Classification System for Outdoor Luminaires.

E. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250, Enclosures for Electrical Equipment.
   2. NEMA SSL 3, High Power White LED Binning for General Illumination
F. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).

G. Underwriter’s Laboratories, Inc. (UL):
   1. UL 1598, Standard for Safety of Luminaires.

H. U. S. Government:
   1. Occupational Safety and Health Administration (OSHA):
      b. 29 CFR 1926 Safety and Health Regulations for Construction.
   2. Federal Communications Commission (FCC):
      a. 47 CFR 18 Industrial, Scientific, and Medical Equipment.
   3. Department of Energy (DOE):

1.3 DEFINITIONS

A. LED – An acronym for “Light-Emitting Diode” used to indicate a semiconductor light source.

1.4 DESIGN REQUIREMENTS

A. Design Criteria:
   1. The Lighting Fixture information on the Contract Drawings constitutes the basis of the lighting design for this Contract, but may not indicate the special design details required.
      a. The lighting fixtures as scheduled meet the requirements of the lighting design for this Contract with respect to the visible style, number of lamps, and lenses desired.
   2. Provide lighting fixtures meeting the requirements of the basis of the lighting design for this Contract, and which have the special details specified in this Section.
      a. Submit Shop Drawings and manufacturer’s installation instructions to show details of assemblies and sub-assemblies, and specially-fabricated supporting and fastening devices.
      b. Submit bills of material for the fixtures and their appurtenances.
         1) Reference the bills of material to the Shop Drawings.
         2) Provide bills of material consisting of itemized lists of the parts required.
            Identify each part with a part number and/or manufacturer number.
      c. Provide fixtures for exterior installation that are designed to be completely waterproof.
      d. Provide luminaire brackets designed to be compatible with configuration of the luminaire.
B. Prior to providing light fixtures substituted for the fixtures identified on the Contract Drawings, submit the following information to obtain the Engineer’s approval to substitute the fixtures:

1. The manufacturer’s catalog cuts indicating the type, design, dimensions, mounting arrangement, and other industry standard lighting fixture information.
   a. Describe the lighting fixtures, exit signs, emergency battery units, and appurtenances.
2. Manufacturer’s photometric data, distribution curves, isolux charts, glare factor data, and coefficient of utilization.
3. Complete photometric data for the fixture, including optical performance, completed by an independent testing laboratory developed according to the standards of the Illuminating Engineering Society of North America as follows:
   a. For direct, lights used for general illumination:
      1) Coefficients of utilization.
      2) Candlepower data, presented graphically and numerically, in 5 degree increments (5 degree, 10 degree, 15 degree, etc.). Data developed for up and down quadrants of normal, parallel, and at 22-1/2 degree, 45 degree, 67-1/2 degree planes to lamp(s). If light output is asymmetric, provide additional planes as required to complete report.
      3) Zonal lumens stated numerically in 10 degree increments (5 degree, 15 degree, etc.) as above.
      4) Average luminaire luminance calculated in the lengthwise, crosswise, and 45 degree vertical planes.
4. Point-by-point lighting calculations showing the uniformity of light on the horizontal work plane in areas where substitutions are proposed. The substituted fixture shall be equivalent to the named fixture, including lighting level, Visual Comfort Performance (VCP), glare, Equivalent Sphere Illumination, energy usage and aesthetics.
   a. Prior to executing the point-by-point lighting calculations, request individual light loss factors, as defined in Chapter 9 of the IESNA lighting handbook, from the Engineer for input into the point-by-point lighting calculation.
   b. For each substituted light fixture provide photometric data and related information in IESNA standard file format for electronic transfer on a CD ROM.

C. Submit a complete lamp inventory for approval, including specific lamp type, manufacturer, and all appropriate lamp criteria including but not limited to: life, initial and mean lumens, beam spread, candlepower, lamp envelope, base type, color temperature, and color rendering index.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   a. The execution of work of this Section must satisfy the applicable requirements of the latest edition of NFPA 70 (NEC), the National
Occupational Safety and Health Act as embodied in 29 CFR 1910 and 29 CFR 1926, and regulations of local jurisdictional authorities.


B. Certifications:
   1. All products must be Underwriters' Laboratories (UL) listed; and each fixture, Emergency Battery Unit, and exit sign must bear the UL label.
      a. The UL standards appropriate for the products specified are listed in Paragraph 1.02.E.
      b. Alternatively, Listing by an OSHA Nationally Recognized Testing Laboratory (NRTL) to the relevant UL standards is permitted.
   2. Fixtures that are to be installed in areas subject to the weather must be UL listed as "Enclosed and gasketed suitable for wet locations".

1.6 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of General and Special Provisions:
   1. Product Data:
      a. Manufacturer’s catalog cuts.
         1) Lighting fixtures catalog cuts
         2) Driver catalog cuts that include specific driver information with sufficient information to show compliance with Contract Documents.
         3) Lamp catalog sheets of each lamp type for approval, including specific lamp type, manufacturer, and all appropriate lamp criteria including but not limited to: life, initial and mean lumens, beam spread, candlepower, lamp envelope, base type, color temperature, and color rendering index
      b. Manufacturer’s photometric data, distribution curves, isolux charts, glare factor data, and coefficients of utilization for each lighting fixture type.
   2. Shop Drawings:
      a. Shop Drawings.
      b. Bills of material.
   3. Quality Assurance/Quality Control Submittals:
      a. Design Data:
         1) Calculations demonstrating that substituted fixtures are equivalent to the named fixtures.
      b. Certificates:
         1) Proof that equipment furnished has the required Underwriters’ Laboratories (UL) listing.
      c. Manufacturer’s Instructions:
         1) Manufacturer’s installation instructions.
1.7 EXTRA MATERIALS

A. Lamps:
   1. For the lighting fixtures furnished, provide an additional 10 percent of each lamp type specified over the quantity required to initially lamp the fixtures furnished.

B. Maintenance Tools:
   1. Provide two each of the special maintenance tools as may be necessary for relamping fixtures and for fixture maintenance.

C. As the equipment for which the extra materials can be used is substantially completed, turn the extra materials for that equipment over to the Owner.

PART 2 PRODUCTS

2.1 MATERIALS

A. Conduit and Raceway:
   1. Provide electrical conduit and raceway in accordance with the requirements of Section 26 05 33.13, as indicated and as appropriate for the application per NFPA 70.

B. Control Devices:
   1. Provide electrical lighting control devices in accordance with the requirements of Section 26 27 26.

C. Fixture Support Devices and Fasteners:
   1. In addition to the supporting devices and fasteners specified in Section 26 05 28, provide suspension accessories, canopies, casing, sockets, holders, reflectors, plaster frames, recessing boxes, and similar items required to support the lighting equipment and luminaries as specified or indicated.

D. Wire and Cable:
   1. Provide electrical wire and cable in accordance with the requirements of Section 26 05 19.

2.2 MANUFACTURED UNITS

A. Light Fixtures:
   1. Provide those fixtures indicated on the Lighting Fixture Schedule on the Contract Drawings or approved substitutions.
      a. The manufacturers’ fixture descriptions and corresponding fixture model numbers are also listed in the Lighting Fixture Schedule.
      b. Additional manufacturers who can provide products comparable to those provided by the manufacturers listed and whose products the Contractor proposes to use for this Contract must first be submitted to and receive the
2. Fixtures Grounding Device and Conductor:
   a. Provide the housing of each fixture with a separate, factory-installed grounding device and ground conductor.

B. Lamps:
   1. Provide the proper type of lamps for the lighting fixtures scheduled on the Contract Drawings or indicated on the approved Shop Drawings.
      a. Provide lamps having the proper type of sockets to suit the fixtures provided.
   2. Basis of design lamp characteristics:
      a. Acceptable Manufacturers:
         1) General Electric (Basis of Design) www.gelighting.com
            a) Ecolux series for T5/T8 lamps
            b) SPX series for Compact Fluorescent
               Osram Sylvania www.sylvania.com
         2) Philips www.usa.lighting.philips.com

C. LED Lighting Fixtures (excluding LED exit signs)
   1. Color temperature of any substituted fixture shall be within 10% of the specified value shown on the drawings.
   2. Power consumption of any substituted fixture shall not exceed the specified value shown on the drawings by more than 10%. If a substituted fixture is submitted and approved at an increased wattage (within 10% of the specified wattage), any power system modifications necessary to accommodate the fixtures will be the responsibility of the contractor (i.e. increased wire sizes, increased circuit breaker size, additional circuits/breakers, etc.)
   3. LED Lumen Efficacy (Lumens/Watt) of a substituted fixture shall not be less than the specified fixture by more than 10%.
   4. Characteristics of substituted fixtures shall have the same features as the specified LED fixtures (i.e. redundant drivers, driver protection, etc.) whether specifically noted on the lighting fixture schedule or not.
   5. Drivers shall not exceed 350mA unless specifically noted otherwise on the lighting fixture schedule. Drivers shall have a Class A sound rating.
   6. LED Light fixtures shall have a minimum expected life of 50,000 hours. The aforementioned life rating must be conducted with a 40 degrees calcium ambient temperature.
   7. Power Factor: The LED fixture shall have a power factor of 0.90 or greater.
   8. Total Harmonic Distortion induced into the AC power line by the luminaire shall not exceed 20 percent.
   9. Surge Suppression: The LED fixture on-board circuitry shall include surge protective devices to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD shall
protect the luminaire from damage and failure for common mode transient peak voltages up to 10 kV (minimum) and transient peak currents up to 5 kA (minimum). SPD shall conform to UL 1449 depending of the components used in the design. SPD performance shall be tested per the procedures in ANSI/IEEE C62.41-1992 (or current edition) for category A (standard). The SPD shall fail in such a way as the Luminaire will no longer operate. The SPD shall be field replaceable.

10. Operational Performance: the LED circuitry shall prevent visible flicker.
11. Thermal Management: The thermal management (of the heat generated by the LED’s) shall be of sufficient capacity to assure the proper operation of the luminaire over the expected useful life. Thermal management shall be by passive design – the use of fans or other mechanical devised is not allowed.

D. Luminaire Brackets:
1. Provide luminaire brackets of the type and style as indicated or scheduled on the Contract Drawings and color matched to light fixture.
2. Provide luminaire brackets fabricated to be compatible with the configuration of the luminaire.

E. Boxes, Gaskets, Hardware, and Support Devices:
1. Provide outlet boxes, neoprene gaskets, and stainless steel hardware to render the installation of the lighting waterproof.
2. Supply pendant stems, special mounting supports and hardware, and miscellaneous materials and incidentals required to install the lighting and emergency battery unit products in place.
3. Provide neoprene spacers for maintaining clearance between lighting and emergency battery unit products and concrete, mortar, and other masonry surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to ordering flush mounted or lay-in type lighting fixtures, verify their locations and clearances, and coordinate with other construction work to verify that the fixtures will fit without interferences.
1. The Engineer assumes no responsibility for clearance, dimensions, tolerances, or exact hanging frame dimensions.

B. Prior to beginning installation of the lighting fixtures and accessories, verify that all other work affecting the installation of the lighting fixtures and accessories is complete to the extent that the light fixtures may be installed over substrates or incorporated into integrated systems without adversely affecting the lighting or other construction.
3.2 INSTALLATION

A. Assemble lighting fixtures if required; and install and wire the lighting fixtures, supports, brackets, and accessories at the locations and mounting heights indicated on the Contract Drawings.

1. Wire the lighting fixtures and accessories as specified in Section 26 05 19.
2. Ground the lighting fixtures in accordance with the requirements of Article 410 of NFPA 70 (NEC) and Section 26 05 26.
   a. Use the fixture grounding device to connect a separate grounding conductor in compliance with requirements specified in Section 26 05 26.
3. Install all photoelectric controls facing north for proper operation.

B. Exposed Fixture Installation:
   1. Install surface mounted and exposed fixtures as indicated on the Contract Drawings.
      a. Hang suspended fixtures plumb, with continuous rows of fixtures in alignment.
      b. Mount suspended fixtures in each room or area at the same height regardless of varying clear height conditions unless otherwise indicated on the Contract Drawings.
      c. Install surface mounted fixtures tight up against the substrate to eliminate gaps except where NFPA 70 (NEC) or local code restrictions require a separation between the fixtures and substrate.

3.3 INTERFACE WITH OTHER WORK

A. Verify the locations and clearances of other installed or proposed work, and coordinate lighting fixture installations accordingly.

B. Coordinate the installation of lighting fixtures with all building systems and components to avoid any installation conflicts.

3.4 FIELD QUALITY CONTROL

A. Inspect, test, and certify lighting and the associated electrical distribution system and equipment in accordance with the requirements of this section.

3.5 CLEANING

A. Clean new lighting fixtures by following the cleaning procedures as recommended by the fixture manufacturer:
   1. Use only those products for cleaning as recommended in the fixture manufacturer's literature.
3.6 AIMING AND FOCUSING

A. Contractor shall notify the owner one week in advance and establish schedule for a night when final aiming will be done.

B. Lock the aiming adjustments, set during final aiming, in position. Position must hold during re-lamping and normal maintenance.

PART 4 MEASUREMENTS AND PAYMENTS

4.01 MEASUREMENTS

A. The work of this section will not be measured for separate payment.

4.02 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.
SECTION 34 20 02

BASIC MATERIAL AND METHODS FOR TRACTION POWER

PART 1 GENERAL

1.1 SUMMARY

A. This specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. The scope includes furnishing and installing basic materials.

C. Related Sections:
   1. 34 20 06 – Grounding and Bonding for Traction Power
   2. 34 20 13 – Wire and Cable for Traction Power
   3. 34 20 15 – Wire Connection Accessories for Traction Power
   4. 34 20 33 – Raceways, Boxes and Cabinets for Traction Power
   5. 34 20 43 – Wire, Cable and Busways for Traction Power
   6. 34 21 20 – DC Switchboard, Stinger System and Controls, DC Pedestal and Wall Mounted Contactor Systems for S&I Shop

D. Compensation for work specified in this section will be made in the following manner:
   1. Basic Material: Lump Sum.
   2. Installation: Lump Sum.

1.2 REFERENCES

A. Codes, Regulations, Reference Standards and Specifications:
   1. Codes and regulations of jurisdictional authorities
   2. NEC
   5. ANSI: C80.1, C80.5, Z55.1, A14.1, B18.21.1, C119.1
   6. NEMA: VE1, AB1, PB1, CC1, ST-20, FG-1, 250
   7. FS: TT-S-227, FF-S-760, FF-S-325
   8. ACI: 318
   9. MS: MIL-I-23053/15

1.3 SUBMITTALS

A. Submit the following for review in accordance with the instructions elsewhere in this Specification and with the additional requirements as specified for each:
   1. Shop Drawings: Shop drawings for cable trays and mounting details, DTS Cabinet, complete ETS Enclosure including all devices and components, ETS light fixture and remote ballast, ETS relay cabinet, panelboards, fiberglass panels, glastic material and through floor barrier/firestop.
   2. Submit shop drawings for incoming service cable tray to the Engineer for approval by PEPCO and Virginia Power.
   3. Certification: Certificates from manufacturers verifying that equipment furnished conforms to the specified requirements.
4. Product Data: Manufacturer's product data for all materials.
5. Samples: ETS enclosure and light fixture, one of each size nameplate, tags, and wire labels, contact rail cable connector assembly, glastic material and danger markers.

1.4 QUALITY ASSURANCE

A. Qualifications: Select manufacturers who are regularly engaged in production of specified materials. Select installation contractors who are regularly engaged in the installation of specified materials.

B. For Codes, Regulations, Reference Standards and Specifications, refer to Article 1.02 above.

1.5 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

2.1 MATERIALS

A. Floor Sealant:
   1. Floor sealant: Water-epoxy concrete floor protective coating providing good resistance to wear, abrasion, spoiling and chemical attack.
      a. Product: Tennant ECO-LTS (405) coating system mixed with Tennant 413SF solvent-free bonding additive (for first coat only) as manufactured by Tennant Company, Minneapolis, or equal.
      b. Tennant 409 Pre-Kote cleaner or equal, for floor preparation and better adhesion of the coating.

B. Insulated Floor Topping:
   1. Description: Insulated floor topping consisting of epoxy resin with filler where indicated. Gray color.
   2. Epoxy resistivity: Minimum $10^{12}$ ohm-cm.
   3. Epoxy manufacturers: Hallemite Grey Amazite by Hallemite, 25 Holden Street, Providence, R.I., 02908, or FX-70-6EE by Fox Industries, 3100 Falls Cliff Road, Baltimore, MD, 21211, or equal.
   4. Filler: Manufacturer's standard for this service.

C. Furniture:
   1. Workbench: Heavy duty, 2-5/8 inch laminated maple top, 35 inch high by 60 inches wide by 30 inches deep with steel base which can be bolted to the floor. Provided with three 14-inch wide by 22-inch deep by 6-inch high drawers, one 20-inch deep by 50-inch wide by 20-inch high cabinet with center shelves and two steel doors. Provided with four inch toe clearance.
   2. Stool: 14-inch diameter seat with tubular steel adjusting leg extensions that lock securely at one-inch intervals, adjustable from 18 inches to 27 inches.
   3. Storage Cabinet: Steel, 36 inches high, 60 inches long and 16 inches deep with one, adjustable height shelf supported every 15 inches. Provided with four doors.
5. Finish for metallic surfaces: Cleaned, degreased, primed with zinc primer and finished with one coat of light gray enamel, ANSI Z55.1, color 61, minimum dry film thickness: one mil.

2.2 EQUIPMENTS

A. Conduit, Cable Tray, Boxes, Cabinets and Fittings:
   1. General Requirements:
      a. Size: As shown, minimum conduit size 3/4 inch.
      b. Materials:
         1) Steel sheet: ASTM A507.
         3) Malleable iron: ASTM A47
         4) Cast iron: ASTM A532
         5) Ductile iron: ASTM A536
         6) Fiberglass Reinforced Polyester (FRE): NEMA FG-1
         7) Bronze Extrusion: ASTM B455, Alloy C38500
         8) Bronze Casting: ASTM B584, Alloy C38600
         c. Zinc coating:
            1) Hot Dip Galvanizing: ASTM A123 and ASTM A386
            2) Electrogalvanizing: ASTM B633
   2. Galvanized Steel Rigid Conduit and Fittings: UL 6 and ANSI C80.1, zinc coating tested in accordance with reference test in appendix.
   3. Aluminum Rigid Conduit and Fittings:
      a. ANSI C80.5 and UL6.
   4. Liquid-tight Flexible Conduit and Fittings: (for use with galvanized steel rigid conduit)
      a. Applicable requirements of UL 360.
      b. Flexible galvanized steel core with extruded liquid-tight neoprene or PVC jacket overall.
      c. Sizes up to 1-1/4 inch provided with continuous copper bonding conductor, spiral wound between convolutions.
      d. Sizes 1-1/2 inch and above provided with separate grounding conductor.
   5. Rigid fiberglass reinforced epoxy conduits and fittings:
      b. Conduit shall be manufactured by using filament winding process with minimum fiberglass content of 65 percent by weight and no fillers.
      c. IPS based conduit shall have nominal wall thickness of 0.09 inch for five- inch nominal conduit size.
      d. Conduits, elbows and fittings manufactured from the same material and using the same manufacturing process.
      e. Conduit sections formed with integral bell-and-spigot type couplings shall use adhesive epoxy compound to make the joints watertight. Rubber sealing gasket at bell end is prohibited.
      f. Adhesive epoxy compound as recommended by conduit manufacturer.
      g. Conduits, elbows and fittings are specified for use throughout a temperature range of -40F to 230F, and they are to be protected from exposure to sunlight by pigmentation uniformly dispersed through the resin material.
      h. 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.
   6. Conduit Expansion Fittings:
      Weatherproof, fabricated from material compatible with conduit with which fittings are to be used. Metallic fittings equipped with bonding jumper cable to provide electrical continuity.
7. Conduit Connector Fittings:
   a. UL 514, material and finish similar to that of conduit with which they are to be used.
   b. Indoor Locations: For enclosures, cabinets, boxes and gutters: Nylon-insulated bushing and locknut.
   c. Outdoor Locations: Watertight nylon-insulated bushing and locknut for termination of galvanized rigid steel conduit. Watertight PVC threaded adapter with 0-ring and locknut or bushings for termination of PVC conduit.

8. 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 PVC or galvanized.
   d. Seal between conduit and concrete to withstand pressure from 50-foot head of water without leakage.

9. Cable and Seal Fittings:
   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.
   e. O-Z type CSBI, CSBE or equal as shown on drawings.
   f. Seal all unused conduits for traction power and auxiliary power using blank seals.

10. Seal Compound:
    a. FS TT-S-227, two-component, fast-setting, polymeric sealing compound to provide watertight seal 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 10F 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 single-conductor or multiple-conductor cable to withstand water pressure of 50 psi without leakage.
    j. Fox Industries, Type FX-571G or equal.

11. Conduit, Cable Tray and Cable Supports:
    a. Retaining straps and fasteners: FS FF-S-760, with the following additional requirements:
       1) Type, style and size: As necessary.
       2) Material and finish: Steel or malleable iron, hot-dip galvanized after fabrication, fiberglass reinforced polyester.
       3) For separating conduit from masonry surface: Galvanized malleable iron spacer assembled with Style a strap.
       4) For vertical run of metallic sheath cable: Basket weave cable support.
       5) For fastening conduit or cable to channel inserts: Galvanized steel fasteners.
    b. Trapeze type hangers: 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:
1) Material and finish: Steel, hot-dip galvanized after fabrication or Fiberglass Reinforced Polyester conforming to the requirements specified for fiberglass channel struts.
2) Hanger rod: Not smaller than 5/8-inch diameter, threaded for sufficient distance at each end to permit at least 1-1/2 inches of adjustment.
3) Horizontal member: Channel, 1-5/8 inches square by 12 gauge or heavier. Weld two or more channels together for greater strength if necessary.
4) 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.

c. Steel Channel Struts:
   1) Size and shape as shown, 12-gauge or heavier hot-dip galvanized, with 7/8 inch wide continuous slot, 9/16 inch base slot, two inches on center or solid base with field drilled holes as required with minimum pull out load rating of 1,000 pounds per linear foot.
   2) Fittings and accessories compatible with associated steel channel struts and having same material and finish.

d. Stainless Steel Channel Struts:
   1) Size and shape as shown, 12-gauge or heavier stainless steel, type 304, with 7/8 inch wide continuous slot, 9/16 inch base slot, two inches on center or solid base with field drilled holes as required with minimum pull out load rating of 1,000 pounds per linear foot.
   2) Fittings and accessories compatible with associated channel struts and having same material and finish.

e. Fiberglass Channel Struts:
   1) Fiberglass reinforced polyester, self-extinguishing, with 7/8" wide continuous slot, 13/32" pre-drilled holes in base on 1-5/8" centers, or solid base with field drilled holes as required with the following additional requirements.

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<th>Physical Properties</th>
<th>Value</th>
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<td>Flammability Rating</td>
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<td>ASTM E84</td>
</tr>
<tr>
<td>Moisture Absorption</td>
<td>1% (24 hrs. at 72°F)</td>
<td>ASTM D570</td>
</tr>
</tbody>
</table>
2) Fittings and accessories compatible with associated fiberglass channel struts and having same material or approved similar material.

f. Cinch anchors: One-piece wedge type, galvanized with threaded stud.

g. Cable support brackets: Size and type as shown, 12-gauge or heavier, hot-dip galvanized.

h. Cable insulators: Saddle type, high glazed porcelain, designed for use with the brackets provided.

12. Boxes:
   a. Outlet boxes:
      1) UL 514, capable of accommodating conduit as shown.
      2) Material and finish:
         a) Steel, cast iron, ductile iron or malleable iron.
         b) Hot-dip galvanized or electro galvanized after fabrication.
   b. Junction and pull boxes:
      1) Internal volume up to 100 cubic inches, UL 514; internal volume above 100 cubic inches, UL 50.
      2) Flush-mounted or surface-mounted as shown.
      3) Size: Suitable to accommodate conduit, raceways, ducts, number of cables and splices shown.
      4) Material:
         a) Stainless Steel, Type 316.
         b) Hot-dipped galvanized or electro galvanized after fabrication.

13. Cable Trays
   a. General:
      1) Dimensions: Minimum four inches inside depth; nine inches rung spacing unless otherwise shown.
      2) Maximum load rating: 50 pounds per linear foot with safety factor of 2.0 at 12-foot support span for steel trays. 200 pounds per linear foot with safety factor of 1.5 at 12 foot support span for fiberglass reinforced polyester trays. Support additional concentrated load of 200 pounds at any point without permanent deflection.
      3) Bend Radius:
         a) For incoming service cable: 36 inches or as approved by the utility.
         b) For all other cable: 24 inches or as shown.
   b. Fiberglass Cable Tray
      1) NEMA FG-1, fiberglass ladder type.
      2) Allowed for carrying all dc positive and negative cable except as otherwise noted. Fiberglass material shall be used for all fittings and accessories associated with the installation of fiberglass trays.
      3) Fiberglass Reinforced Polyester in accordance with the following:

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Value</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>40,000 PSI</td>
<td>ASTM D638</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>45,000 PSI</td>
<td>ASTM D790</td>
</tr>
<tr>
<td>Barcol Hardness</td>
<td>95</td>
<td>ASTM D2583</td>
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<tr>
<td>Dielectric Strength</td>
<td>200 VPM</td>
<td>ASTM D149</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.7</td>
<td>ASTM D792</td>
</tr>
<tr>
<td>Coefficient of Thermal Expansion (Longitudinal)</td>
<td>5x10^-6 in/in/F</td>
<td>ASTM D696</td>
</tr>
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Basic Material and Methods for Traction Power

<table>
<thead>
<tr>
<th>ASTM D696</th>
<th>Flammability Classification</th>
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<tr>
<td>1% (24hrs. at 72°F)</td>
<td>V-O</td>
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<tr>
<td>ASTM D570</td>
<td>UL 94</td>
</tr>
<tr>
<td>Flammability Rating</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>ASTM E84</td>
</tr>
</tbody>
</table>


15. Wireways and Auxiliary Gutters:
   a. Galvanized steel with formed flanges on both body and cover, screw on covers, in accordance with UL870, complete with all necessary fittings, couplings and end pieces.
   b. Size as shown.
   c. Electrogalvanized and finished with light gray enamel, ANSI Z55.1, Color 61.

16. DTS Cabinet/Remote Control and Monitoring Cabinet:
   a. Wall-mounted, single-door, NEMA 250, Type 12, with panel, similar to Hoffman Engineering Company or equal, as shown.
   b. 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. (Note: The Remote Control & Monitoring Cabinet shall be identical to the DTS Cabinet for Tie Breaker Station, except that the nameplate shall be modified to suit.)
   c. 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.
   d. Hardware: Corrosion-resistant steel continuous piano hinge with removable pin. Hasp and staple for padlocking.
   e. Panel: Formed of 12-gauge steel.
   f. Finish: Galvanized enclosure, door, and panel and latch mechanism. Painting by manufacturer's standard method in accordance with the following:
      1) 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.
      2) Inside including panel: Two coats of white enamel or epoxy coating.
   g. Breather drain: One 1/2 inch diameter, Crouse-Hinds Catalog No. ECD11 or equal.
   h. Grounding stud: Manganese bronze, ASTM B138, Alloy No. 675 hard, 3/8 inch high; Evedur GSI, American Brass Company or equal.
   i. Terminations: Assembly rail and modular terminals, Weidmuller Terminations, Incorporated or equal.
      1) Terminal: Modular test terminal, Melamine plastic, screw clamp connections, with socket screws; type SAKC4, Catalog No. 3406.2, with the following additional requirements:
         a) Amperes: 25.
         b) Volts: 300.
         c) Wire gauge range: 22 AWG to 12 AWG.
         d) Thickness: 0.256 inch.
         e) UL-listed.
         f) Standard accessories: compatible with terminal, with the following additional requirements:
            (1) End section: Type AP, No. 1179.2.
            (2) End bracket: Type EWK1, No. 2061.6.
            (3) Test plug: Type PS, No. 1804.0
(4) Jumpering Combination: Type QB, No. 91455.0.
(5) Disconnect plug for SAKC4 terminal: Type TST, No. 413074.
(6) Locking pin: Type SST3, No. 1527.0.

2) Assembly rail: Type TS 32 steel standard section compatible with terminals, with fixing slots, Catalog No. 1228.0 and standard rail mounting screws.

3) Marking tags: Horizontal in sequence, Type FW, No. 4681.6 white thermoplastic. Consecutive numbering conforming to that of DTS box.

4) Group marking carrier with paper marking strip and transparent cover.
   a) Type SCHT5, Catalog No. 2924.6.
   b) Type ES05, Catalog No. 2937.0.
   c) SST5, Catalog No. 2940.0

17. ETS Enclosures:
   a. Enclosure: Nonventilated, single-door fiberglass enclosure NEMA 250, Type 3R, with mounting brackets as shown, complying with applicable requirements of UL 508.
   1) Molded fiberglass reinforced polyester material 1/8 inch thickness, minimum, and in accordance with the following:

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Value</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength</td>
<td>17,000 PSI</td>
<td>ASTM D790</td>
</tr>
<tr>
<td>Deflection Temp</td>
<td>400F</td>
<td>ASTM D648</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>0.5%</td>
<td>ASTM D570</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>6,500 PSI</td>
<td>ASTM D638</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>1.8</td>
<td>ASTM D792</td>
</tr>
<tr>
<td>Flammability</td>
<td>V-O</td>
<td>UL94</td>
</tr>
<tr>
<td>Dielectric Strength</td>
<td>400 Volts/Mil</td>
<td>ASTM D149</td>
</tr>
<tr>
<td>Arc Resistance</td>
<td>180 Sec</td>
<td>ASTM D495</td>
</tr>
</tbody>
</table>

   2) Gasket: Oil-resistant 100 percent neoprene by polymer content, ASTM-D1056 grade SCE-42 with oil-resistant adhesive.
   3) Piano hinges: Stainless Steel, one inch wide by 1-3/4 inches high, with model pins and fasteners, two per enclosure.
   4) Door handle: T-handle, One half turn, Vise Action Type, die cast zinc, matte black, polyester powder finish with stainless steel hardware, SOUTHCO catalog No. E3-10-105-50 or equal.
   5) Panels, back plates, barriers and brackets: 10 gauge stainless steel as shown.
   6) Hardware: Stainless steel bolts, nuts and screws; ASTM F593, size as shown.
   7) For ultra-violet protection of fiberglass box, the material shall contain ultra-violet inhibitor on inside and outside surfaces coated with polyurethane paint, 1.5 mils minimum dry film thickness.
   8) Color: Fiberglass material, gray inside and out.
   9) Open/Close Decal: Pressure sensitive weatherproof, vinyl tape with 1/4" high red on a white background. “OPEN” shall have red letters, “CLOSE” shall have green letters.
10) Nameplates: Each ETS Enclosure provided with three-ply laminated plastic, multi-layered nameplates inscribed with 1-inch lettering identifying the ETS Box Number, Supervisory Control Identification Nos. of the dc breakers being tripped. A typical example of engraving is as follows:
   a) EMERGENCY TRIP SWITCH NO.
   b) E-F07-31
   c) E-F08-41

b. Emergency pushbutton: Provide on the backplate, mushroom head trip switch with 4 NC poles similar to Square-D Cat. No. 9001-4-KA-3 with head No. 9001-KR-5R.

c. Terminal block: Provide on the backplate one 12-point terminal board similar to GE Cat. No. CR151B2 or equal.

18. ETS Relay Cabinets:
   a. Wall mounted, single door, NEMA 250, type 12, with enclosure and back panel similar to Hoffman Engineering Company or equal, as shown.
   b. Enclosure formed of minimum 14-gauge steel with sufficient structural reinforcements to ensure a plane surface, to limit vibration and to provide sufficient rigidity during shipment, installation and operation. A print pocket shall be attached to the inside of the door of enclosure.
   c. Door formed of minimum 14 gauge steel with rolled lip formed along top and sides to mate with enclosure. Provided with hasp and staple for padlocking.
   d. Back panel formed of minimum 12 gauge steel.
   e. Relays and Terminal Blocks: The cabinet shall have mounted on its back panel auxiliary relays of hinged armature construction, 125V dc rated coil and electrically held, self-reset type with 2 NO and 4 NC contacts similar to GE Catalog No. 12HFA51A42H code No. 24 contact arrangement or equal. Terminal blocks with cover similar to GE Type EB shall be mounted on back panel. Quantity of relays and points on terminal blocks as shown.
   f. Name Plates and Wire Labels: In accordance with Article 2.02.C.

B. Circuit breakers & Panelboards:
   1. General Requirements:
      a. Interchangeability: Components of the same type, size, rating, functional characteristics and make are to be interchangeable.
      b. Finish for enclosures for panelboards.
         1) Clean and degrease metallic surfaces.
         2) Prime with zinc primer.
         3) Finish with one coat of light gray enamel, ANSI Z55.1, Color 61; two mils minimum DFT.
   2. Circuit Breaker: NEMA AB1, UL489, 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. 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 40°C with the following parameters as shown:
      a. Number of poles.
      b. Rated voltage, ac or dc
      c. Rated interrupting current.
      d. Trip setting.
      e. Frame size.
   3. Enclosed Circuit Breakers:
      a. NEMA AB1.
      b. Circuit breaker: As shown and specified. Overcurrent trip device coordinated to provide selective tripping under overload conditions.
      c. Enclosure:
1) Galvanized steel, surface-mounted, unless otherwise shown.

d. Type:
   1) Above-ground indoor locations and electrical rooms: NEMA 1.
   2) Tunnel areas and underground locations, except electrical rooms: NEMA 12.
   3) Outdoor locations: NEMA 3R.

4. Panelboard:
   a. NEMA PB1, UL 67
   b. Enclosure:
      1) UL 50.
      2) Galvanized steel, surface mounted unless otherwise shown.
      3) NEMA 250, Type 1
      4) Gutter size

<table>
<thead>
<tr>
<th>Main Bus Rating Amperes</th>
<th>Minimum Top and Bottom Gutter Size in Inches</th>
<th>Minimum Side Gutter in Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 and below</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>225</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

5) Interior components mounted on backplate of reinforced steel for rigid support and accurate alignment.

6) One piece sheet steel front panels with hinged door and lock so constructed that when panelboard door is locked front cannot be removed.

7) Provide latch and handle in accordance with UL 50; screw fastenings will not be accepted in lieu of latch.

8) Provision for enclosure grounding.

c. Busbars:
   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) Neutral and ground bus equipped with integral mechanical connectors.

d. Circuit Directory:
   1) Neatly typed to identify the load fed by each circuit by number.
   2) Mounted on a metal frame with clear plastic cover inside cabinet door.

e. DC Panelboard: 125 volt dc, 2-wire. Main and branch circuits with 2-pole breakers, quantity and ratings as shown. AIC-10,000 amps minimum.

C. Nameplates, Tags, and Wire Labels:

1. Nameplates:
   a. Three-ply, laminated phenolic plates, engraved through black face to white core, attached by stainless steel rivets or screws.
   b. Lettering: Vertical gothic using round or square cutter. V-shape groove is prohibited.
   c. Size: One-inch high with 1/2-inch high lettering.

2. Conduit and Cable Tags: Stainless steel, round, punched with cable or conduit number as shown.

3. Wire labels: Sleeve-type, heat shrinkable, flame retardant Raychem TMS product line, Type XPE or equal and conforming to UL224. Wire identification same as corresponding terminal block identification unless otherwise shown. The labels on 1000 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.

D. Emergency Trip Station Light Fixture Type 9.
1. Lighting Fixture: Enclosed and gasketed mercury-vapor fixture suitable for outdoor locations conforming to UL-1572 and as shown. Hubbell Catalog No. VMWX-50C-R or equal.
   a. Lamp: Mercury-vapor, 40 watt B-17, medium base, 24,000 hours rated average life, and conforming to applicable ANSI Standards.
   b. Lampholder: In accordance with UL 496, glazed porcelain base and body, rated 660 watts, 600 volts, medium screwbase, and self-retaining neoprene gasket for dust and moisture-proof seal between lamp and lampholder.
   c. Housing: Copper free heavy-duty die cast aluminum with 90-degree arm for wall mounting, natural color, threaded to provide a secure fit for the globe and guard.
   d. Globe: Thermal shock and impact resistant blue tempered glass, threaded to ensure secure fit to housing.
   e. Guard: Copper free die cast aluminum to provide protection to the globe and lamp, threaded and provided with a flush mounted set screw for a positive and secure fit to housing.
   f. Ballast: UL 1029, high power factor, H45 type, Class H insulated, capable of starting a 40 watt mercury vapor lamp at an ambient temperature of minus 20F and above, 277 volt, 60 Hertz, suitable for mounting in an enclosure for remote mounting.
   g. Remote ballast enclosure: Fiberglass or aluminum with polyester powder paint finish, front access and weathertight construction with 3/4” conduit entry and exit knockouts, with mounting lugs suitable for mounting on channel inserts or inside interface box as shown.

E. Danger Markers:
1. Danger markers for conduit and cable installed in track areas:
   a. Danger plate for use on timber ties supporting conduit and cable.
      1) Three-ply, laminated phenolic plates, engraved through red face to white core, attached by stainless steel lag screws.
      2) Lettering: Vertical Gothic using round or square cutter. V-shape groove is prohibited.
      3) Size: Four-inch high with one-inch high lettering as below and applicable.

DANGER 750 VOLTS

   4) Ultra-Violet Protection: coated with polyurethane paint 1.5 mils minimum dry film thickness on all surfaces.
   b. Danger label for use on conduit:
      1) 2-1/2-inch wide pressure sensitive vinyl with red background and white lettering 1-1/4 inch high, Gothic Capital Style as follows and applicable. (“DANGER 750 VOLTS” & “DANGER 480 VOLTS”)
      2) Lettering printed with weather resistant ink and shall be durable and scuff resistant.
      3) Marker provided with permanent type back adhesive for long term outdoor use.

2.3 ACCESSORIES

A. Wire Connection Accessories:
1. Connectors, terminal lugs and fittings.
   a. In accordance with UL486, and NEMA CC1.
b. For 10 AWG and smaller conductors: Compression type, high conductivity copper, tin-plated ring tongues, with nylon self-extinguishing insulating grip with temperature rating equal to that of conductor insulation. Thomas and Betts STA-KON type or equal.

c. For 8 AWG to 4/0 AWG conductor cable: Tin-plated copper compression connectors and terminal lugs with nylon insulating sleeve for insulation grip.

d. For 250 KCMIL and larger conductor cable: Long barrel double-compression tin-plated copper connectors and terminal lugs with two-hole pad.

e. 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.

f. Hardware: High strength silicon bronze, corrosion resistant, non-magnetic, and electrolytic action free when in contact with copper.

g. Ground connector:
   1) O-Z, Type KG or equal.
   2) Two-piece, designed for connecting grounding conductor to bus bar.
   3) Copper-alloy bolt and silicon-bronze bolt, nut and lock washer with interlocking clamp.

h. Contact rail terminal lugs: Compression type, 98-percent-pure copper, hot-dip tin-coated to 0.3 mils minimum thickness. Tongues not less than two inches square by 1/2-inch thick and drilled for 5/8-inch diameter fastener. Compatible with 1000 KCMIL, extra flexible cable.

2. Bundling Straps:
   a. Self-locking steel barb on one end, with tapered strap of self-extinguishing nylon, temperature rating minus 65F to 250F.

   b. For outdoor use: Ultraviolet-resistant.

3. Insulating Tape:
   a. Plastic tape: Vinyl plastic tape with rubber-based pressure-sensitive adhesive, pliable at zero degrees F with the following minimum properties when tested in accordance with ASTM D1000:
      1) Thickness: 8.5 mils.
      2) Breaking strength: 20 pounds per inch width.
      3) Elongation: 200 percent.
      4) Dielectric breakdown: 10,000 volts.
      5) Insulation resistance, indirect method of electrolytic corrosion: 1,000,000 megohms.

   b. Rubber tape: Silicone rubber tape with silicone pressure-sensitive adhesive, with the following minimum properties when tested in accordance with ASTM D1000:
      1) Thickness: 12 mils.
      2) Breaking strength: 13 pounds per inch width.
      3) Elongation: 525 percent.
      4) Dielectric breakdown: 13,000 volts.
      5) Insulation resistance, indirect method of electrolytic corrosion: 1,000,000 megohms.

   c. Arc-proof tape: Flexible and conformable organic fabric tape, coated one side with flame-retardant flexible elastomer, self-extinguishing, non-combustible, with the following minimum properties:
      1) Thickness, ASTM D1000: 30 mils.
      2) Tensile strength, ASTM D1000: 1500 pounds per square inch @ 23C.
      3) Elongation, ASTM D1000: 150 percent @ 23C.
      4) Thermal conductivity, ASTM D1518: 0.078 BTU per hour per square foot per degree F.
      5) Electrical arc resistance: one half-lap layer capable of withstanding a high current fault arc temperature of 13,000K for 75 cycles.
d. Glass tape: Woven glass fabric tape with pressure-sensitive thermosetting adhesive, with the following minimum properties when tested in accordance with ASTM D1000:
   1) Nominal width: 3/4 inch.
   2) Thickness: Seven mils.
   3) Breaking strength: 170 pounds per inch width.
   4) Elongation: Five percent.
   5) Dielectric breakdown: 2,500 volts.
   6) Insulation resistance, indirect method of electrolytic corrosion: 5,000 mega-ohms.

4. Epoxy Resin: Suitable for insulating and moisture sealing cable splices, with the following minimum properties:
   a. Dielectric strength, ASTM D149: 400 volts per mil.
   b. Volume resistance, ASTM D257: 2.8 x 10^30C.
   c. Water absorption, ASTM D570:
      1) 0.193 percent in 24 hours at 23C.
      2) 0.62 percent in 24 hours at 53C.
   d. Tensile strength, ASTM D638: 8,000 psi.
   e. Elongation, ASTM D638: 2.4 percent.
   f. Coefficient of expansion, ASTM D696: 6.8 x 10^{-5} inch per inch per degree.

5. Contact Rail Cable Connector Assemblies:
   a. Cable connectors: Compression type, MAC Products, Inc., No. B-9180 or equal, 98 percent pure copper with four hole tongues and necessary silicon bronze flat washers, lockwashers, nuts and bolts. Tongues not less than 9/16 inch thick and drilled for 1/2 inch bolts on 1 3/4 inch centers.
   b. Insulating covers and accessories: Two-piece, glass reinforced polyester, orange colored, not less than 0.125 inch thick. Equipped with neoprene gaskets, sealing collars and captive screw fasteners.
   c. Heat shrinkable tubing: T & B Cat. No. HSB400-225-1 or equal.
   d. Completed assembly to be watertight and readily disassembled.

6. Terminal Blocks:
   a. Barriered, screw type equipped with washer head binding screws, white marking strips for terminal identifications and hinged covers; unless otherwise shown or specified.
   b. Rated 600 volts, 30 amperes per point and designed to accommodate wire sizes 19 AWG through 10 AWG inclusive.

B. Exothermic mold kit, consisting of mold and handle and Exothermic Weld Cartridge:
   1. Exothermic weld mold for making #4 AWG cable connections to the base of the composite contact rail. Erico part No. PB10QTIL84C or equal.
   2. Exothermic weld mold for making #4 cable connections to the neutral axis of the running rail, Erico part No. PB13STIL or equal.
   3. Mold handle for holding the exothermic mold to the composite contact rail and the running rail. Erico part No. PBL160 or equal.
   4. Exothermic Weld Cartridge: Consisting of welding powder, steel discs and packing material required to make an exothermic weld of #4 AWG cable to the composite contact rail and running rail. Erico part No. PB65 or equal.

C. Heat-shrinkable tubing: UL-approved, flame retardant, corrosion resistant thick wall tubing with factory-applied sealant for field insulation on inline 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 properties:
   1. Material: Cross-linked polyolefin.
   2. Shrink ratio: 3 to 1 (min.)
   3. Physical properties:
4. **Electrical properties:**
   a. Dielectric strength 450 volts ASTMD149 per mil
   b. Volume resistivity $1 \times 10^{14}$ ASTMD 257 ohm cm

5. **Thermal properties:**
   a. Continuous operating temp. -55C to +135C
   b. Air oven aging (7 days @ 175C):
      1) Tensile strength 2680 psi
      2) Elongation 375 %
      3) Low temp. flexibility No cracking
         (4 hours @ -55C) when flexed
      4) Heat shock (4 hours @ 225C)
         No cracking, flowing or dripping

6. **Chemical properties:**
   a. Corrositivity Non-corrosive MIL-I-23053/15
   b. Fungus resistance Non-nutrient ASTM G21

**D. Nuts, Bolts, U-Bolts and Miscellaneous Hardware.**

1. **Material**
   a. All nuts, bolts, u-bolts and washers for outdoor locations including tunnels shall be Type 316 stainless steel in accordance with ASTM F593 and F594.
   b. All nuts, bolts, and flat washers for indoor locations in TBS and TPS shall be galvanized steel in accordance with ASTM A325.
   c. The dimensional data and type hardware for all nuts, bolts and miscellaneous parts shall be shown and specified; where not shown as recommended by the manufacturer.

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. 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

**E. Structural Steel Shapes:**

2. Structural tube: ASTM A500, Grade A, hot-dip galvanized. galvanizing: Hot-dip galvanized after fabrication in accordance with ASTM A123, zinc coating weight two ounces per square foot, minimum.

**PART 3 EXECUTION**

**3.1 INSTALLATION**

A. Install generally as shown and in accordance with approved shop drawings, the NEC and jurisdictional agencies.

B. Conduit, Cable Tray, Boxes, Cabinets and Fittings:
   1. General:
a. Use size, type, general routing, location of conduit, raceways, boxes and cabinets as shown and specified.
b. Install metallic raceway, fittings, boxes and cabinets free from contact with reinforcing steel.
c. Where aluminum is placed in contact with dissimilar metal or with concrete, separate contact surfaces by means of gasket, non-absorptive tape or coating to prevent corrosion.
d. Unless specified or shown otherwise, make metallic conduit, raceways, and cable trays, electrically and mechanically continuous, and grounded in accordance with NEC and as shown.

2. Conduit:
   a. Run exposed conduit parallel to building lines.
   b. Install exposed conduit to avoid interference with other work.
      1) Where shown and as necessary, install cable seal in accordance with the manufacturer’s recommendation.
      2) Use sealing compound where approved and in accordance with manufacturer’s recommendations, with the following additional requirements:
         a) Before applying sealing compound, prime conduit and cable surface using primer recommended by the manufacturer.
         b) Pour or inject compound to prevent voids inside seal and to keep cable centered in conduit.
      3) In empty conduit installed for future use, install blank cable seal inside conduit to prevent seepage of water.
      4) Ensure conduits are free of water before conduit seals are installed.
   c. Apply lead-free conductive anti-seize compound to threaded conduit joints.
   d. For outdoor locations use threaded conduit hub to attach conduit to equipment enclosure. Use watertight conduit fitting for attachment of conduit to enclosure having punched or formed knockout.
   e. For indoor locations use locknut and nylon-insulated bushing to attach conduit to enclosure.
   f. Install suitable caps or plugs in empty conduit for future extension.
   g. Thread and ream ends of field-cut conduit to remove rough edges. Use bushing at conduit entrance to boxes, cabinets and equipment enclosures.
   h. Bends:
      1) Unless otherwise shown or specified, install conduit bends in accordance with reference codes.
      2) Bend conduit so that field made bend is free from cuts, dents and other surface damage and does not reduce cross-sectional area of conduit.
   i. Support horizontal conduit 1-1/2 inches and smaller with one-hole pipe straps or individual pipe hangers.
   j. Support horizontal conduit larger than 1-1/2 inches with individual pipe hangers.
   k. Spring steel fasteners, clips or clamps specifically designed for supporting exposed single conduits may be used in lieu of pipe straps or pipe hangers. Use 1/4 inch minimum diameter galvanized steel rods for hanger rods with spring steel fasteners, clips and clamps.
   l. Secure conduit supported on multi-hangers (trapeze) or channel inserts by fasteners suitable for such purpose.
   m. Where conduit is attached to masonry surface, use malleable iron spacers with Style A pipe straps.
   n. Support and secure vertical conduit spanning open areas at intervals not exceeding 10 feet.
   o. Install conduit so as to drain moisture to nearest outlet or pull box.
   p. Use only metallic conduit in exposed locations in tunnels and buildings.
q. Ensure waterproof conduit connection where conduit is installed in outdoor locations.

r. Use Schedule 80 PVC conduit for cable which is buried directly in ballast or at trackside locations for contact rail heater segment jumper cables.

s. Install expansion fittings in exposed conduit runs longer than 300 feet.

t. Use metallic conduit routed between control cable trays and equipment enclosures.

3. Channel Inserts and Spot Inserts:
   a. Mount outlet boxes.
   b. Keep number of knock-outs to minimum.
   c. Clean boxes thoroughly after installation and correct damage to boxes and to finish.
   d. Install covers on boxes mounted on walls and ceilings.
   e. Install junction and pull boxes so that covers are readily accessible.

4. Cabinets:
   a. Fasten cabinets using expansion bolts, toggle bolts or mounting ears.
   b. Touch-up damaged painted finish.

5. Cable Trays:
   a. For incoming service cable from power company, coordinate with the power company, and install cable tray with covers as approved by the power company.
   b. Support cable tray straight sections, elbows, tees and crosses at the locations specified in NEMA FG-1 for fiberglass tray. Provide supports on 10 foot centers for horizontal positive and negative cable tray and not more than 12 feet on center for all other cable trays.

6. Fasteners:
   a. Fasten equipment and devices to concrete surfaces with lag screw shields, cinch anchors, expansion bolt anchors or lead jacketed tamp-in inserts. Use bolt sizes providing a safety factor of 2.5.
   b. Fasten equipment and devices to concrete masonry units with toggle bolts.
   c. Fasten equipment, devices and supports to structural steel with beam clamps, welded studs or drilled and tapped holes no greater than 1/4 inch diameter.

7. DTS Cabinet and ETS Relay Cabinet:
   a. Install as shown. Wall-mounted and fixed by expansion bolt anchors or toggle-bolts.
   b. Terminate all wires as shown, including spares.
   c. Ground DTS and ETS relay cabinets.

8. ETS Enclosures:
   a. Install as shown.

9. ETS lighting fixtures:
   a. Install as shown.

10. Filling of openings:
    a. Where conduit and raceway (including cable tray and bus duct) pass through fire-rated walls, ceilings or floors, provide approved firestops to prevent passage of fire and fumes and to maintain integrity of fire-rated structure.
    b. Close unused openings or spaces in floors, walls and ceilings. Plug or cap unused conduit and sleeves.
    c. Seal unused traction power conduits in ductbank at both ends using OZ Gedney CSBE seals or equal.

11. Cleaning of raceways:
    a. Rod and swab raceways and ducts through which cables are to be installed. Use a mandrel with an outside diameter 3/8-inch less than the inside diameter of the duct and remove all obstruction. Install a non-metallic pull line...
fish wire, as approved by the Engineer in each raceway or duct immediately after rodding and swabbing and, unless cables are pulled immediately.

b. The Contractor shall be responsible for the dewatering and removal of all dirt, rocks, track ballasts and trash from trenches, pipe, manholes, pull chambers, cable trough, surface trench, conduit and ductbank prior to and during the installation of cable, at no additional cost to the Authority.

12. Cable Troughs (Track Right-of-Way):
   a. Remove the trough covers, install wire and cables and reinstall the trough covers.
   b. The Contractor is specifically warned of the following conditions and potential problems with the track right-of-way cable troughs:
      1) The covers for these troughs are not of uniform length and locations of drill holes, i.e., each cover section must be replaced on the trough section from where it was removed.

13. Apply anti-corrosion joint compound to connectors, terminal lugs and bolting pads before installation. Install lockwasher under each bolt head and nut.


15. Attach contact rail cable connector assembly compression connectors to the cable with manufacturer's recommended tooling. Install a lockwasher under the head of each bolt and under each nut when bolting tongues together. Tighten bolted connections to a uniform torque of 450 inch-pounds.

16. Prior to assembly of contact rail cable terminal lugs to composite contact rail, coat mating services with oxide-inhibiting paste, NO-OX-ID, Dearborn Chemical, or equal. Coat all interfaces of the compression fasteners. Fasten terminal lugs to the composite compact rail using methods and equipment recommended by the rail manufacturer.

17. Exothermic Welded Connections: Make connections using exothermic mold kit and cartridge in accordance with the manufacturer's recommendations. Remove all extraneous weld metal and test connection for mechanical strength by striking twice with a two-pound hammer.

18. The splicing of power and control cables is not permitted in manholes, ductbanks and cable troughs. However, if permitted by the Engineer, make water tight splices as approved.

C. Panelboards:
   1. Install panelboards at locations shown.
   2. Mound panelboards with front straight and plumb.
   3. Connect branch circuit wires as shown. Connect neutral wire of branch circuit to neutral bar in panelboard.
   4. Make power cable connections to circuit breakers, neutral and ground bus bars in panelboard by means of integral mechanical connectors. If such items are not furnished with integral mechanical connectors, make connections using compression connectors.
   5. Ground panelboards.
   6. Apply matching touch-up paint where necessary.
   7. Provide directory for each panelboard.

D. Furniture:
   1. Provide one workbench, two stools, one storage cabinet and one stepladder for each traction power substation. Provide one storage cabinet and one stepladder for each tie breaker station. Place furniture inside each location where directed by the Engineer.

E. Insulated Floor Topping:
1. Job Conditions:
   a. Maintain substrate temperature within limits recommended by the flooring materials manufacturer.
   b. Provide adequate ventilation during installation and curing.

2. Inspection: Examine substrate and conditions under which flooring materials are to be prepared and installed. Do not proceed with the installation until all unsatisfactory conditions have been corrected.

3. Surface Preparation:
   a. Inspect all surfaces to determine that entire area to receive insulating floor topping is structurally sound. Remove loose sections down to the substrate.
   b. Remove grease, oil, asphalt, mastics, and other contaminants that may prevent adhesion, by scrubbing with degreasers, detergents, or solvents. Grinding, scarifying, or sandblasting are other acceptable methods.
   c. Repair cracks, holes, eroded and damaged areas with patching materials recommended by the insulating flooring manufacturer.
   d. Prepare concrete surface by acid etching, grinding, sandblasting, scarifying, or other approved method.
   e. Saw cut at all termination points.
   f. Prior to applying base coats and top coats, apply marking tape at all termination points and adjacent surfaces not to be coated.
   g. Remove tape immediately after broadcasting and after top coating.

4. Materials Protection: Mix and prepare materials in accordance with manufacturer's written instructions.

5. Application: Mix and apply each component of the insulating flooring system in accordance with the manufacturer's written instructions and as indicated to provide an uninterrupted, uniformly thick, seamless, and monolithic surface.

6. Contraction Joints: When floor insulating topping material crosses contraction joints in the floor slab, a contraction joint shall be provided in the topping. Provide a vee shaped groove, 1/2 inch wide at the base of the groove, but not less than the width of the contraction joint, and insure the groove is 1/2 inch wider at the top than at the bottom. A bond breaker shall be provided to top of the concrete. An epoxy shall be used to seal damp surfaces before application of the primer and polysulfide. The groove shall then be filled with two component, self-leveling, gray polysulfide. Epoxy primer and polysulfide material shall be as recommended by the floor topping manufacturer. Surface preparation, and mixing and installation of materials shall be in accordance with manufacturer's instructions. Sheets of Haysite, not less than 1/16 inch thick, and 1/4 inch narrower than the groove at the top, shall be placed on top of the polysulfide and flush with the top of the insulated floor topping.

7. Cleaning: After completion of insulating flooring installation, clean free of residue those surfaces not required to receive insulating flooring materials.

8. Protection: Close to all traffic for 24 hours, minimum, completed insulating flooring installation. Protect it for 3 days from acid, alkali, or solvent which may spill on the flooring.

F. Install appropriate power company furnished metering panel as shown and in accordance with power company instructions. Ground metering panel to substation ground bus. Connect to 120V, AC, 1-phase circuit in emergency panel as shown.

G. Nameplates, Tags and Wire Labels:
   1. Nameplates: Attach nameplates to all panelboards, DTS cabinets, remove control and monitoring cabinet, ETS enclosures and ETS relay cabinets.
   2. Cable Tags: Attach cable tags to each cable at all pull boxes, manholes and terminations.
3. Wire labels: Attach wire labels at all control, announcement and supervisory wiring at each terminal point. Attach label to a clean, dry section of wire as close as possible to the terminal point.

H. Danger Marker:
   1. Attach danger marker plate on top of timber ties on both ties where contact rail heater conduit transition occurs.
   2. Attach conduit danger label on each exposed conduit carrying contact rail heater control and power cable installed in track area at a maximum interval of five feet as noted below:
   3. Conduit carrying DC power cables: DANGER 750 VOLTS.
   4. Conduit carrying AC power and control cables: DANGER 480 VOLTS.

I. Arc-Proofing:
   1. Cover all cables installed in manholes and pits with arc-proof tape, applied in a single layer, half-lapped with the coated side next to the cable and held in place with random wrap of glass cloth electrical insulating tape.

J. Floor Sealant:
   1. Apply to finished floor surfaces in all traction power substations and tie breaker stations excluding areas with insulating floor topping.
   2. Prepare floor by removing compacted dirt.
   3. Treat with 409 Pre-Kote cleaner, mixed in ration one part 409 to nine parts water. Apply mix solution to the floor liberally (100 square fee per gallon) with a spray. Allow to soak for 10 minutes but do not allow it to dry. Scrub floor clean and vacuum using a wet vacuum. Scrub and rinse with clear water and repeat the scribe/rinse/vacuum process to ensure removal of all residue. The texture of floor should feel like sand paper before applying sealant.
   4. Let the floor dry completely.
   5. Mix Tennant ECO-LTS Parts A and B and Bond Additive (for the first coat) as recommended.
   6. Applicator or airless sprayer. Ensure ambient temperature is 65°F or higher during application. Apply two additional coats of the mix with four hours drying time in between.
   7. Allow to cure for 16 hours at 75°F before opening up the floor to traffic.

3.2 FIELD QUALITY CONTROL

A. Submit test procedure for approval and perform approved tests. Do not perform tests without approved test procedure. Schedule tests through the Engineer with minimum of 14 days prior notice. Furnish the necessary equipment and perform the following tests:
   1. Test metallic conduit and boxes for electrical continuity.
   2. Panelboards: Perform insulation resistance tests of each bust section phase-to-phase and phase-to-ground for one minute using 1,000 volt megger. Insulation resistance not less than manufacturer’s recommended value, two megohms minimum. Test enclosure for continuity to substation ground bus. Test circuit connections in accordance with wiring diagrams.
   4. Prior to installation, test two contact rail cable connector assembly compression connections, prepared under the direction of foremen who will supervise the installation, as follows:
a. Measure the electrical resistance between distal end of the cable and the connector tongue. Resistance shall not be greater than that of an equivalent length of uncut cable.

b. Subject the test connections to a sustained tension of 5000 psi for three hours. At the end of three hours, verify that there has been no slipping of the cable in the connector, deforming or loosening of the connection or increase in the electrical resistance beyond that specified.

c. Should any sample fail to meet the specified test requirements, the qualification of the foreman and the equipment shall be disapproved.

5. Test contact rail, DC switchgear and negative switchboard 1,000 KCMIL cable terminal lugs as specified for contact rail cable connector assembly compression connectors.

6. Testing of Exothermic Connections of Composite Contact Rail and Steel Running Rail:

a. All exothermic connections shall be tested for mechanical strength using a two-pound hammer. A minimum of three sharp blows fifteen inches in stroke shall be directed to the weld nugget. The weld shall sustain the blows without cracking weld metal or at the interface with the steel contact rail. Defective welds shall be removed and the rail and cable thoroughly cleaned before rewelding.

b. Electrical Resistance: Using a megohmmeter, measure and record the insulated flooring electrical resistance to ground at four points designated by the Engineer. Resistance not less than 100 mega-ohms for a 12-inch by 12-inch floor area.

B. Submit certified test reports within 10 days of completion of tests.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. No Measurement will be made of the work in this system.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to rooftop access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 34 20 06
GROUNDING AND BONDING FOR TRACTION POWER

PART 1 GENERAL

1.1 DESCRIPTION
A. This specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)
B. This section specifies providing complete grounding and bonding system.

1.2 QUALITY ASSURANCE
A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. National Electrical Code (NEC)
   4. UL 467, Grounding and Bonding Equipment
B. Source Quality Control:
   1. Each item, except for exothermic-welded electrical connections, listed per referenced UL or ITS directory.

1.3 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. 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.

1.4 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

2.1 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. Ground electrode conductors:
      1) Insulated or bare conductor, as shown, in accordance with the following:
         a) Insulated conductor: As specified in Section 34 20 43 for single-conductor cable.
         b) Bare conductor: Section 34 20 43.
      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 NEC Table 250-66.
   b. Equipment grounding conductor:
      1) Sized in accordance with NEC Article 250-122 unless otherwise shown.
      2) Insulated equipment grounding conductor: Single-conductor cable as specified in Section 34 20 43.
      3) Bare equipment grounding conductor integral with multiple-conductor cable: Section 34 20 43.
   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 34 20 43 for single-conductor cable.
         b) Bare conductor: Section 34 20 43.
      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

3.1 GROUNDING

A. Ground connection
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 and manholes, frame columns of bus passenger and bus supervisor shelters and station entrance pylon (type B) 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-inch 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. Switchboardroom.
   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. Bus passenger and supervisor shelters equipped with light fixtures: Provide multiple ground paths as follows:
   a. Bond and ground two separate frame columns of each single or double bus passenger shelter or supervisor shelter to two separate ground rods using 6AWG insulated grounding conductor. Drive 5/8-inch diameter by 10-foot long ground rod with top of rod six inches below finished grade.
   b. Bond and ground each shelter to equipment grounding conductor in branch circuit.
7. Passenger shelter equipped with illuminated diorama and receptacle at station platform: Provide multiple ground paths as follows:
   a. Bond and ground two separate frame columns of each shelter to nearest ground bus in electrical room or sub-bus or to 5/8-inch diameter by 10-foot long ground rod driven so that the top of rod is three inches above finished floor of under platform space using 6AWG insulated grounding conductor unless otherwise shown.
   b. Bond and ground each shelter to equipment grounding conductor in branch circuit.
8. Illuminated diorama, station pylon equipped with light fixtures, map case and telephone enclosure: Provide multiple ground paths as follows:
   a. Bond and ground illuminated diorama frame, column of station pylon equipped with light fixtures, map case and telephone enclosure to nearest ground bus in electrical room or sub-bus or to 5/8-inch diameter by 10-foot long ground rod driven so that the top of rod is three inches above finished floor of under platform space using 6AWG insulated grounding conductor unless otherwise shown.
   b. Bond and ground frame of each illuminated diorama, pylon equipped with light fixture, map case and telephone enclosure to equipment grounding conductor in branch circuit.
9. 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.

10. 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 ½-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.

11. 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 the General and Special Provisions specification. Repair finish of shelter, map case and telephone enclosure and diorama frame to match existing finish.

3.2 BONDING FOR STRAY CURRENT AND CATHODIC PROTECTION

A. Reinforcing Steel in Tunnel, At-Grade and Aerial Sections:
   1. Bond reinforcing steel using 250 MCM, Class G, stranded bare conductor exothermically welded to steel straps as shown, in accordance with Section 03200.

B. Floating-Slab Expansion Joints:
   1. Bond floating-slab expansion joints, using 1/0 AWG, Class G, stranded bare conductor exothermically welded to longitudinal bar.

C. Fabricated Gray-Iron or Ductile-Iron Tunnel-Lining Segments:
   1. Bond gray-iron or ductile-iron segments as shown in accordance with Sections 02415 and 02416.

D. Fabricated Steel Tunnel-Lining Segments:
   1. Bond steel segments as shown in accordance with Sections 02415 and 02417.

E. 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 WMATA Standard Mechanical Specifications.
      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

F. 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.

G. 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.

H. 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.

3.3 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.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. No Measurement will be made of the work in this system.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

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SECTION 34 20 13

WIRE AND CABLE FOR TRACTION POWER

PART 1 GENERAL

1.1 SUMMARY

A. This specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. This section specifies furnishing, installing and testing wire and cable.

C. 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.

D. Related sections include:
   1. 34 20 02 - Basic Materials and Methods for Traction Power
   2. 34 21 20 - DC Switchboard, Stinger System and Controls, DC Pedestal and Wall Mounted Contactor Systems for S&I Shop

1.2 REFERENCES

A. Codes, Regulations, Reference Standards and Specifications:
   1. Codes and regulations of the jurisdictional authorities.
   2. NEC.
   4. IEEE: 383
   5. NEMA: WC7, WC8
   7. UL: 44, 224, 1581, 1569, 1685

1.3 SUBMITTALS

A. Submit the following for approval in accordance with the Special Conditions and with the additional requirements as specified for each:
   1. Shop Drawings: Submit shop drawings for each type of cable in accordance with Section 16051.
   2. Samples: Specified smoke-density test sample will become property of the Authority.
   3. Certification:
      a. 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.
      b. 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.
      c. Certified test reports demonstrating that cable complies with specified requirements and those of referenced ICEA and NEMA Standards.
      d. Certificates from manufacturers verifying that products conform to specified requirements. Include certificate with submittal of shop drawings and with each cable shipment.
1.4 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.

1.5 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

2.1 MATERIALS

A. General Requirements for Single-Conductor and Multiple-Conductor Cable:
   1. Type and size: Type I cable having low smoke-generating characteristics as shown on contract drawings.
   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:
      b. Other cable: ICEA S-68-516, NEMA WC8.
   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 polyethylene (XPLE) or cross-linked polyolefin unless otherwise specified.
   5. Cross-linked polyolefin complying with the following physical requirements. Properties tested in accordance with Part 6 of ICEA S-68-516, NEMA WC8 if ethylene-propylene-rubber (EPR) insulation is used, or with Part 6 of ICEAS-66-524, NEMA WC7 if cross-linked polyethylene insulation is used. Jacket material free of PVC and PVC-based compounds.
      a. Tensile strength, minimum pounds per square inch: 1,800.
      b. Elongation at rupture, minimum percent: 150.
      c. Aging requirement: After 168 hours in air oven test at 100C, plus or minus 1 degree C:
         1) Tensile strength, minimum percentage of unaged value: 100.
         2) Elongation at rupture, minimum percentage of unaged value: 80.
      d. Oil immersion: 18 hours at 121 degree C, plus or minus one degree C, ASTM D471, Table 1, No. 2 oil:
         1) Tensile strength, minimum percentage of unaged value: 80.
         2) Elongation at rupture, minimum percentage of unaged value: 80.
      e. Jacket materials other than cross-linked polyolefin complying with ICEAS-68-516, NEMA WC8. Jacket material free of PVC and PVC-based compounds.

Wire and Cable for Traction Power
   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:
      2) Other conductors: In accordance with paragraphs 3.5.2, 6.27.1 and 6.27.2 of ICEA S-68-516.

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 manufacturer's jacket or insulation identification code or number.
   4. Test values for cross-linked polyolefin 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
         3) Other conductors: In accordance with paragraphs 3.5.2, 6.27.1 and 6.27.2 of ICEA S-68-516

C. 15-kV Single-Conductor Cable:
   1. Rated voltage: 15-kV.
   2. Conductor: As specified and with an extruded semi-conducting strand screen.
   3. Insulation: Ethylene-propylene rubber, 133 percent insulation level, with an extruded semi-conducting insulation screen.
   4. Shield: Copper tape, minimum thickness 2.5 mils.
   5. Jacket: Overall nonmetallic jacket of chlorosulfonated polyethylene or cross-linked polyolefin.
D. 2000-Volt Single-Conductor Cable:
   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. 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 jacket 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.

E. 2000-Volt, Aluminum-Sheathed Multiple-Conductor Cable for Polarity Reference for Tie
   Breaker Stations:
   1. Individual conductors:
      b. Conductor Size: 6 AWG, Class B stranded.
      c. Number of conductors: As shown.
      d. Insulated with ethylene-propylene-rubber, with nonmetallic jacket.
      e. UL-listed as Type RHW-2 or XHHW-2.
      f. Insulation power factor: Two percent maximum.
      g. Bond jacket to insulation to prevent moisture pockets. Minimum peel
         strength of the jacket from insulation: Four pounds per inch width for chlorosulfonated
         polyethylene or cross-linked polyolefin and 10 pound per inch for heavy-duty neoprene.
   2. Conductors assembled with non-wicking, flame-retardant filler to form cable of
      circular cross section.
   3. Metallic-sheath:
      a. Continuous corrugated sheath in accordance with ICEA S-19-81, Table 4- 26A or
         UL 1569.
   4. Jacket: Overall nonmetallic jacket of T-33-655 thermoset type II or cross-linked
      polyolefin.
   5. Cable UL-listed: Type MC, suitable for wet and dry locations.
   6. Color coding:
      a. Individual conductors shall be black.

F. 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.

G. 600-Volt, Nonmetallic Sheathed Multiple-Conductor Cable:
   1. Individual conductors:
      a. Rated voltage: 600 volts.
      b. Number of conductors: As shown.
      c. Construction: Complying with one of the following:
         1) Insulated with ethylene-propylene-rubber, with nonmetallic jacket.
2) Insulated with composite compound of ethylene-propylene-rubber and polyethylene, UL Class EPCV, without outer jacket.
3) Insulated with filled cross-linked polyethylene without outer jacket.

- Phase and neutral conductors: Individually insulated.
- Neutral conductors: Same size as phase conductors.
- Insulated ground conductors: Sized in accordance with the NEC, unless otherwise shown.
- UL-listed as Type RHW-2 or XHHW-2.

2. Conductors assembled with non-wicking, flame-retardant filler to form cable of circular cross section.

3. Multiple-conductor cable provided with overall nonmetallic jacket of T-33-655 thermoset type II or cross-linked polyolefin.

4. Cable UL-listed as follows:
   a. Nonmetallic-sheathed cable: Type TC, suitable for wet and dry locations.

5. Color coding:
   a. Power cables: In accordance with paragraph 200-6, 200-7 and 210-5 of the NEC.
   b. Control cables: In accordance with ICEA S-66-524, Table K-2.

H. 600-Volt, Aluminum-Sheathed Multiple-Conductor Cable (ALS) for connection between ETS and between Junction Box and Type 9 Light Fixture Cabinet and ETS in Tunnels:

1. Individual conductors:
   a. Rated voltage: 600 volts.
   b. Number of conductors: As shown.
   c. Construction: Complying with one of the following:
      1) Insulated with ethylene-propylene-rubber, with nonmetallic jacket.
      2) Insulated with composite compound of ethylene-propylene-rubber and polyethylene, UL Class EPCV, without outer jacket.
      3) Insulated with filled cross-linked polyethylene without outer jacket.
   d. Phase and neutral conductors: Individually insulated.
   e. Neutral conductors: Same size as phase conductors.
   f. Insulated ground conductors: Sized in accordance with the NEC, unless otherwise shown.
   g. UL-listed as Type RHW-2 or XHHW-2.

2. Conductors assembled with non-wicking, flame-retardant filler to form cable of circular cross section.
   a. Metallic-sheath:
   b. Provide continuous corrugated sheath in accordance with ICEA S-19-81, Table 4-26A.

3. Multiple-conductor cables provided with overall non-metallic jacket of T-33-655 thermostat type II or cross-linked polyolefin.

4. Cable UL-listed as follows:
   a. Metallic-sheathed cable: Type MC, suitable for wet and dry locations.

5. Color coding:
   a. In accordance with ICEA S-66-524, Table K-2.
   b. Power cables: In accordance with ICEA S-66-524, Table K-1.

I. Instrumentation Cable: 2/C, twisted pairs:

1. Individual conductors:
   a. Rated voltage: 600 volts.
   b. Number of conductors: As shown.
   c. Construction: Insulated with polyethylene insulation.

2. Conductors twisted and covered with a tinned copper braided shield; Class B stranded.

3. Provided with overall jacket.
J. Bare Conductor: ASTM B3, annealed copper conductor; 8 AWG and larger, Class B stranded.

K. Medium Voltage Cable Terminations:
   1. Except as otherwise specified, heat shrinkable tubing kit type, with grounding accessory kits, in accordance with the characteristics of the medium voltage cable shall be furnished.
      a. Shrinkable tubing kits to be pre-stretched shrinkable tubing and shall contain all necessary components to reinstate cable insulation, metallic shielding/grounding system and overall jacket.

L. 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 State of Virginia (depending on the location), and District of Columbia, depending on the location and bear the seal and signature of the engineer who is responsible for the calculations. Calculations shall be made for all conductors including DC power cable, 15kV cable, and multiconductor control cable 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 Engineer. 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 exiting 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 Engineer for approval. Cable shall not be installed until the contractor receives approval from the Engineer for the pulling calculations and cable installation.
PART 3 EXECUTION

3.1 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 shown. Install UL Type TC multiple-conductor cable in cable trays. Install UL Type MC multiple-conductor cable and ground cable on channel inserts, cable trays or racks, using straps and fasteners as specified in Section 34 20 02 (Basic Materials and Methods). Install UL Type MC multiple-conductor cable in conduit where shown or required. 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, Appendix H of ICEA S-66-524, NEMA WC7 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. Support cable installed in manholes at each invert location with cable brackets, racks and insulators specified in Section 34 20 02 (Basic Materials and Methods). Provide brackets of suitable length with one insulator for each cable.

I. Support traction power cable installed in vertical risers with nonmetallic cable grip support at top of riser and with nonmetallic or aluminum multiple segment wedging plug type cable support at intermediate pull box provided as specified in Section 34 20 02 (Basic Materials and Methods).

J. Where shown or necessary, install cable seal fitting specified in Section 34 20 02 to prevent entry of water into electrical facilities. Where approved, use seal compound specified in Section 34 20 02 (Basic Materials and Methods).

K. Terminate medium voltage cable, using the specified termination kits, in accordance with the manufacturer’s recommendations.

L. The splicing of power and control cables is not permitted in ductbanks, cable troughs or cable trenches. However, if permitted by the Engineer, make watertight splices as approved.

M. The Contractor shall hook up 1000 KCMIL traction power cables at switchgear end and trackside (negative and positive rails) when directed by the Engineer.

N. All 1000 KCMIL cables shall be secured at every rung on the cable tray with tie wraps.

O. Identify cable terminations, feeders, power and control circuits using the following:
1. Cable Tags: Stainless steel tags punched with conduit or cable number as shown.
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 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.

3.2 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. Schedule all tests through the Engineer 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 Engineer. Tests include but not limited to the following:
1. 600-volt non-metallic sheathed 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 1000-volt megger. Insulation resistance: one megohm minimum, corrected to 15.6 C. Testing procedures shall be as follows:
      1) Disconnect all wires of the cable under test at both ends and tape the far end of the wire under test with insulating tape of 600-volt class. Connect the bare end of the wire under test to the positive terminal of 1000-volt megger.
      2) Connect the negative terminal of 1000-volt megger to the nearest available ground terminal.
      3) Measure the insulation resistance of the wire under test by cranking the megger.
   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. 600-volt aluminum sheathed multiple-conductor cable:
   a. Test continuity of each conductor using ohmmeter.
   b. Disconnect the cable under test at both ends. Proof-test insulation resistance between each conductor and the metal sheath. While conducting the test, all conductors of the cable and the metallic sheath other than that under test shall be grounded. Insulation resistance shall be measured with a 1000-volt megger for minimum of one minute between the wire under test and 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.
3. 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.

4. 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.
      9) traction power cables.

5. 2000-volt aluminum-sheathed multiple-conductor cable:
   a. Test continuity of each conductor using ohmmeter.
   b. Disconnect the cable under test at both ends. Proof test insulation resistance between each conductor and the metal sheath. While conducting the test, all conductors of the cable and the metallic sheath other than that under test shall be grounded. Insulation resistance shall be measured with a 2500-
volt megger for minimum of one minute. Insulation resistance: 500 megohms minimum corrected to 15.6 degree C.

   c. When cable shows insulation resistance less than 500 megohms, perform high potential test at 80 percent of factory test voltage or as recommended by cable manufacturer. A gradual decrease of leakage current with time indicates an acceptable cable installation.

6. 15-kV single-conductor cable:
   a. Test continuity of conductors using ohmmeter.
   b. Proof-test insulation resistance between conductor and the metallic shield. While conducting the test, the metal shield shall be tied to ground. Insulation resistance shall be measured with a 2500-volt megger for minimum of one minute. Insulation resistance: 500 megohm minimum corrected to 15.6 degree C.
   c. Submit certified test reports within 10 days after completion of test.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

   A. No Measurement will be made of the work in this system.

4.2 PAYMENTS

   A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 34 20 15

WIRE CONNECTION ACCESSORIES FOR TRACTION POWER

PART 1 GENERAL

1.1 SUMMARY

A. This specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. This section specifies providing wire-connection accessories, such as connectors, terminal lugs and fittings, bundling straps, insulating tape and resin.

1.2 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.
   3. UL: 486A, Wire Connectors and Soldering Lugs for Use With Copper Conductors.

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.

1.3 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.

1.4 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

2.1 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:
   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 x 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 X 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.
      3) Hardness, Shore D: 42, ASTM D2240-00.
      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 x 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.
3) Flammability: Self-extinguishing.

PART 3 EXECUTION

3.1 SPLICE 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.

3.2 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.

3.3 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.
PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. No Measurement will be made of the work in this system.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
PART 1 GENERAL

1.1 DESCRIPTION

A. This specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. This section specifies providing conduit, raceways, cable trays, boxes and cabinets to form raceway and support system for power, communication and control cables.

1.2 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.
   3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum); VE.1, Metallic Cable Tray Systems; TC-2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
   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; 651, Schedule 40 and 80 Rigid PVC Conduit; 884, Underfloor Raceways and Fittings; and 1684, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.


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.

1.3 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. Certifications

1.4 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

2.1 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:
      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:

B. Galvanized-Steel Rigid Conduit and Fittings: UL 6 and ANSI C80.1, zinc coating tested in accordance with reference test in appendix.

C. Plastic Conduit and Fittings:
   1. PVC, UL 651, NEMA TC-2, Schedule 40 and 80 heavy-wall, for use with 90C conductors.
   2. Solvent cement: Manufacturer's standard.

D. Aluminum Rigid Conduit and Fittings:
   1. ANSI C80.5 and UL 6.

E. 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.

F. 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.
      b. For PVC conduit: Rigid metal expansion/deflection fitting with galvanized rigid steel to PVC conduit adapters at each end.
   2. Conduit expansion fitting: Weatherproof.
   4. Metallic fittings equipped with bonding jumper cable to provide electrical continuity.

G. Conduit Connector 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-Seal Fittings:

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.
   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.
         c) Stainless steel in tunnel areas.
      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:
            1) 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.
(2) 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.

(3) Reinforcement:
   (b) Areas subject to vehicular traffic: Deformed steel bars, ASTM A615/A615M-00.

(4) Loading:
   (a) Sidewalk and landscape locations: AASHTO’s SSHB H15-44.
   (b) Areas subject to vehicular traffic: AASHTO’s SSHB H20-44.
   (c) Hardware: Stainless steel.
   (d) 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:

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Values</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength</td>
<td>11,000 psi</td>
<td>ASTM C109</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>1,700 psi</td>
<td>ASTM D638</td>
</tr>
<tr>
<td>Flexural strength</td>
<td>7,500 psi</td>
<td>ASTM D790</td>
</tr>
<tr>
<td>Water Absorption (24 hours)</td>
<td>0.5 percent</td>
<td>ASTM D570</td>
</tr>
</tbody>
</table>

(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
   (c) 0.5 coefficient of friction.
   (d) Metro Type “B” logo with 3-1/8 inch by 4-inch envelope and service designation recessed in center of cover.
   (e) Secured to box with bolts.
   (f) Non-protruding provisions provided for lifting.

(3) Loading:
   (a) Sidewalk and landscape locations: AASHTO’s SSHB H15-44.
   (b) Areas subject to vehicular traffic: AASHTO’s SSHB H20-44.

(4) Hardware: Stainless steel.

(5) 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

<table>
<thead>
<tr>
<th>Properties</th>
<th>Values</th>
<th>Method</th>
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</thead>
<tbody>
<tr>
<td>Flexural strength</td>
<td>17,000 psi</td>
<td>ASTM D790</td>
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<tr>
<td>Deflection temperature</td>
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<td>ASTM D648</td>
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<tr>
<td>Water absorption (24 hours)</td>
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<td>ASTM D570</td>
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<tr>
<td>Tensile strength</td>
<td>6,500 psi</td>
<td>ASTM D638</td>
</tr>
<tr>
<td>Specific gravity</td>
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<td>ASTM D794</td>
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<td>Flammability</td>
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<td>UL 94</td>
</tr>
<tr>
<td>Dielectric strength</td>
<td>400 volts per mil</td>
<td>ASTM D149</td>
</tr>
<tr>
<td>Arc resistance</td>
<td>180 seconds</td>
<td>ASTM D495</td>
</tr>
</tbody>
</table>

(1) 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.

(2) 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.
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.
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.
   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 SCHT5, 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:
   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

3.1 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 34 20 06.
   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 34.5 kv incoming-service cable with concentric neutral, install cable seal in traction-power substations, ac-switchboard rooms and 34.5 kv utility company manholes adjacent to WMATA facilities in accordance with the following requirements:
      1) Do all work in coordination with a utility company representative.
      2) Install O-Z CSBI cable seal at each end of the conduit for the service entrance cables (one at the last utility company manhole and one at the WMATA facility entrance). Use torque recommended by manufacturer for this type of cable seal, do not over-torque.
   d. 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.
   e. In empty conduit installed for future use, install blank cable seal inside conduit to prevent seepage of water.
   f. 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:

<table>
<thead>
<tr>
<th>Size of Conduit (in inches)</th>
<th>Minimum Radius of Factory-Bend (in inches)</th>
<th>Minimum Radius of Field-Bend (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>30</td>
</tr>
</tbody>
</table>
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 underplatform 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

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.
3.2 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 WMATA standard requirements.

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 WMATA standard requirements.

C. Close unused openings or spaces in floors, walls and ceilings. Plug or cap unused conduit and sleeves.

3.3 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.

3.4 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.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. No Measurement will be made of the work in this system.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be
considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 34 20 43

WIRE, CABLE AND BUSWAYS FOR TRACTION POWER

PART 1 GENERAL

1.1 SUMMARY

A. This specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. This section specifies providing wire, cable and busways.

C. Definitions:
   1. Cable: Cable having low smoke generating characteristics.

D. Requirements for single-conductor cable and for multiple-conductor cable as stated except
   as otherwise specified.

E. Related Work Specified Elsewhere:
   1. 34 20 15 - Wire connection accessories
   2. 34 20 33 - Raceways, boxes and cabinets

1.2 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.
   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.
      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 Thermostet-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.
      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.

1.3 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. Samples:
      a. Smoke-density test sample for jacket material: Specified sample will become property of the Authority.
   3. Certification:
      a. 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.
      b. 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.
      c. Certified test reports demonstrating that cable complies with specified requirements and those of referenced ICEA Standards. Submit test reports prior to cable shipments.
      d. Certificates from manufacturers verifying that products conform to specified requirements. Include certificate with submittal of shop drawings and with each cable shipment.

1.4 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

2.1 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:
   5. Non-metallic jacket for single-conductor cable and an overall covering on multiple-conductor cable:
      a. Chlorosulfonated polyethylene or cross-linked polyolefin.
b. Cross-linked polyolefin complying with the following physical requirements. Properties tested 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 if ethylene-propylene-rubber (EPR) insulation is used, or with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692 if cross-linked polyethylene insulation is used. 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. Flame retardancy: Single-conductor and multiple-conductor cable tested by independent agency demonstrating flame retardancy in accordance with the following:


b. Single-conductor cable, size 1/0 AWG and larger, passing vertical tray flame test, using ribbon gas burner in accordance with IEEE 1202 or IEEE 383. Cable size for testing: 1/0 AWG.

c. Multiple conductor cable passing vertical tray flame test using ribbon gas burner in accordance with IEEE 383 or IEEE 1202. Cable size for testing: 7/C or 9/C with No. 12 AWG or No. 14 AWG conductors.

7. 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.

a. Conduct tests on specimens of overall jacket material for multiple-conductor cable and of jacket material for single-conductor cable.

b. 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.

1) Prior to testing, submit six-inch square portion of each specimen. Tag sample with manufacturer’s jacket or insulation identification code or number.

c. Test values for chlorosulfonated polyethylene not to exceed the following:
   1) Flaming mode:
      a) Uncorrected maximum specific optical density during first four minutes of test: 325.
      b) Uncorrected maximum specific optical density for entire 20-minute test: 400.
   2) Nonflaming mode:
      a) Uncorrected maximum specific optical density during first four minutes of test: 325.
      b) Uncorrected maximum specific optical density for entire 20-minute test: 480.

d. Test values for cross-linked polyolefin not to exceed the following:
1) Flaming mode:
   a) Uncorrected maximum specific optical density during first four minutes of test: 150.
   b) Uncorrected maximum specific optical density for entire 20-minute test: 300.

2) Nonflaming mode:
   a) Uncorrected maximum specific optical density during first four minutes of test: 150.
   b) Uncorrected maximum specific optical density for entire 20-minute test: 300.

8. 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:

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 ICEAS-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692.
            a) 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.

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.
   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.
   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.
   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

3.1 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 34 20 33. 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.


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 General and Special Provisions. 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 34 20 33 to prevent entry of water into electrical facilities. Where approved, use seal compound specified in Section 34 20 33.

3.2 IDENTIFICATION

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.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

   A. No Measurement will be made of the work in this system.

4.2 PAYMENTS

   A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

END OF SECTION
SECTION 34 21 19.16

METAL-ENCLOSED DC SWITCHGEAR FOR TRACTION POWER

PART 1 GENERAL

1.1 SUMMARY

A. This specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. This section includes furnishing, delivering and installing 700 Volt DC switchgear and spare parts.

C. Related Sections:
   1. 34 20 06 – Grounding and Bonding for Traction Power
   2. 34 20 13 – Wire and Cable for Traction Power
   3. 34 20 15 – Wire Connection Accessories for Traction Power
   4. 34 20 33 – Raceways, Boxes and Cabinets for Traction Power
   5. 34 20 43 – Wire, Cable and Busways for Traction Power
   6. 34 21 20 – DC Switchboard, Stinger System and Controls, DC Pedestal and Wall Mounted Contactor Systems for S&I Shop

D. Compensation for work specified in this section related to equipment will be made in the manner of Lump Sum. In addition, other payment as described below will be paid on a unit basis. (See PART 4 Measurement and Payment, for project specific payment schedule)
   1. 750 Volt DC Cathode Circuit Breaker removable element, 6,000 amps: Each
   2. 750 Volt DC Cathode Circuit Breaker removable element, 8,000 amps: Each
   3. 750 Volt DC Feeder Circuit Breaker removable element, 6,000 amps: Each
   4. 750 Volt DC Positive/Negative Tie Circuit Breaker removable element, 8,000 amps: Each

E. Compensation for work specified in section associated with installation will be made in the following manner (See PART 4 Measurement and Payment, for project specific payment schedule):
   1. Included in the lump sum installation cost of each traction power substation and tie-breaker station.

1.2 REFERENCES

A. Codes, Regulations, Reference Standards and Specifications:
   1. Codes and regulations of jurisdictional authorities
   2. NEC, NECS.C2
   3. NEMA: CC1
   4. ANSI/IEEE: C37.100, C37.14, C37.16, C37.16a, C37.17, C37.20.1, C39.1, Z55.1
   5. ASTM: B187
   6. AHA: IS1
   7. ISO: 9001

1.3 SYSTEM DESCRIPTION

A. Design Criteria
   1. Floor loading: Compatible with floor design loading of 250 pounds per square foot.
2. Switchgear suitable for anchoring to a concrete floor steel float finished to tolerance level of 1/8 inch in 10 feet and covered with insulating topping material.

3. Numbers, types and arrangements of switchgear units as shown on contract drawings.

4. Switchgear design shall be provided with the cable shield monitoring systems, suitable for installation of shielded feeder cables, including termination of cable shields and feeder conductors in the switchgear cubicles.

1.4 SUBMITTALS

A. Submit the following for approval in accordance with Special Conditions and with the additional requirements as specified for each:

1. Shop Drawings: In accordance with WMATA standard requirements.

2. Certification:
   a. Design Tests reports or certified copies of test reports for identical units performed for each type and rating of switchgear and circuit breaker as assembled in its complete switchgear unit, furnished under this contract. Test shall have been conducted not more than four (4) years prior to submittal to the Authority. Certified test reports shall be certified by an independent ANSI certified factory in the USA.
   b. Certified test reports for specified factory production testing.
   c. Certificates from manufacturer verifying that equipment conforms to the specified requirements.
   d. Certify switchgear complies with floor design loading of 250 pounds per square foot.

3. Documentation:
   a. Short-circuit calculations and system coordination study in accordance with WMATA standard requirements.

4. Operations, Maintenance Manuals and PMI: In accordance with the following:
   a. Preventive Maintenance Instruction (PMI) The O &M Manual provided for contractually furnished or installed equipment shall include a “Preventive Maintenance Instruction” (PMI) section, to ensure the continued safe and reliable operation of the specific system or equipment. This section of the manual shall contain the manufacturers and/or installer’s recommended procedures for periodic inspection and maintenance of the equipment. Training on these procedures shall be included in the contractor provided maintainer training curriculum. If the section contains more than one PMI procedure the section shall begin with a Table of Contents. The PMI procedures shall be written in language easily understood by every maintainer skill level of the responsible WMATA maintenance discipline. Prior to acceptance, clarity and effectiveness of each PMI procedure shall be demonstrated in coordination with the maintenance discipline using the recommended minimum number of the lowest skill level maintainers. The maintenance team or individual must be able to understand and successfully perform the draft PMI without coaching from contractors or engineers. Each procedure shall be formatted similar to standard PMI formatting as currently approved by the Authority Representative maintenance discipline responsible for future maintenance of the equipment, including a standard approval signature cover sheet. Sample PMI’s, as formatting examples, may be obtained from the appropriate maintenance discipline after contract award. Each procedure shall contain:
      1) A recommended performance frequency (interval) that is adjusted to the installed environment and expected level of use the maintenance crew size and average time for performance of the PMI the system -specific and/or equipment-specific objectives of the PMI lists of:
         a) Prerequisites.
b) Required reference documents.
c) Industry standards or regulations governing the performance of the maintenance action.
d) Necessary tools and test equipment.
e) Definitions and graphics, as much as practical to clarify instructions Warnings, Cautions and Safety Notices, plentifully and prominently interspersed to prevent injury, damage or unsafe operating conditions before any procedure step to which they apply.
g) Data-sheets and check-lists, for data collection regarding conditions that are measured and to ensure that important steps are not skipped.
h) Step-by-step instructions to verify and document that all safety features of the equipment or circuit are operational, functioning properly and are not being defeated or compromised.
i) Step-by-step instructions to verify and document that the tested mechanism or circuit or subsystem functions within design parameters.
j) Step-by-step instructions, types of solvents, cleansers and lubricants with intervals for lubrication and cleaning of mechanisms to prevent or minimize grime, corrosion and wear.
k) Step-by-step instructions to verify the adjustment of the system, equipment or circuit which will allow it to operate properly (safely, reliably and without causing excessive wear) until the next scheduled PMI.
l) Step-by-step instructions to verify the integrity of all fasteners, couplings, electrical connections, etc. which may fail or loosen between scheduled maintenance intervals.
m) Step-by-step instructions to document the measured condition of the equipment or circuit, to be used for abatement of deterioration, future failure analyses and in case of catastrophe.
n) Step-by-step detailed adjustment instructions for any mechanism or circuit found to be out-of-adjustment.

5. Spare Parts List

1.5 QUALITY ASSURANCE

A. Qualification: Select a manufacturer/installation contractor who is regularly engaged in production of similar switchgear and has demonstrated a successful record of providing/installing equipment of similar type and rating for extra heavy duty traction service for at least five similar projects. The equipment manufacturer will be required to submit documentation to support these qualifications as part of the Pre-Award process. The equipment manufacturer shall have as a minimum ISO 9001 certification.

B. For Codes, Regulations, Reference Standards and Specifications, refer to Article 1.02 above.

C. Factory Testing: Submit test plans and procedures for all production tests and scheduled test date for approval at least 30 working days in advance of scheduled test dates. No test results will be accepted prior to receipt and approval of test plans and procedures. Factory test requirements are as follows:
1. Circuit breaker design and production tests in accordance with the latest edition of ANSI/IEEE C 37.14, ANSI/C 37.16/16a, including the following as applicable:
2. Design tests:
   a. Sequence 1:
      1) Short-time current test.
      2) Continuous current test.
      3) Load (low) current switching tests.
b. Sequence 2:
1) Trip device calibration check test.
2) AC dielectric withstand test
3) Peak current test.
4) Short-circuit current test.
5) Trip device calibration check test.
6) AC dielectric withstand test at 60%.
c. Production tests shall include the following:
1) Calibration test.
2) Control, secondary wiring, and device check
3) Dielectric withstand voltage test.
4) No-load operation test.

3. Switchgear assembly tests: Table of compliance for these requirements shall be included, with all laboratory test data, photographs, etc. provided as attachments. For any tests conducted after contract award, notify the Authority Representative prior to testing to allow witnessing of tests. The following tests are required in accordance with the requirements of ANSI C37.20.1.
   a. Design Tests:
      1) Dielectric tests.
      2) Rated continuous current test.
      3) Momentary current tests.
      4) Mechanical endurance tests.
      5) Rod entry test.
      6) Flame resistance tests for applied insulation.
      7) Short time current withstand test.
      8) Paint qualification test.
      9) Short circuit current withstand test.
   b. Notify the Engineer not less than 21 days prior to factory testing to allow witnessing of tests.
   c. Production Tests: All tests in accordance with requirements of ANSI C37.20.1
   d. Control wiring tests:
      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 60 Hertz to ground for one minute.
      3) Verify that wiring is in accordance with manufacturer's wiring diagrams.
      4) Check wiring complete, including interconnections at, shipping breaks.

D. Major Components: Products of the same manufacturer.

E. Components, Limit Switches, Relays, Assemblies and Sub-assemblies: All shall be listed or labeled and be rated for utility or heavy-duty industrial use. All components that are not Listed shall be identified as NOT LISTED in the parts list submitted for approval prior to manufacture. The Authority may direct the manufacturer to use an alternative that is Listed if another comparable Listed device is available.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Equipment for each facility shall be delivered after its completion and in accordance with the facility access dates in Special Condition and shall be coordinated with the Engineer.
B. Ship each unit securely packaged, braced and labeled for safe handling in shipment and to avoid damage or distortion.

C. Temporary Bracing: Where necessary, brace switchgear for hoisting, lowering and skidding into position. Label temporary internal bracing: 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 impact record chart with manufacturer’s instructions for disposition of damaged material.

E. 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 dimension of doors and access hatches to ensure shipping dimension 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.
   5. For shipping split, interconnecting wiring coiled on one side of the shipping split with matching terminal block on other side of split. Wiring and terminal block points identified for reconnection.

F. Store switchgear in secure and dry storage facility.

G. Temporary Bracing: Where necessary, brace switchgear for hoisting, lowering and skidding into position.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The switchgear shall be manufactured by one of the following or equal:
   a. English Electric
   b. Whipp & Bourne
   c. Control Power Corporation

2.2 EQUIPMENT

A. DC Switchgear: metal-enclosure, drawout power circuit breaker switchgear in accordance with the following:
   1. The switchgear shall be manufactured in accordance with specified standards and shall have latest ANSI/NEMA/IEEE certification as applicable, prior to award of contract.
   2. NEMA SG5 and ANSI C37.20.1 for indoor use.

B. Ratings:
   1. Maximum voltage: 800 Volts DC.
   2. Rated voltage: 750 Volts DC.
   3. Power frequency withstand: 4.2 kV, rms.

C. Insulation structure:
D. Power circuit breakers:

1. NEMA SG 5, ANSI/IEEE C37.14, ANSI C37.16/16a, C 37.17, single-pole, single-throw, air break, draw out type, high-speed, 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 C 37.16a and with the following additional requirements. For the purpose 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. Rated voltage: 750 Volts DC.
   b. Rated maximum voltage: 800 Volts DC.
   c. Insulation dielectric withstand: 4200 Volts DC.
   d. Continuous Current ratings:
      1) Cathode circuit breaker: 8,000 Amperes, DC, as indicated, capable of carrying the rated overloads corresponding to 3000kW extra heavy duty traction rated silicon rectifier.
      2) Feeder circuit breaker: 6000 ampere DC, as indicated.
      3) Positive and Negative Bus Tie Breakers: Ampere ratings, 8000 ampere
   e. Short-circuit interrupting capacity: 200kA. In addition, feeder breakers high-speed, capable of interrupting the theoretical maximum fault current supplied from silicon rectifier units with a total capacity of 9000 kW. Cathode circuit breakers complying with rated peak current and short-time current ratings in Table 11, ANSI C 37.16a.
   f. Operation counter: Non-resettable with at least four digits for recording trip operations.
   g. Endurance: Electrical and mechanical endurance performance not less than requirements in ANSI C 37.16/16a.
   h. Control voltage:
      1) 125 Volts DC nominal, individually fused
      2) Upon loss of control voltage, a DC feeder circuit breaker shall automatically open. The under voltage release mechanism shall be designed and rated to operate at 135V DC without overheating.
   i. 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. By rotating the racking mechanism clockwise the breaker moves toward the connected position and when in the fully racked-in connected position the racking mechanism turns freely. Rotating counterclockwise the breaker will withdraw from the connected to the test and then to the disconnected position. Use of electro-mechanical toggle device for racking mechanisms shall not be permitted. With connected, test and disconnected positions; manually operated closed-door mechanism by preventing over travel, guides for alignment of breaker with stationary unit and an indicator to show breaker position within the compartment; racking mechanism gear ratio shall be designed in combination with design of shutters covering main stationary disconnect, such that shutters can withstand the force of racking mechanism if shutters fail to open as breaker is racked in.
      1) Connected position: Both primary disconnect device and secondary disconnect device in full contact, breaker ready for normal operation.
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2) Test position: Primary disconnect device open and separated by a safe distance, secondary disconnect device in full contact.

3) Disconnected position: Both primary disconnect device and secondary disconnect device open and separated by a safe distance.

j. 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) Automatic shutters constructed to withstand force of racking mechanism in case shutters fail to open when breaker is racked into connected position or shutter opening visible as breaker is racked into position.

k. 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.

l. 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.

m. 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 mechanism coil capable of operation from 90-140 Volts DC.
      b) Tripping by means of tripping mechanism 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.

n. Arc chute: Provided to house the main contacts, confine and direct opening arcs until extinguished. 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. Ceramic plates are not permitted. Proper extinguishing devices 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 will 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.

o. Main contacts: Surfaced with silver, non-welding silver alloy or equivalent combining high conductivity and necessary arc-resistant properties.

p. For moving circuit breaker element in and out of cubicle: Breaker carriage mounted on wheels and shall not require use of lifting device.
q. Removable elements for the same type and rating completely interchangeable. Removable element of different type or rating not interchangeable.

E. Space heater
1. Each unit of switchgear provided with 120 Volt, single phase, 60 Hertz heating element to facilitate drying and prevent condensation.
2. Heaters enclosed in grill guards with no sharp edges and located so that they are easily accessible for replacement without de-energization of switchgear bus and not located close to any equipment which may be adversely affected by their heat.
3. Heaters thermostatically controlled. Thermostat adjustable from 40 degree F to 80 degree F. Thermostat set in accordance with manufacturer's recommendation. Panel ammeter approximately 2-1/2 inches square, marked to indicate heater load.
4. Provide ungrounded 120 V AC power circuit from an Isolation Transformer to supply heaters within the DC switchgear assemblies.

F. Positive Bus Bars:
1. General requirements:
   a. ASTM B187, 98% conductivity bare copper.
   b. Voltage rating: 1,000 Volts.
   c. Continuous current rating: As shown on drawing.
      1) Size sufficient to carry the overloads specified for the silicon rectifiers without exceeding the allowable temperature rise specified in ANSI and NEMA standards. Maximum current density of 800 amperes per square inch.
   d. Capable of withstanding mechanical stresses and heat due to maximum short-circuit current.
   e. Bus contact surface silver-plated or tin-plated at connection.
   f. Each joint having impedance not more than that of bus bar of same length, clamped to maintain that impedance throughout life of equipment and treated to prevent corrosion.
   g. All connections to bus made with cadmium plated, galvanized or similarly coated, high strength steel bolts of sufficient number and size to provide solidly bolted connections. Mounted on barrier type insulation or post type insulators of sufficient strength to withstand without damage or permanent distortion all stresses produced by short-circuit current equal to the interrupting rating of the circuit breakers.
   h. The bus shall be mounted on barrier type insulation or post type insulators of sufficient strength to withstand without damage or permanent distortion all stresses produced by short-circuit current equal to the interrupting rating of the circuit breakers.

G. Control Buses:
1. Switchgear control bus:
   a. 125 Volt ungrounded DC bus; copper, #6 AWG minimum with 600 Volt insulation extending the full length of the switchgear assembly. Terminated on a terminal blocks and marked in each cubicle for connection to individual cubicle for connection to supply source.
   b. One two-pole knife switch provided in each switchgear cubicle for disconnecting the control circuit of associated breaker only.
   c. UL Class J fuses used for control and auxiliary service protection.
   d. Separate fuses in the closing and tripping circuits of each breaker.
2. Switchgear negative bus:
   a. 1,000 - Volt DC, copper bus, insulated #6 AWG minimum wire, extended the full length of the switchgear assembly. The bus shall be terminated on terminal
blocks in each cubicle for connection to individual cubicle control and metering functions.

b. Substation: Extended the full length of the switchgear assembly and terminated on a terminal block for connection to the Drainage and Negative Switchboard.

c. Tie Breaker Station: #6 AWG minimum. Extend negative buses and terminate on terminal blocks for connection to the impedance bond on both trackside.

d. Tapped at each circuit breaker unit and extended to the load measuring circuit.

H. Enclosure:

1. Dead-front, free-standing, indoor ventilated steel enclosure, high resistance grounded and provided with suitable hardware for insulated anchoring to a concrete floor which has been steel float finished to a tolerance of 1/8 inch in ten feet and covered with an insulating topping

2. 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. Reinforced as required to form a rigid self-supporting structure. All sheet-metal shall be 11-gauge minimum and each cubicle shall have edges formed by appropriate metal brake tooling with joints welded and grounded smooth and having insulated edges. The bottom of the cubicle shall be 1/8" steel plate provided with ½ inch steel angle minimum guide the wheels of the circuit breaker carriage.

3. Designed to allow adequate clearance to ground and dissipation of ionized gases from the breaker arc chutes without hazard to personnel or possibility of establishing a conducting path to grounded structure or objects when interrupting rated short circuit current at rated maximum voltage. Include adequate provisions for release of gases from the units by means of suitable stacks, louvered vent openings or vent opening covered with grilles and arranged in such a way that hot gases or other materials cannot be discharged in a manner hazardous to personnel. Ventilation openings on top are not permitted.

4. Switchgear cubicles and circuit breaker compartment equipped with hinged front and rear doors with suitable handle, latch and doorstop.

5. Each power circuit breaker in separate metal-enclosed compartment with a minimum of 24 inches wide, equipped with stationary disconnect device contacts and carriage with integral wheels to permit withdrawal without use of additional lifting device.

6. Circuit breaker compartment door designed not to hinder movement of breaker in and out of compartment when door is open and doorstop set. Capable of being closed with breaker in test or disconnected position.

7. Circuit breaker compartment to provide for interchangeability of removable elements within frames of same size and operating characteristics.

8. Barriers with removable cover plates to separate ionized gases.

9. Control panels: Dead-front, hinged swinging panels mounted on the switchgear frame.

a. Support flush and semi-flush devices without distortion from plane surface in any position.

b. Supported by hinges allowing the panel to swing open to provide free access to the equipment and wiring behind the panel.

c. Secured in the closed position by captive wing-headed bolts, captive knurled knobs or other captive devices capable of being tightened or loosened by hand.

d. Equipped with door stop to prevent damage to equipment due to overswing of the panel.

10. Mechanical and electrical interlocks:

a. Prevent moving the circuit breaker in or out of the connected position with main contacts closed.

b. Prevent closing the circuit breaker mechanically unless the breaker is in the test or disconnected position.
c. Prevent closing the circuit breaker electrically unless the breaker is in the connected position and the compartment door fully closed and latched, or in the test position.
d. Mechanical or electrical interlock to prevent opening the compartment door when the circuit breaker is closed in the connected position.
e. Prevent racking in or out with the charging spring in charged position.

11. Key interlocks:
a. Prevent the cathode circuit breaker closing unless the rectifier anode disconnect switch is closed.
b. Prevent operation of the rectifier anode disconnect switch unless the cathode circuit breaker is open.

12. Finish: Metallic surfaces degreased, primed and finished with light gray enamel, Color No. 61 ANSI Z55.1 in accordance with referenced standard.

13. Cathode bus duct entrance: Provisions for connecting cathode bus to the cathode circuit breaker compartment through a bus duct section insulated to an insulation level of 2000 Volts.

14. Feeder cable connections: Provisions for support and termination of the number of feeder cables, entering from the switchgear top, specified in Section 16051 Table III. Feeder cable terminal connectors: NEMA CC 1, long barrel, double indentation type with two hole contact pad for copper conductors.

I. Protective devices and metering

1. Furnish and connect meter, instrument and relay circuits in accordance with the One Line Diagram.

2. Provide additional components such as auxiliary relays, isolating diodes and similar devices not shown but required for complete installation.

3. Semi-flush mounted, plumb and square, on the control panel. Arranged in a neat, modular and logical order and readily accessible and easily visible. Cases finished in dull black. Devices of the same general type manufactured by the same company.

4. Lockout relay: Rotary, hand-reset, 125 Volt DC, equipped with green light for indicating reset position. Wired to trip and lockout all cathode and feeder circuit breakers.

5. Enclosure ground detection system: To monitor enclosure insulation, as manufactured by SMC, type Swartz relays or equal as follows:
   a. A high resistance ground relay, connected between the DC switchgear enclosure and ground and to detect any accidental grounding of the DC switchgear metal enclosure, with auxiliary contacts to permit initiation of a local annunciator and fail-safe so that if its own circuit should malfunction, an annunciation is initiated (Device 64Y).
   b. A hot structure ground relay, connected between the DC switchgear enclosure and ground to detect any part of the DC switchgear metal enclosure which may become energized in the event of a fault between the enclosure and any of the current carrying components, with auxiliary contacts connected to the DC switchgear lock-out relay to initiate tripping and lock-out of the dc circuit breakers in the switchgear and to initiate a local annunciator and fail-safe so that if its own circuit should malfunction, an annunciation is initiated. (Device 64D). The 64D circuitry should be designed to prevent the tripping and lock-out of the DC breakers in presence of transient voltage or induced voltage of milliseconds duration on the DC switchgear enclosure.
   c. Power Requirements: 125 VDC ± 10%

6. Cathode circuit breaker metering: DC ammeter, ANSI C39.1 and C12, switchboard type with 250 or 270 degree scale with one percent accuracy complete with ammeter shunt and zero to 20,000 Ampere scales, for 8000 Ampere breakers respectively with additional requirements as specified for high voltage switchgear meters. Provide current limiting fuses at the connection to shunt.
7. Feeder circuit breaker metering: DC ammeter, ANSI 39.1 and C21, switchboard type with one percent accuracy complete with ammeter shunt. With 15,000-0-15,000 Ampere scale, for 6000 Ampere breakers with additional requirements as specified for high voltage switchgear meters. Provide current limiting fuses at the connection to shunt.

8. Bus voltage metering: One DC voltmeter, ANSI C 39.1 and C12, switchboard type with 250 or 270 degree scale with one percent accuracy complete with zero to 1000 Volt scale with current limiting fuses for each 750 Volt DC positive bus.

9. Cathode circuit breaker equipped with reverse current trip device: Provided to trip the breaker in the event the current reverses. Reverse current series trip device range 500-2000A (Device 32).

10. Cathode circuit breaker forward current trip device: Provided and coordinated with dc feeder breakers to trip the breaker upon failure of any feeder breaker to clear a fault (Device 76).

11. Feeder breaker automatic reclosing equipment (including gap breaker): Provided for each main line feeder circuit breaker and including voltage divider type load measuring relay (Device 182), load measuring resistors, adjustable time delay reclosing relay (Device 183), time delay relays, counters and other devices required to perform the following functions; all assembled in a separate, isolated plug-in housing within the breaker cubicle. All equipment, except load measuring resistor, shall be panel-mounted as draw-out units for ease of removal.

12. Feeder breaker and bus tie breaker series trip device: Direct acting, direct release, forward and reverse (bi-directional), series trip device adjustable between 200% and 400% of circuit breaker continuous current rating. Provided for each feeder circuit
breaker and bus-tie breaker. Use of control power to accomplish series tripping shall not be permitted. (Device 176).

13. Each feeder and gap breaker shall be equipped with a Rate-of-rise trip device (Device 150) equal to Swartz type 176/150 relays for feeder circuit breakers. The rate-of-rise current detection system shall be as manufacture by SM C Electrical Products or approved equal. Multi-function relays shall be acceptable. Additional requirements as follows:
   a. Includes rate of rise sensing circuitry, adjustable rate of rise trip level, adjustable time delay trip and a flag or indicator lamp to verify operation.
   b. Designed to detect remote short circuit and initiate breaker tripping if the magnitude of short circuit current is below the setting of the breaker direct acting series overcurrent trip device. Capable of discriminating between remote short circuits and train accelerating inrush and insensitive to transients. Make rate of rise trip device connections through a fused disconnect to a DC current shunt with appropriate device rating.

14. Surge arrestors for each feeder circuit breaker: DC surge arrester, metal-oxide type suitable for DC transit system distribution, rated 1000 volts maximum permissible line to ground DC voltage and 970 volts DC maximum continuous operating voltage. DC surge arrestors shall be enclosed in a fiberglass enclosures with visible windows, base insulated from switchgear enclosure, the discharge (ground) cable connected to the station ground shall be in a fiberglass conduit.

15. Shunt/Isolation/Amplifier (Voltage Transducer): Provide one voltage transducer in the DC switchgear at each substation. The shunt amplifier shall be a linear amplifier designed to amplify DC shunt millivolt signals. The input shall be from 0-1,000 volt and output shall be 1 milliamp. Provide complete isolation of the input signal. A magnetic amplifier shall be used in the input circuit to isolate the inputs from all other circuits and grounds. The input shall be tested at 4,000 Volts DC for one minute to insure that no breakdown will occur when connected to shunts operating at high voltage above ground. The output shall be a hybrid amplifier operating in the transconductance mode to provide a constant current output. Load resistance variations from 0-10K shall have less than 0.1% effect on the output current to make the amplifier an ideal device for telemetering, scaling and recording applications. The output should be filtered.
   a. A variation resistor from zero to maximum gain adjustment shall be provided and be accessible through the top cover. Large gain changes should be accomplished by changing the auxiliary gain resistor.
   1) Power Requirements 125 VDC + 10% 10 VA (Max)
   2) Input Impedance 5000 ohms/Volt
   3) Load Impedance Any load between 0-10K
   4) Accuracy +0.5% RO @ 25°C
   5) Temperature Range -10°C to +70°C
   6) Temperature Coefficient + 0.04% °C
   b. The transducer shall be compatible with the rating of the DC switchgear Contract.
   c. The Shunt/Isolation/Amplifier shall be SWARTZ type or equal.

16. Shunt/Isolation/Amplifier (Current Transducer): Provide in each substation switchgear a current transducer for each of the cathode breakers as shown. The shunt amplifier shall be a linear amplifier designed to amplify DC shunt milliamp signals. The input shall be 50mV rated at 20,000 Amps for 8,000 Amps Cathode breaker with 1 milliamp output.
   a. Provide complete isolation of the input signal. A magnetic amplifier shall be used in the input circuit to isolate the inputs from all other circuits and grounds. The input shall be tested at 4,000 Volts DC for one minute to insure that no breakdown will occur when connected to shunts operating at high voltage above ground. The output shall be a hybrid amplifier operating in the transconductance
mode to provide a consistent current output. Load resistance variations from 0-10K shall have less than 0.1% effect on the output current to make the amplifier an ideal device for telemetering, scaling and recording applications. The output should be filtered.

b. A variable resistor from zero to maximum gain adjustment shall be provided and be accessible through the top cover. Large gain changes should be accomplished by changing the auxiliary gain resistor.

1) Power Requirements: 125VDC + 10% 10VA (Max)
2) Input Impedance: 5000 ohms/Volt
3) Load Impedance: Any load between 0-10K
4) Accuracy: +0.5% R O @ 25°C
5) Temperature Range: -10°C to +70°C
6) Temperature Coefficient: +0.04% / °C

17. DC Watt Transducer: Provide in each substation DC switchgear a DC Watt Transducer for each of the cathode breakers as shown. The DC Watt transducer shall be able to measure direct current watts. The transducer shall be able to convert Digilologic Transducer Input Circuits to accept direct currents. The current input can be direct from a 50mV or 100mV internal shunt. The line-to-line voltage input shall be made for an internal multiplier resistance box for voltages from 600 VDC to 2,000 VDC.

a. Potential Input Nominal: 100 VDC to 2,000 VDC, for inputs above 600VDC, an external Multiplier Resistance Box should be supplied.

b. Overload: Rated Voltage +20

c. Burden: 200 ohms/Volt Nominal
d. Current Input: From External 50mV source.
e. Nominal: 100mV shunt
f. Overload: 5 VDC maximum
g. Burden: 10.0 mA maximum
h. Auxiliary Power: 125 VDC +10%, 6 Watts
i. Dielectric Withstand: 4,000 VDC for 1 second
j. Temperature Operating Range: -20°C to +80°C
1) Effects on Accuracy: +0.15% / °C
k. Storage: -40°C to +80°C
l. Accuracy: +0.5% of Rated Output for 100 mV Shunt
m. Output: 0-1 mA DC into 0-10,000 ohms

18. Transducer inputs to RTU: Current, voltage and watt transducer-outputs shall be identified on terminals for connection to analog input modules on DTS /RTU I/O modules.

19. Bus Meter: 0-1000 Volts + 1%

J. Control and Indication:

1. Control switch: Provided on each circuit breaker for electrical closing and tripping of the breaker.
2. Local-Remote selector switch: Provided on each circuit breaker for transferring control from the local control switch to the remote control system.
3. Indicating lights: LED panel indicator lamp, General Electric Company Type ET-16 or equal provided on each circuit breaker as follows:
   b. Green: Breaker open.
   c. White: Selector switch in local position.
K. Emergency tripping: Means provided on each feeder circuit breaker to electrically trip the breaker from a remote emergency trip system, when the breaker is in the connected position, regardless of Local-Remote selector switch position. The emergency tripping circuits shall be independent and isolated from other tripping circuits of the circuit breakers. Emergency Trip System activation shall be monitored at the TPSS, TBS Annunciator Panel and MOC (via DTS).

L. Loss of control power: Means provided on each feeder circuit breaker to automatically trip the breaker on loss of control power. A separate relay shall be provided to monitor loss of control power and provide 2NO and 2NC contacts for connection to annunciator panel.

M. Acceleration gap feeder circuit breaker control: Automatically trips when either adjacent contact rail section dc feeder circuit breakers trip. Allowed to close automatically when both adjacent contact rail section dc feeder circuit breakers are closed. Automatic reclosing should initiate only after both adjacent breakers are closed.

N. Positive and Negative Bus tie breaker control (Storage Yard TPS): Equipped with bi-directional overcurrent series-trip unit (Device 176) and coordinated with adjacent feeder breaker tripping. Negative bus tie breaker shall only operate (close or open) when the positive bus tie breaker is open. Positive bus tie breaker shall only close after the negative bus tie breaker is closed and shall only be opened prior to the negative breaker opening. In the remote mode, both positive and negative tie breakers shall be controlled by one control switch. Electrical interlocks shall be provided to automatically trip the positive breaker if the negative breaker trips, and vice versa.

O. Control and instrument wiring:
1. Factory-installed.
2. Insulation rated 2000 Volts as well as 600 volts, Type SIS, 14 AWG minimum copper conductor unless otherwise specified. Flexible Class C or higher stranded insulated copper wire used for wiring across hinged joints.
3. One continuous length of wire used from terminal to terminal without splices or taps.
4. Removable element control wiring installed and connected according to manufacturer's standard for circuit breaker wiring.
5. Control wiring so designed and installed that fault in one main circuit cannot be transferred to control wiring of another main circuit.
6. Connections made at terminals of device, on terminal blocks or on control buses. Wiring connection made using insulated flange fork tongue type terminals.
7. Interconnecting wiring between cubicles and compartments terminated on terminal blocks before being wired to components.
8. Terminal blocks: With screw terminals, circuit marking strips for indicating control wire number, phenolic laminated dust cover and minimum um of 10% spare terminal points.
9. For each individual wire, corresponding identification used on terminal block marking strips.
10. Internal wiring identified at each termination, with same number shown on wiring diagram, using suitable plastic sleeve attached within six inches of terminal connections. Terminals shall be color-coated for ready identification of voltage (e.g. 750 VDC, 125 VDC, 24 VDC etc.)
11. External wiring: Provision made for external control wiring to enter from top and with space allowed to terminate external multiple-conductor copper control cable. Top entrances provided with removable cover plates for field drilling of conduit and cable entrance holes.

P. Remote control and indications:
1. Control: Provisions for closing and tripping each circuit breaker except cathode circuit breakers, from the remote control system. Remote control enabled only with
Local-Remote switch in Remote position and circuit breaker in connected position. Provide interposing relays for closing and tripping circuits to interface with remote control for each breaker. The relay coils shall be General Electric Type HGA or HFA, equipped with arc suppression and have 24 VDC rating except for those serving Storage Yard and controlled from Yard Control Tower which shall be 125 VDC rated.

2. Indication:
   a. Contact from each circuit breaker for remote indication of circuit breaker position as follows:
      1) Closed: Circuit breaker closed and in the connected position.
      2) Tripped: Circuit breaker open or in the test or disconnected position.
      3) Contact bounce not to exceed five milliseconds.

3. 125 Volt DC Yard Control cables shall be shielded type cable.

Q. Auto Manual control of Cathode Breaker: An Auto/Manual selector switch shall be provided to control the cathode breakers locally when the selector switch is selected in the Manual position. When Auto Selection is made the cathode breaker shall be controlled by the position of 15 kV or 34.5 kV rectifier breakers described in Section 16321 and 16322.

R. Nameplates:
   1. 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.
   2. Nameplate provided on each switchgear showing manufacturer’s name and brand designation, the referenced standard, type, class and rating as applicable in accordance with referenced standard.
   3. Additional functional nameplates for each component:
      a. Each switchgear compartment labeled, front and back, with nameplate 2-1/2 inches by 6-1/2 inches, inscribed in letters ½ inch high: CATHODE CIRCUIT BREAKER NO. 2, FEEDER CIRCUIT BREAKER NO. 1, POSITIVE TIE BREAKER, NEGATIVE TIE BREAKER as appropriate.
      b. Each circuit breaker compartment labeled, front only, with nameplates 2-1/2 inches by 6-1/2 inches, inscribed in letters ½ inch high with the circuit breaker Supervisory Control Identification Number, as shown on drawing.
      c. Provide nameplates for all internal components such as relay, fuse, terminal block, etc.
      d. In addition to other information normally displayed on equipment, provide one inch nameplates showing, in letters ½ inch high, switch positions, meaning of indicator lamp and other pertinent information.

S. Accessory equipment: One set of the following provided for each substation and tie breaker station:
   1. Cranking device to be used for moving the circuit breakers to and from the connected, test and disconnected positions.
   2. Removable closing lever or crank for manually closing the circuit breakers, if required.
   3. A set of test plugs for draw-out relays and instruments.
   4. A set of wrenches for the primary disconnecting devices of the circuit breaker, if required.
   5. Fuse tongs or hook sticks, depending on the requirements.
   6. Twenty-five feet of test cable for each switchgear assembly to permit operating a circuit breaker when completely removed from its compartment. This cable will be required to connect the control circuits of the withdrawn breaker and operate the breaker without the use of the test cabinet.
7. Test cabinet, suitable for wall mounting, for operating, testing and inspecting the circuit breakers when removed from their compartments. Include test jumper not less than twenty-five (25) long for connection between the breaker and the test cabinet.

8. Set of test jumpers for connecting breaker units to the test cabinet.

9. Pegboard: Hardboard, AHA IS 1, tempered, SIS, 1/4-inch nominal thickness, perforated, sized to accommodate all products specified. Framed with one-inch by one-inch hardwood. Frame and hardboard painted with color selected by the Engineer. Include hardware for wall mounting and pegboard accessories suited to the products to be mounted. Provide nameplates as specified, one inch high with accessory names inscribed in 1/2-inch vertical letters.

T. Additional Circuit Breaker Elements: There shall be an additional circuit breaker elements as indicated on drawing.

U. Cable Shield Monitoring System: Provide relay to monitor failure or degradation of insulation or jacket of the 1000 MCM shielded track feeder cables. The associated relays and devices for this system shall be provided to all DC switchgear line-up. The relay shall function to indicate alarm for cable insulation/degradation failure. The cable shield relay and each component shall be isolated from the 750 VDC. The jacket failure alarm and insulation failure alarm shall be designed so as to facilitate cable identification with selective disabling switches in each feeder breaker(s) cubicle. The relay shall include sufficient filtering and adjustable trigger points and time delays to minimize nuisance alarms. The relay shall be manufactured by SMC Electrical Products or approved equal and include, but not be limited to the following:

1. Provide two cable shield monitoring relays for each DC switchgear assembly containing five (5) feeder breakers or more. For less than five (5) feeder breakers, provide one relay.

2. Provide and install single knife switches in each feeder breaker cable compartment door to provide means of isolation of single feeder cable. Suitable opening shall be provided in each switch enclosure for control cables to enter from the bottom. The switch shall be rated for 1000V, designed similar to ABB Flexitest switch and mounted as follows:

3. Relay control wiring connected to the shield wire shall be insulated with minimum of 2kV, 12 AWG minimum copper conductors, Judd Wire or approved equal.

4. The Contractor shall provide a working model of the cable shield monitoring system and demonstrate operation and submit test results of the same to WMATA engineers for approval before installation.

5. Move to shield cable

6. Shield monitoring system shall be connected to the substation annunciator and DTS for local and remote alarm monitoring.

PART 3 EXECUTION

3.1 INSTALLATION

A. Floor Preparation:
1. Finish concrete to the tolerance recommended by the manufacturer.
2. Install insulated floor topping in accordance with WMATA standard requirements.

B. Install switchgear as shown and in accordance with approved shop drawings and as follows.
1. The number of shipping splits at each facility is indicated below. Contractor shall make bus connections in accordance with manufacturer’s requirement and connect all control wiring at the appropriate terminal blocks.
2. Contractor shall furnish and install anchors in insulated floor for DC switchgear at locations indicated by the manufacturers and as shown in typical detail for anchoring DC switchgear to the insulated floor. The required number of anchors at each facility is given below:

<table>
<thead>
<tr>
<th>NAME OF FACILITY</th>
<th>ANCHOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Location – TDB] TPS</td>
<td>[TBD]</td>
</tr>
</tbody>
</table>

C. Install busways as shown and in accordance with approved shop drawings as Section 34 20 43.

D. Install conduit, raceways and bus duct as approved and in accordance with Section 34 20 33.

E. Make power cable and control wire connections as approved and in accordance with Section 34 20 13. The required number of 1000 KCMIL cable lugs shall be furnished by the DC switchgear manufacturer.

F. Use services of manufacturer’s engineering representative for assistance in field assembly and installation of the switchgear in accordance with WMATA standard requirements.

G. Connect space heater circuit to prevent condensation during installation. Connect space heater to 125-volt AC supply as shown.

H. Install DC circuit breaker test cabinet and connect it to 125-volt DC supply as shown.

I. Coordinate installation of all DC Shielded cable terminations with specification Section 34 20 15.

J. 2000 Volt Shielded Cable for Traction Power.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. No Measurement will be made of the work in this system.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.

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SECTION 34 21 20
DC SWITCHBOARD, STINGER SYSTEM AND CONTROLS, DC PEDESTAL AND WALL MOUNTED CONTACTOR SYSTEMS FOR S&I SHOP

PART 1 GENERAL

1.1 DESCRIPTION

A. This specification is applicable at the following Facilities:
   1. D90 – New Carrollton Maintenance Facility (NC)
   2. K90 – West Falls Church Maintenance Facility (WFC)

B. This Section covers specifications for furnishing all labor, materials, equipment, services, and tools necessary and required for electrical construction of the following S&I shop traction power systems.
   1. 750 VDC Switchboard
   2. 750 VDC Stinger system for traction power to married pairs for movement inside the shop.
   3. 750 VDC Pedestal and wall mounted contactor system

C. Under this contract, the contractor will remove existing DC stinger (conductor/collector) related equipment and assemblies as noted on the contract drawings. Certain tracks will require new DC stinger (conductor/collector) related equipment to be installed by the contractor.

D. Requirements for the new DC stinger system shall be furnished and installed by the contractor, which are described in this specification and are detailed on the contract documents.

E. These documents do not anticipate that the contractor will furnish, install, and/or modify anything related to the S&I Shop DC pedestal and wall mounted contactor system under this contract.

F. These documents do not anticipate that the contractor will furnish, install, and/or modify anything related to the S&I Shop DC switchboard under this contract.

1.2 RELATED SECTIONS

A. Related Work Specified Elsewhere:
   1. 34 20 13 - Wire and Cable for Traction Power
   2. 34 20 33 - Raceways, Boxes and Cabinets

1.3 QUALITY ASSURANCE

A. Qualification: Select a manufacturer who is regularly engaged in the production of “DC switchboard, Stinger system and controls and DC pedestal and wall mounted contactor systems” equipment of the types and ratings described in these specifications using the latest technology and who has proven record of successful manufacturing and testing of same or similar type equipment for the last five (5) years. The equipment manufacturer shall have and maintain ISO9001 or ISO9002 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 WC8
5. UL
6. NESC C2 (Safety Code)
7. IP Code (Ingress Protection)

C. Inspections and Tests:
1. The Engineer and his representatives reserve the right to witness all tests and manufacturer inspections that the Engineer deems necessary.
2. The Contractor and his supplier shall grant the Engineer, or the Engineer’s 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.

1.4 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the Submittals Section of the contract specifications.

B. In addition to the requirements set-forth in other sections of the contract, the Contractor shall submit to the Engineer, prior to final acceptance of work, a drawing(s) showing the complete layout of the 750 VDC switchboard, stinger system, DC pedestals and wall mounted contactors as well as all UL listings.

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”x6”) of the constructed and functional stinger system in detail. The photographs shall be bound in a suitable product delivery, storage and handling 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 Engineer or authorized 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 shall be included for each major piece of equipment.

3. The contractor shall provide six copies of the complete operation, maintenance and repair instruction manuals in paper copies as well as in electronic file media on CDROM. Manuals shall include complete equipment layout drawings, one-line diagrams, elementary diagrams, control schematics, interconnection wiring diagrams, inventory part list with component number, part nomenclature, manufacturer’s part number and any third party’s part number. Maintenance instructions shall include full descriptive and pictorial literature and all parts of the equipment.

4. The electronic file media shall be in the following formats:
   a. Drawing in editable AUTO CAD format.
   b. Text in Word
   c. Image in Tiff

E. Spare Parts Lists:
   1. A list of suggested spare parts for each section to include all items given part number, model number, component name, manufacturer's name, price, phone numbers and suggested quantities.
   2. Parts numbers by others shall be identified.

F. Certification:
   1. The Contractor shall furnish to the Engineer, 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. As applicable to this project, certification shall include, as a minimum, the following items:
      a. DC Stinger System and control - system integration, which shall include operation with the wheel truing and car progression systems if provided.
      b. DC switchboard (if applicable)
      c. DC Pedestal and wall mounted contactor system (if applicable)

PART 2 PRODUCTS

2.1 DC SWITCHBOARD

A. These contract documents do not anticipate that the contractor will need to make any modifications to the existing DC switchboard.

B. DC Switchboard: (existing switchboard; this section is not applicable to this contract)
   1. The shop dc switchboard shall be a dead front, free-standing, metal enclosed assembly, suitable for indoor service. Ambient temperature will not exceed °C. The switchboard shall contain dc positive bus and bus connections, a minimum six (6) combination fusible branch circuit switches and magnetic contactors to supply power to a minimum six (6) individual stingers as required, and a minimum twenty (20) fusible branch circuit switches for receptacles at 750 V,
dc. The switchboard shall contain terminal connectors and other auxiliary equipment and devices required. Shipping sections including shipping skids shall not be longer than 11'-0".

2. 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".

3. 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
   e. Short Circuit Rating
      1) Peak
         75,000 amperes
      2) Steady-State
         75,000 amperes
      3) Rate-of-Rise
         2,000,000 amp/sec
      4) Continuous Current Ratings

   4. Description and Materials
   a. 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 combination feeder switch and magnetic contactor and 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 will be covered by an insulating topping (Leveling channels will be required). 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.

5. Design:
   a. The switchboard shall be designed and arranged to provide convenient access to all components for normal operation and maintenance. The switches, fuses and contactors 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. All compartments shall have a hinged doors interlocked with the handle so the door cannot be opened while the switch is in the "ON" position. 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 bus work and cable connections shall be accessible from the rear of the switchboard. The rear of the switchboard shall be provided with removable covers.

6. Branch Circuit Switches
   a. Each branch switch shall be single pole, Bolted pressure (BPS), 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.
   b. 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.

7. Terminal Connectors
   a. The combination switches, contactors and 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. Each contactor shall be provided with two (2) 250 MCM connectors; each 150 ampere switch with one (1) No. 1/0 connector.

8. Nameplates:
   a. Each switch shall be provided with a circuit identifying nameplate attached to the equipment with bolts, screws or rivets. Nameplates shall consist of three-ply laminated phenolic plates (2 1/2"x 6 ½") engraved through black face to white core. Lettering shall be ½" high condensed vertical gothic using a rounded or square cutter. V-shaped grooves are not acceptable. Nameplate legends shall be as follows:
      1) DC STINGER NO. 1 (etc. through No. 6)
      2) DC RECEPTACLE POWER NO. 1 (etc. through No. 20)

9. DC Bus Section:
   a. DC switchboard isolated from the DC switchgear (e.g. separate rooms) shall be provided with a DC bus section which shall include provisions for the connections of a total of six (6) 1000 MCM copper cables to the switchboard bus, entering from the top. Connectors shall be of the long barrel, double-indentation, and 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. The switchboard enclosure shall not be insulated from ground.
   b. The switchboard shall be provided with a bus connection to the DC switchgear when both switchboard and switchgear enclosures are in the same room and bonded. The switchboard enclosure shall then be insulated from ground. The enclosure will be bonded to the dc switchgear, to that the switchgear-mounted ground relay shall monitor and protect the switchboard, as well as the switchgear, from accidental grounding and accidental energizing of the enclosures.

10. Description of Contactors
    a. Switchboard-mounted dc contactors shall be normally open, magnetically held, single pole, load break with 8-hour enclosed rating of 600 amperes inductive load at 750 volts dc and shall be NEMA size 6. The contactor shall be used to control the dc current to the stinger systems. 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 two (2) N.O. and (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 switchboard 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 designed to control the dc current to a single stinger system only.

11. Testing
   a. 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 switchboard shall also withstand for one minute, without breakdown, a direct current test voltage of 5.2 times the maximum rated voltage. 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.

C. Receptacle Contactors
   1. Provide 750 VDC contactors in accordance with the following:
      a. DC contractors shall be normally open, magnetically held, single pole, load break rated as listed below at 750 volts dc. The contractor shall be used to control the DC current to the receptacle circuits. Each contractor 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.
      b. Contactors supplying power to receptacle circuits shall have 8 hour enclosed ratings of at least 150 amperes inductive load at 750 volts dc and shall be NEMA size 4. The short-circuit withstand capability shall be coordinated with the available peak-through current of the dc distribution switchboard 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 have a 120 volt ac coil operation.

D. Enclosure
   1. Each contactor shall be enclosed in a NEMA type 12 ventilated self-supporting fiberglass enclosure suitable for wall mounting. Each 150 ampere rated contactor enclosure shall be provided with one key operated momentary contact switch to energize the control coil and one mushroom head stop pushbutton. The switch and pushbutton shall be located on the front cover and shall be accessible with the enclosure door closed. The door shall be suitable for padlocking. An internally-mounted 120 volt ac toggle switch which shall disconnect the control power shall be provided. Enclosure shall be manufactured of glass-reinforced polyester and shall have the following minimum strength:
      a. Tensile Strength 13,000 psi
      b. Flexural Strength 23,000 psi
      c. Compression Strength 17,000 psi
      d. Impact Strength 15 ft*lbs/inch
2. Enclosures shall be provided with a gasket hinged front door, suitable for padlocking. Enclosures shall be as manufactured by the Vynco Division of the English Electric Corporation, Crouse-Hinds, or Hoffman, or an approved equal.

2.2 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-safe standard” (UL-E99342, and/or D1N57470).
   3. 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).
   4. 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.
   5. The new stinger systems being installed on Track 17 & 18 requires that an additional contactor be mounted within the stinger collector trolley assembly. This contactor shall be used to energize the stinger section independently from the other sections.
   6. 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.
   7. No special tools should be required for installation.
   8. 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.
   9. The Contractor shall submit to the Engineer and the Car Maintenance Department (CMNT) plan and details of the Stinger System for review and approval, prior to procurement and installation.

B. Acceptable Manufacturers
   1. The following manufacturers are approved for manufacture of the DC Stinger power and control system:
      a. MAC Products, Inc. or approved equal
      b. WAMPFLER Products, Inc. or approved equal
   2. DC Stinger Collector System Contactor:
      a. Microeletrica-Scientifica LTNS 800 or approved equal.
      b. HUBBELL Type 700 Series, 120Vac operating coil 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. The conductor rail shall be a one piece copper trolley trough with a self “V”
groove contact surface for the trolley collector assembly, and shall be suitable
for the voltage rating.
   2. The conductor rail shall have an intermittent current carrying capacity of 1250
amperes, with a DC resistance of 16.6 micro-ohm s/ft, having sufficient thermal
capacity to withstand 300% overload for intermittent duty cycles. Expansion
joints shall not be required for lengths up to 660 feet. Each rail section shall
be 16.4 feet in length in order to reduce the number of connection joints. All
rail connectors shall be a bolted design. Rail shall be rated IP23 for indoor or
outdoor use.
   3. Designed utilizing collectors having sufficient mechanical strength to support and
electrically feed a 100 amp (nominal) rated trolley/collector assembly.
   4. The conductor bar hanger’s material shall be macrolon with galvanized
hardware. The hanger shall swivel to self-align with the rail and allow for the
rail to snap in to the clamp during installation. The hanger will support the
rail without “pinching” the rail side. Hanger design must provide free
conductor movement to accommodate the 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 flash over strength of four time’s 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 7.5 ft. intervals (maximum) between support members center to
center.

E. Stinger Power Collector Trolley:
   1. Rated 1000 Volt DC, 600 amperes capacity and compatible with the DC power
conductor.
   2. A power contactor shall be installed within the collector trolley assembly to
independently energize the stinger sections.
      a. Power collector trolley-mounted dc contactors shall be normally open,
magnetically held, single pole, load break with a rating of 600 amperes
inductive load at 750 volts dc and shall be NEMA size 6. The contactor
shall be used to control the dc current to the stinger section. 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 two (3) N.O. and (1) 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 switchboard 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 designed to control the dc current to a single stinger section only.

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 pair of “C” channel mounted in tandem with the power conductor.

4. The trolley housing shall be of NEMA type 4 /IEC 1 P65 enclosure construction.

5. Contact with the power bus shall be by pairs of contact shoes that are spring-loaded with minimum contact pressure of 6 pounds and shall be adjusted to permit free longitudinal movement of the complete trolley assembly along the power conductor.

6. Provide horizontal and vertical guide wheels with sealed ball bearings, 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-long force from creating abnormal pressure and shall maintain contact shoe alignment.

7. Collector assembly to accommodate one power conductor. Provide solderless type pressure cable connectors and insulate connections using heat-shrinkable sleeves as manufactured by Raychem, 3M products, or Engineer approved equal.

8. The complete trolley assembly will consist of 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 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.

10. Collector shoes shall be simple to replace without the use of tools.

F. Control Conductor:

1. The conductor rail shall be a one piece copper trolley trough with a self “V” groove contact surface for the trolley collector assembly, and shall be suitable for the voltage rating.

2. A current carrying capacity of 100 amperes, with impedance rating of 1.1 x 10^{-4} ohms/ft. The assembled conductor shall be enclosed in a safety orange, extruded PVC cover.

3. Designed utilizing collectors having sufficient mechanical strength to support and electrically feed a 100 amp (nominal) rated trolley/collector assembly.

4. The conductor bar hangers’ material shall be macrolon with galvanized hardware. The hanger shall swivel to self-align with the rail and allow for the rail to snap in to the clamp during installation. The hanger will support the rail without “pinching” the rail side. Hanger design must 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 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.

7. Collector shoes shall be simple to replace without the use of tools.
G. 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) Conductors rated 600VAC with a UL rated current capacity of 250 amperes at 100% duty cycle and at 35 degree C. All bar must be copper. With resistance greater than 2.78 x ° C. Expansion joints shall not be required for lengths up to 660 feet. Each rail section shall be 13 feet in length in order to reduce the number of connection joints and shall be compatible with the AC multi-conductor control cable. All rail connectors shall be a bolted design. Rail shall be rated IP23 for indoor or outdoor use.

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.

4. The trolley housing shall be of NEMA type 4 /IEC IP 65 enclosure construction.

5. Contact with the AC control bus shall be by pairs of contact shoes that are spring-loaded with a minimum of contact pressure of 4 pounds and shall be adjusted to permit free longitudinal movement of the complete trolley assembly along the control conductors. Provide horizontal and vertical guide wheels with sealed ball bearings, 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 pull-along force from creating abnormal pressure and shall maintain contact shoe alignment. Collector assembly to accommodate three (3) control conductors. Provide solderless type pressure cable connectors or terminal strip.

6. The complete control trolley assembly will consist of two auxiliary support and movement rollers mounted to a common bracket held in alignment by the captive trolley.

7. Collector assembly to accommodate three (3) control conductors as indicated on the drawings. Collector shoe lead wire shall be bolted direct to collector shoe to eliminate any potential of hot spots or thermal overloads. Provide solderless type pressure cable connectors and insulate connection using heat shrinkable sleeves as manufactured by Raychem, 3M Products or engineer approved equal.

8. 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.

H. 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 for transit vehicle in the elevated and at floor positions on the car hoists.

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 B 172) #4/0 AWG, coated, annealed copper power cable, having low smoke and low toxic silicon rubber insulation thickness rated for 2kV in accordance with ICEA NEMA W C8. Provide low smoke, zero halogen cross linked 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. Each stinger assembly shall have an independent 600A DC contactor. A single DC contactor shall not supply two stinger assemblies.

8. Provide all required means to permit passage of overhead crane loads between adjacent shop tracks.

I. Control Station Assembly

1. The control station assembly shall be provided with control cable, and pendent-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.

J. 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 5000 lbs.

   b. cantilever strength 9000 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

   h. creep distance plate to plate - 4.75 inches (min) insert to
I. dielectric strength
   (a) dry - 40 kV minimum
   (b) wet - 19 kV minimum

j. impulse
   80 kV minimum - (1.5 x 40 wave)

K. 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 traveling at a speed of 5 mph without damage to trolley or overhead busway system (power and control conductors).

L. System Operation: (System shall match existing S&I Shop operation. Typical operation is written below)
   1. It is the intent of the project to maintain this existing operation of the S&I Shop. The contractor shall immediately inform the WMATA Engineer if the existing operation varies from the system operation listed below.
   2. The contractor shall witness the current operation of the stinger system. If the existing system does not operate as described in the existing sequence of operation, listed in this specification, the contractor shall take immediate action and work with WMATA engineering to fix the issue(s). The contractor shall work with WMATA engineering to design, furnish and install any equipment necessary to restore the stinger system to its intended operation.
   3. All stinger cable assemblies, control station cable assemblies, power and control system wiring, and auxiliary devices shall permit the following sequence of operation.
      a. 750 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 the green lights switch off, alarm will sound, rotating red lights will start flashing. After a preset time delay (15 seconds), 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 of the three (3) emergency (maintained) pushbutton stations are pressed.
      f. Only one (1) stinger systems can be operated at any given time.
      g. After the move is made, the stinger control station momentary pushbutton is released red lights stop flashing and the green lights come on. The stinger is stored on its cable hanger.
      h. Alarm/horn activation is maintained when the 750V DC contactor malfunction and fail to de-energize the stinger system.

M. 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 Engineer approved equal.
N. 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. Cube relays are not acceptable.  
2. Acceptable Manufacturers:  
   a. Agastat  
   b. Square D Co.  
   c. ASCO  
   d. Potter Brumfield  
   e. Allen Bradley  
   f. GE  
   g. Approved equal.

O. Stinger Control Panel: (Existing control panel)  
1. The contractor shall integrate with the existing stinger system control panel. The contractor shall relabel all control wiring for stinger circuits modified under this project.  
2. This contract does not anticipate that the contractor will need to provide additional control panels or control relays. The contractor must immediately notify the WMATA Engineer if additional control panels or relays are required.  
3. Provide Stinger Control Panel (SCP) as described herein. The SCP shall be manufactured by the same manufacturer as the DC Stinger System and Controls.  
   a. SCP - Provide a completely engineered assembly that is arranged in a manner that affords safety for the maintenance personnel and operators. The components and wiring are to be well identified and shall reflect the exact configuration as the control ladder diagrams, wiring diagrams and assembly diagrams.  
      1) The minimum wire size for control wiring within the SCP shall be #14 AWG rated 2000 VAC.  
      2) Control wiring shall be EPR insulated, stranded copper wire.  
   b. Multi-Conductor Control Cable (SCP - DC Switchboard).  
      1) Provide an 8-conductor #10 AWG

P. Warning Devices: (Additional devices not required)  
1. Provide warning devices to indicate presence of 750 VDC in areas having controlled DC stinger power. Maintain activation of the alarm/horn where stinger system is energized even when hand-held momentary push button switch is released, where contactors in DC Switchboard malfunction.  
2. All stinger areas shall be provided with rotating red lights for visual indication and warning horns for audible indication.

Q. 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 WMATA).  
   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 Engineer that is within 20 miles of the Project's location
2.3 DC PEDESTAL AND WALL MOUNTED CONTACTOR SYSTEM (EXISTING DC PEDESTALS; THIS SECTION IS NOT APPLICABLE TO THIS PROJECT)

A. Spare Parts
1. 150 Amp, 800 Volts, DC, electrically operated contactor, 120 Volts AC operated solenoid. Provide 120 VAC from external source for control circuit operation as shown on the Contract Drawings. Control relays shall be as manufactured by General Electric Company, Allen-Bradley, ASCO, or approved equal.
2. Internal air clearances or solid dielectrics sufficient to withstand 4500 volt transient potentials on the circuit.
3. Acceptable Manufacturer’s:
   a. Microelectrica Scientifica; Model LTC-250-M-ADA.
   b. General Electric Company
   c. Cutler Hammer
   d. Approved Equal

B. POWER CABLE
1. 1/C # 1/0 extra flexible Class K copper stranded conductor with low smoke, zero halogen silicon rubber insulation, rated 2 kV.
2. Power cable shall be 30 feet long at a minimum. The contractor shall coordinate with WMATA engineering to ensure the accurate length of cable is provided to safely operate the revised stinger system. Power cable shall be equipped with a spring-loaded clamp and protective 2 kV insulated boot over clip.

C. ENCLOSURE - DC CONTACTOR (THIS SECTION IS NOT APPLICABLE TO THIS PROJECT)
1. 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.
2. Provide wire way to guide 1/0 AWG conductors within the enclosure.
3. Acceptable Manufacturer’s:
   b. Approved Equal

D. CONTROL AND INDICATION (EXISTING SYSTEM; THIS SECTION IS NOT APPLICABLE TO THIS PROJECT)
1. Key Operated “ON” Pushbutton
2. Position, cylinder lock momentary (oil tight) pushbutton with key removable in “LOCK” position only. Allen Bradley 800T-E11A or equal, with extra-large legend plate.
3. “OFF” non-illuminated extended head oil tight pushbutton, red color, Form B contact block. Allen Bradley 800MR-N26 or equal, with extra-large legend plate.
4. “ON” Pilot Light, oil tight, red lens, push-to-test, full voltage 120 Volt LED, with extra-large legend plate. Allen Bradley 800T-QTH10R or equal.
PART 3 EXECUTION

3.1 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. Test performance and operation of the DC stinger system and DC contactor systems and operating procedures, to the satisfaction of the Engineer.
   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.
   3. Test new system completely prior to turning system over to WMATA. Existing system operation must match the existing S&I Shop operating procedure.

C. The Contractor shall provide final testing under power subsequent to completion. The Contractor shall coordinate the interconnection between the DC Stinger System and the DC Switchboard power and control circuits. The contractor shall be responsible for final connections to the DC Switchboard power and associated commissioning, and final acceptance of the DC Stinger System by WMATA.

PART 4 MEASUREMENTS AND PAYMENTS

4.1 MEASUREMENTS

A. No Measurement will be made of the work in this system.

4.2 PAYMENTS

A. The payment for work of this section shall not be measured for payment, but shall be considered incidental to roof top access platform at either New Carrollton or West Falls Church Maintenance Facility contract Lump Sum price.