Washington Metropolitan Area Transit Authority

Technical Specifications

for

3421 Pennsy Drive

Landover, Maryland, 20785

Contract No. FQ12165

IFB Issued: August 2012

BOOK 3 – Technical Specifications

Contract FQ12165 – 3421 Pennsy Drive
Technical Specifications
Table of Contents

SECTION 02 41 00

DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Building demolition excluding removal of hazardous materials and toxic substances.

B. Selective demolition of building elements for alteration purposes.

C. Abandonment and removal of existing utilities and utility structures.

1.02 REFERENCE STANDARDS

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

B. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.

C. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2009.

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Site Plan: Showing:
   1. Areas for temporary construction and field offices.

D. 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.
   3. Include a summary of safety procedures.

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

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

PART 2 PRODUCTS-- NOT USED

PART 3 EXECUTION

3.01 SCOPE

A. Remove portions of existing building as indicated on the drawings.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   3. Provide, erect, and maintain temporary barriers and security devices.
   4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   5. Do not close or obstruct roadways or sidewalks without permit.
   6. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
   7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.

B. Do not begin removal until receipt of notification to proceed from The Authority.

C. Protect existing structures and other elements that are not to be removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Stop work immediately if adjacent structures appear to be in danger.

D. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

E. If hazardous materials are discovered during removal operations, stop work and notify The Authority; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.

F. Perform demolition in a manner that maximizes salvage and recycling of materials.
   1. Dismantle existing construction and separate materials.
   2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

3.03 EXISTING UTILITIES

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. 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.

E. 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.

F. 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.

G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility arrangements are as shown.
   2. Report discrepancies to Owner before disturbing existing installation.
   3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

B. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.

C. Remove existing work as indicated and as required to accomplish new work.
   1. Remove items indicated on drawings and any items not shown specifically on drawings required to be removed to accomplish new work.

D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): 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.

E. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.
   4. Patch as specified for patching new work.

3.05 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 02 41 19.19

SELECTIVE ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of material for demolition and salvaging existing electrical systems, wiring, raceways, supports, equipment and minor repair of underlying structure.

B. Related Sections:
   1. Refer to Procurement Documents

1.02 REFERENCES

A. Reference Standards
   1. U. S. Government:
      a. Federal Transit Administration (FTA):
   2. 49 CFR 661 Buy America Requirements

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

1.03 SUBMITTALS

A. Submit demolition plan.

1.04 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.

1.05 COORDINATION AND SEQUENCING

A. Coordinate all power outages with Authority.

B. Perform demolition in a manner not to delay or interfere with other operations of work in the Project and operations of the Authority.

1.06 SCHEDULING

A. Schedule all work with the Authority through the Authority's designated representative. Start no work in an area until a schedule has been prepared, submitted and approved.

B. Coordinate the work schedule with the Authority, Engineer, and other Contractors. Coordinate the work so not to interfere or conflict with the performance of work by the Authority and the Authority's tenants.

1.07 PROJECT/SITE CONDITIONS

A. Care shall be used so not to impede the ongoing work of any tenant.

B. Demolition work, as specified herein, is not intended to be performed as a wrecking operation but as work relative to the performance of the various construction operations of the Project.

C. Existing Conditions:
   1. Demolition information shown or otherwise indicated on the Drawings is based on visual field examination and existing record documents. While the information provided is believed to be correct, no assurance is implied relative to its total completeness or accuracy. Report discrepancies to Construction Manager for disposition of the Engineer before disturbing existing installations.
   2. The Contractor hereby distinctly agrees that neither the Construction Manager, the Engineer nor the Authority is responsible for the correctness or sufficiency of the information given and after his own Site Investigation:
      a. That he must have no claim for delay or extra compensation or damage on account of the information given; and
      b. That he must have no claim for relief from any obligation or responsibility under the Contract with respect to the above stated stipulations.

D. Protection: Exercise care during demolition work to confine demolition operations to the areas as indicated on the Drawings. The physical means and methods used for protection are at the Contractor's option. However, the Contractor will be completely responsible for replacement and restitution work, of whatever nature, at no expense to the Authority.
   1. Additionally, if public safety is endangered during the progress of the demolition work, provide adequate protective measures to protect public pedestrian and vehicular traffic on streets and walkways.
   2. Conform signs, signals and barricades to requirements of Federal, State and local laws, rules, regulations, precautions, orders and decrees.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Those products such as conduit, raceway, wire and cable, support devices, fasteners, and control devices as required for work of this Section are specified in other Sections.

B. Equipment along with machinery and apparatus, motorized or otherwise, used to perform the demolition may be chosen at the Contractor's discretion. However, the chosen equipment shall perform the work within the limits of the Contract requirements.

C. Patching Materials: Patching materials shall match, as nearly as practical, the existing material for each surface being patched.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify that measurements and existing circuiting arrangements are as shown on Drawings.

B. Equipment, machinery and apparatus, motorized or otherwise, used to perform the demolition work may be used as chosen at the Contractor's discretion, but which will perform the work within the limits of the Contract requirements.

C. Verify that abandoned wiring and electrical equipment serve only the abandoned facility.

3.02 DEMOLITION

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 Construction Manager and the Engineer.
   1. Remove all conduit systems, including conduit systems above accessible ceiling systems unless indicated otherwise on the drawings.
   2. Remove all wiring in conduit systems back to source of power supply.
   3. Wiring Devices:
      a. Disconnect all outlets and remove devices.
      b. Disconnect and remove all electrical devices and equipment serving utilization equipment that has been removed.
   4. Lighting:
      a. Disconnect and remove all luminaires and poles, lighting fixtures and floodlighting units unless indicated otherwise on the drawings. Remove all brackets, stems, hangers and other accessories.
      b. Disconnect and remove all concrete luminaire pole bases.
   5. Equipment:
      a. Disconnect and remove all electrical equipment.
      b. Disconnect and remove all distribution equipment, panelboards, disconnect switches and motor starters or as otherwise required due to the removal of associated equipment.
   6. In exposed through-structure conduit locations, or where concealed conduits become exposed by penetrating a structural floor, wall or ceiling, the conduit must be cut below the finished structural surface in order to perform surface patching.

B. System De-activation: Prior to demolition and removal work, de-activate existing electrical systems.

C. Use means and methods for permanent disconnection, which render the remaining electrical systems and apparatus in conformity with NFPA 70.

D. Remove all wiring from disconnected circuits, feeders, and equipment. Remove all raceways and related supports. Cut all exposed raceways flush with floor and plug.

E. Coordinate electrical power outages with requirements in Section 26 05 00.

F. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor except as otherwise specified. Use equipment and methods that do not damage items to remain or salvaged and areas adjacent to demolition operations. Use methods that do not interfere with Authority's operations and which do not cause excessive dust. Remove debris as it accumulates.

G. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.

H. Debris Removal: Dispose of demolition debris off site in a lawful manner. Containerize or otherwise store debris as work is in progress.

I. Patching: After demolition and removal work is performed patch the existing structure as required to match surrounding finish and appearance including the appropriate surface decoration.

J. Abandoned Electrical Equipment and Apparatus: Existing electrical equipment and apparatus in or on the structures not claimed as salvage by the Authority 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.

K. Salvage: The Authority 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 the Authority, move and neatly store removed items on the site in a location agreeable to the Authority and in a manner approved by the Engineer.

END OF SECTION

SECTION 02 42 13

DECONSTRUCTION OF STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY:

A. This section specifies removing, restoring and reinstalling miscellaneous facilities on public and private property which are removed during construction.

B. Related Requirements:
1. Section 02 41 00 - Demolition.
2. Section 03 10 00 - Concrete Forms and Accessories.
3. Section 03 20 00 - Concrete Reinforcing.
4. Section 03 30 00 - Cast-in-Place Concrete.
5. Section 31 20 00 - Earth Moving
6. Section 32 11 23 - Aggregate Base Courses.
7. Section 32 12 16 - Asphalt Paving.
8. Section 32 13 13 - Concrete Paving.
9. Section 32 16 00 - Curbs, Gutters, Sidewalks, and Driveways.
10. Section 32 31 00 - Fences and Gates.
11. Section 32 90 00 - Planting.
12. Section 32 91 00 - Planting Preparation.

1.02 REFERENCES

A. Definitions:
1. *Miscellaneous facilities* include, but are not limited to, the following: Store fronts, alarm and sprinkler systems, bay windows, cornices, signs, fire escapes, canopies, awnings, security grilles, heating, cooling and electrical facilities, vaults, entrance walkways, steps, sidewalks, curbs, walls, railings, fences, planter boxes, shrubs, lawns and trees.
2. For definitions pertaining to trees, shrubs and other plants refer to ANSI Z60.1 – American Standard for Nursery Stock.
3. *Salvage*: To remove and store material and equipment for reuse in this or other Authority contracts.

B. Reference Standards:
1. ANSI: Z60.1 – American Standard for Nursery Stock.
2. ASTM C4 - 00 - Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile.
3. ICNCP (International Commission for the Nomenclature of Cultivated Plants): International Code of Nomenclature for Cultivated Plants.
4. U.S. Government:
   a. Federal Transit Administration:
      1) 49 CFR 661 Buy America Requirements.

1.03 SUBMITTALS:

A. Submit the following to the Authority Representative (AR) for approval in accordance with

the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:

1. Shop Drawings:
   a. Complete details of proposed reconstruction of store fronts and shop windows.
   b. Complete details of temporary signs including method of reinstalling existing permanent signs. Submit prior to removing signs.
2. Certificates:
   a. Buy America Act Certification

1.04 QUALITY ASSURANCE:

A. Regulatory Agency Sustainability Approvals:
   1. Authorities Having Jurisdiction:
      a. Comply with codes and regulations of the jurisdictional authorities.
   2. 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:
   1. Buy America Act Certification:
      a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.
      b. Submit the Buy America Act Certification to the Authority Representative for approval.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Materials for Restoration: New materials, unless otherwise approved, conforming to existing undisturbed materials in quality, color and finish.

B. Topsoil:
   1. Provide topsoil materials as specified in Section 32 91 00, Planting.

A. Seeding and Sodding:
   1. Provide seeding and sodding materials as specified in Section 32 91 00, Planting.

D. Trees, Shrubs and Other Plants:
   1. Provide the same species of trees, shrubs and other plants as those removed, unless otherwise specified, and identified in accordance with the International Code of Nomenclature for Cultivated Plants.

E. Clay Drain Tile:
   1. Provide clay drain tile conforming to ASTM C4 – 00 - Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile.

PART 3 - EXECUTION

3.01 PREPARATION

A. Alarm and Sprinkler Systems and Fire Escapes:
   1. Protect system from freezing where exposed to open-air conditions.

B. Tree Preservation:
   1. Repair injuries, abrasions or other damage to planting by cleanly removing broken members, loose or torn bark and shape edges in order to permit drainage of rain water from wounds. Perform pruning in accordance with Section 32 90 00, Planting.
   2. Where depth of soil over root system of existing plantings is to be modified by final grading, provide the following:
      a. Where increase of one foot or more in elevation is shown, spread continuous layer of rock aggregate, graded 1/4 inch to two inches, six inches deep from trunk to drip line of branches prior to installation of fill.
      b. Provide proper aeration by installing, within perimeter of spread, system of four-inch clay drain tile, vertically from soil surface into aggregate fill.
      c. Construct stone wells around trunks as shown, detailed or as approved. Extend stone work from rock fill layer to final grade, allowing sufficient space for trunk growth.
      d. Protect trees, shrubs, groundcovers and features such as landforms, walls, wells, coping and similar items that are to remain. Exercise special precautions and provide treatment for retention and protection of such landscape items in preference to removal.

3.02 RESTORATION

A. Store Fronts, Bay Windows and Cornices:
   1. Store Fronts:
      a. Rebuild store fronts at or behind building line to match existing fronts insofar as practicable.
      b. Complete restoration in accordance with approved working drawings.
   2. Bay Windows:
      a. Rebuild bay windows at or behind building line as window walls.
   3. Cornices:
      a. Do not replace cornices which have been removed.
      b. Parge areas disturbed by removal with cement plaster.

B. Alarm and Sprinkler Systems and Fire Escapes:
   1. Alarm Systems:
      a. Maintain existing alarm systems in operating condition. On completion of construction, reinstall components to provide same degree of protection as original system.
   2. Sprinkler Systems:
      a. Maintain existing sprinkler systems fully operative in areas temporarily occupied for construction purposes.
      b. Restore sprinkler system to provide same degree of protection as original system.
   3. Fire Escapes:
      a. Relocate fire escapes temporarily and maintain safe egress.
      b. Replace fire escapes in original location as soon as practicable.

C. Canopies, Awnings and Grilles:
   1. Canopies and Awnings:
      a. Store canopies and awnings during construction.
      b. Reinstall as soon as construction permits.
   2. Grilles:
      a. Remove and reinstall security grilles concurrently with building modifications.

D. Vaults:
   1. Perform work on vaults as specified in Section 31 20 00, Earth Moving.

E. Heating, Cooling and Electrical Facilities:
   1. Heating and Cooling Facilities:
      a. Remove and rebuild heating and air-conditioning facilities as necessary to provide service.
   2. Electrical Facilities:
      a. Remove and reconstruct electrical facilities to extent necessary to provide electrical service inside building line.

F. Signs, Flagpoles, Railings and Fences:
   1. Salvage signs, flagpoles, railings and fences where shown.
   2. Provide temporary sign for each permanent sign removed in accordance with approved working drawings. Remove on completion of construction.
   3. Reinstall items in their original locations or in other locations shown. Reinstall or replace chain-link fences in accordance with Section 32 31 00, Fences and Gates.
   4. Repair existing surfaces, damaged during the work, by cleaning and restoration to match existing.

G. Steps, Walls and Copings:
   1. Salvage steps and copings of wall components where shown and rebuild them to match existing.
   2. Where new reinforcing steel and concrete construction is necessary, provide such items in accordance with Section 03 10 00 - Concrete Forms and Accessories, Section 03 20 00 - Concrete Reinforcing, and Section 03 30 00 - Cast-in-Place Concrete so as to maintain continuity of quality and appearance between existing and new construction.

H. Sidewalks And Curbs:
   1. Salvage components of sidewalks and curbs where shown. Dispose of six-inch granite curb. It will not be reused.
   2. Restore sidewalks and curbs to line and grades which existed originally or new lines and grades shown.
   3. Restore asphalt and concrete sidewalks and curbs using new asphalt and concrete of equal quality to existing and to match lines, grades, thickness and construction existing prior to removal. Perform work in accordance with Section 32 11 23 - Aggregate Base Courses, Section 32 12 16 - Asphalt Paving, Section 32 13 13 - Concrete Paving and Section 32 16 00 - Curbs, Gutters, Sidewalks, and Driveways.\

I. Parking Areas and Driveway Pavements:
   1. Restore parking area and driveway pavements to lines, grades, thickness and construction existing prior to removal. Perform work in accordance with Section 32 11 23 - Aggregate Base Courses, Section 32 12 16 - Asphalt Paving and Section 32 13 13 - Concrete Paving.

J. Landscaping:

1. Where existing trees are to be removed and replaced by others at present locations, use replacement trees of comparable species and size up to four inches maximum caliper, except that the jurisdictional authorities have the right to specify alternate tree species or varieties of comparable size and cost, if such are readily available. Do not replant or relocate trees over 12 inches in caliper, except in cases of historical significance, rarity of type, excellence of form or other special considerations.
2. Replace trees of minimum three-inch caliper, removed by construction, on the basis of diameter inch for diameter inch, up to four-inch maximum caliper, and on total diameter inches removed, so that planting can be complete and uniform throughout.
3. Use replacement trees of prime specimen quality, field selected and seal-tagged Measure, grade, install and maintain plants in accordance with ANSI Z60.1, except for National Park Service lands where trees are to be measured for diameter by taking the average of two trunk caliper measurements at right angles, six inches above the root crown.
4. Replace shrubs removed with same species and varieties and of same size in height or width or substitute at locations designated by the Engineer a number of plants of same species and variety whose total measurements equal measurement of plant or plants to be replaced.
5. Topsoil:
   a. Provide and place topsoil in tree spaces and areas to be seeded in accordance with Section 32 91 00, Planting Preparation.
6. Grassed Areas:
   a. Unless otherwise shown, provide seed in accordance with Section 32 91 00, Planting Preparation. If sodding is required, provide in accordance with Section 32 91 00, Planting Preparation.
7. Replace landscaping, trees and grassed areas, inside and outside limits of work, if removed or damaged.

K. Joints Between Existing and Restored Work:
   1. Make joints between existing and restored work as inconspicuous as practicable.
   2. Use saw to cut straight line at joint between existing and new concrete surfaces.
   3. Make joints between existing and restored work at least equal structurally to original undisturbed items.

3.03 CLEANING

A. Removals:
   1. Remove work to extent shown minimizing damage to work which is to remain in place.

B. Salvage:
   1. Clean salvaged items of foreign material and store in accordance with the Special Provisions at accessible points within right-of-way unless otherwise shown, approved or directed.
   2. Repair or replace salvaged items which are damaged or destroyed.
   3. Unless otherwise specified, items removed but not to be salvaged will become the property of the Contractor.

3.04 MAINTENANCE

A. Plant Maintenance and Replacements:
   1. For 18 months after completion of plant installation, maintain planting and incidental work by replacing plants, watering, weeding, cultivating, fertilizing, remulching, pruning, controlling insects and diseases, reguying, rewrapping and by performing other

maintenance operations for promotion of root growth and plant life so that work is in satisfactory condition at completion of Contract and throughout maintenance period.

2. Water and weed root system of plants at regular intervals and keep surrounding soil in condition for promotion of root growth and plant life.
3. Provide planting and planting materials that will be in a condition acceptable to the Engineer at end of maintenance period.
4. During next planting season, replace trees, ground cover, vines and shrubs which are discovered during and at end of maintenance period to be dead or in unhealthy, unsightly or badly impaired condition. Replace with healthy plants of same kinds and sizes as originally specified.
5. The Contractor will not be held responsible or liable for damages to plants and planting materials by animals, malicious or careless damage by human agencies over which he has no control, or by fire and storm damage following completion and acceptance of original planting.

END OF SECTION

SECTION 02 65 00

UNDERGROUND STORAGE TANK REMOVAL

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Requirements for removing existing underground storage tanks (USTs), fuel dispenser pumps, and their associated piping and appurtenances in accordance with Maryland Department of the Environment (MDE) and related local government agency requirements at the locations indicated on the Contract Drawing Demolition Plan, C-102, and includes the following activities:
      a. Collecting, testing, and analyzing waste characterization samples from the contents remaining in the tanks, excavated soils, and water from excavations.
      b. Emptying contents remaining in the tanks by pumping.
      c. Cleaning the empty tanks.
      d. Removing, transporting, and properly disposing of the USTs and their associated piping, leak detection systems, appurtenances, and residual contents.
      e. Removing, transporting, and properly disposing of the dispenser pumps and their associated piping, appurtenances, and residual contents.
      f. Performing Site remediation activities (if required).
         1) Excavation, removal, and disposal of potential petroleum-contaminated soil in the tank, dispenser or petroleum piping excavations.
         2) Removal of potential petroleum-contaminated water present in the tank, dispenser or petroleum piping excavations.
      g. Collection of closure assessment samples following removal of the tanks systems or post-excavation samples following remediation activities.
      h. Backfilling and Site restoration.
      i. Furnishing notification and obtaining permits required by federal, state, and local regulating agencies as well as official closure documentation required.

B. By submitting a cost proposal, the Contractor acknowledges that he has visited the site, investigated and satisfied himself as to:
   1. The conditions affecting the work, including, but not limited to: physical conditions of the site that may bear upon site access; handling and storage of tools and materials; volume of fluids remaining in the USTs, access to water, electric or utilities; or that may otherwise affect performance of required activities.
   2. The character and quantity of all surface and subsurface materials or obstacles to be encountered in so far as this information is reasonably ascertainable from an inspection of the site, as well as information presented on plans and in specifications included with this contract.
   3. The Contractor shall verify all dimensions in the field and inform the Engineer of any discrepancy before ordering equipment or performing work. The Contractor shall be responsible for the coordination and proper relation of this work to the site and to the work of all trades Hours of Work.
   4. Any failure by the Contractor to acquaint himself with available information will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work. WMATA is not responsible for any conclusions or interpretations made by the Contractor on the basis of information made available by WMATA.

C. Related Sections:
1. Section 01 33 00 - Submittal Procedures.
2. Section 01 40 00 - Quality Requirements.
3. Section 01 56 00 - Temporary Barriers and Enclosures.
4. Section 01 57 00 - Temporary Controls.
5. Section 02 41 00 - Demolition.
6. Section 31 23 19 - Dewatering.
7. Section 31 20 00 - Earthwork.
8. Section 32 12 16 - Asphalt Paving.
9. Section 32 13 13 - Concrete Paving.

1.02 REFERENCES

A. Definitions:
1. Combustible Gas Indicator (CGI): A device having sensors calibrated to measure the amount of a combustible gas or vapor in a given atmosphere, and used to test atmospheres for sufficient oxygen content for life support and/or the presence of combustible gases or vapors posing a potential flammability/explosion hazard.
2. Lower Explosive Limit (LEL): A lower limiting concentration of a gas or vapor in air at normal ambient temperatures that is needed for the gas or vapor to ignite and explode, expressed as a percentage of the gas or vapor in the air by volume; at gas or vapor concentrations below the LEL in air, there is not enough fuel to continue an explosion.
   a. The concentration of the gas or vapor in air is usually given as a percentage of the LEL.
3. Underground Storage Tank (UST): As defined by the United States Environmental Protection Agency, any one or combination of tanks, including underground pipes connected thereto, which is used to contain an accumulation of regulated substances, and the volume of which including the volume of the underground pipes connected thereto is 10 per centum or more beneath the surface of the ground.

B. Reference Standards:
1. All work described herein shall be conducted in accordance with these specifications and all applicable laws, ordinances, rules, standards, codes, and regulations of Federal, and local governments and agencies.
2. Except to the extent that more explicit or more stringent requirements are written directly into the contract documents, all applicable standards, guidelines, codes, and regulations listed below have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith. If there are any discrepancies between the technical specifications and the regulations, the most stringent requirements will supersede the other. As new and revised regulations are published by governmental authorities, they become a part of this specification at the time of their effective date.
   a. American Petroleum Institute (API) RP 1604, Closure of Underground Petroleum Storage Tanks
   b. API RP 1615, Installation of Underground Petroleum Storage Systems
   c. API RP 1628, Guide to the Assessment and Remediation of Underground Petroleum Releases
   d. API Standard 2000, Venting Atmospheric and Low-Pressure Storage Tanks

e. API 2202 - Dismantling and Disposing of Steel from Aboveground Leaded Gasoline Storage Tanks.
f. API 2207 - Preparing Tank Bottoms for Hot Work.
g. API Standard 2015, Safe Entry and Cleaning of Petroleum Storage Tanks
h. API 2219 - Safe Operation of Vacuum Trucks in Petroleum Service.
i. ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
j. ASTM D1785-04, Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
k. ASTM D2922, Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
l. ASTM D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
m. National Fire Protection Association (NFPA), NFPA 30, Flammable and Combustible Liquids Code
n. NFPA 30A, Automobile and Marine Service Station Code
o. NFPA 37, Use of Combustion Engines and Gas Turbines
p. NFPA 70, National Electric Code
q. NFPA 326, Standard Procedures for the Safe Entry of Underground Storage Tanks
r. NFPA 329, Underground Leakage of Flammable and Combustible Liquids.
s. Petroleum Equipment Institute (PEI) RP 100, Installation of Underground Liquid Storage Systems
t. PEI RP 1100, Storage and Dispensing of Diesel Exhaust Fluid (DEF).
u. U.S. Environmental Protection Agency (EPA) Regulations, 40 CFR
v. U.S. EPA 530/F-93/004, Test Methods for Evaluating Solid Waste (SW-846)
w. U.S. EPA 600/4-79/020, Methods for Chemical Analysis of Water and Wastes
x. U.S. Department of Transportation (DOT) Regulations, 49 CFR
y. U.S. Occupational Safety and Health Administration (OSHA) Regulations, 29 CFR
z. Code of Maryland Regulations (COMAR), Title 26

1.03 ADMINISTRATIVE REQUIREMENTS

A. Scheduling:
1. Coordinate disconnections or interruptions in utility service as outlined in Section 02 41 00, Demolition.

1.04 DESIGN REQUIREMENTS

A. Underground Storage Tank Removal Work Plan (USTWP):
1. Prepare and submit to the Engineer an Underground Storage Tank Removal Work Plan (USTWP) that describes in detail the proposed procedures for removing and properly disposing of existing underground storage tanks, dispensers, and potential petroleum-contaminated soil and liquids indicated to be removed on the Contract Drawings.
a. A detailed sequence of operations, and a description of the methods and equipment to be used for each operation.
b. Procedures for carefully removing, testing, and disposing of solid materials and liquid wastes; and for safely conducting the Work.
1) Describe the proposed method for product removal from the tanks, pipelines, and ancillary equipment.

2) Insure that the procedures comply with off-site transportation and disposal requirements.

c. Names and locations of appropriately licensed disposal facilities intended to be used for the disposal or recycling of removed tanks, piping, tank supports, liquid waste, solid waste, and appurtenances.

d. Maintenance of traffic, submittal schedule, licenses and certifications for laboratory and disposal site, and staging/storage/stockpile areas.

B. Detail drawings and design calculations for sheeting, shoring, and other temporary support of excavation and methods of construction shall be submitted for record purposes. The drawings shall bear the seal and signature of a professional engineer registered in the State of Maryland. The Engineer will not review the drawings or calculations for approval. The Contractor shall be solely responsible for the adequacy of the excavation supports, and for the safety of excavations.

C. Except as otherwise specified or indicated on the Contract Drawings, comply with the requirements of the API standards listed in Paragraph 1.02B.

1.05 SUBMITTALS

A. Prior to commencement of work, submit the following information to the Engineer for review and approval in accordance with the requirements of Section 01 33 00, Submittal Procedures:
1. Copies of all licenses and certifications maintained by the Contractor and its employees required to perform the work from each jurisdiction where work will be performed.
2. Copies of all notifications made to regulatory agencies.
3. Copies of the permit obtained from each jurisdiction required to complete the work under this contract.
4. UST Work Plan that describes methods, means, sequence of operations, and schedule to be employed in the testing, pumping, cleaning, de-vaporizing, inspecting, removal, and disposal of storage tanks and piping.
5. Disposal/treatment facility permits and certifications/licenses for transporter and disposal facility.

B. Within 15 days of completion of work, submit copies of the following:
1. All transport manifests, trip tickets, and disposal receipts for all wastes removed from the Site including, but not limited to, soil, water, tanks, residual tank contents (product and sludge).
2. Copies of material certifications, test results, test reports, inspection records, closure reports, as-built drawings, and directives/correspondence from regulators.

1.06 QUALITY ASSURANCE

A. Qualifications:
1. Tank Removal Personnel:
a. Only employ personnel qualified to perform underground storage tank and fuel pump dispenser removal operations that can demonstrate at least 5 years of experience performing removals similar to those required as the Work of this Section and licensed in the State of Maryland in accordance with requirements specified in COMAR 26.10.06.02.

1) Persons responsible for testing tank atmospheres using a combustible gas indicator (CGI) must be completely familiar with the use of the instrument and the interpretation of the instrument's readings.

b. Submit the resumes, licenses, and other qualifications of the personnel intended for performing tank removal operations to the Engineer for approval.
   1) Attach evidence that the persons responsible for CGI testing have been trained to use and read the CGI employed at the Site.

2. Utility Locator Company:
   a. Employ a utility locator company capable of confirming the location of utilities as indicated on the Contract Drawings, and of identifying additional utilities that may be located at the Site.
   b. Employ an experienced utility locator company that can demonstrate at least 5 years of experience performing utility locations similar to those required as the Work of this Section.
   c. Submit the licenses, certifications, and other qualifications of the firm intended for performing utility location operations to the Engineer for approval.
3. Off-Site Disposal/Treatment Facility:
   a. Use only disposal/treatment facilities properly licensed to handle the types of waste materials generated by the Work of this Section, and listed in the approved Underground Storage Tank Removal Work Plan (USTWP).
   b. Off-Site disposal facilities must be approved by the Engineer prior to being used to receive waste materials from this Contract.
   c. Submit the name and location, licenses, certifications, and other qualifications of disposal and recycling facility(s) intended for use for the disposal or recycling of tanks, piping, tank supports, liquid waste, solid waste and appurtenances to the Engineer for approval.
4. Testing and Inspection Agency:
   a. Employ an independent Testing and Inspection Agency having both the qualifications specified in Section 01 40 00, Quality Requirements, and the following additional qualifications:
      1) Capable of performing the reviews, inspections, and testing required by this Section to verify compliance with the Contract Document; including but not limited to the following:
         a) Providing the sampling and laboratory analytical services required in a manner acceptable to the disposal and recycling facility receiving materials.
         b) Collecting waste characterization samples from the tank contents.
         c) Providing compaction testing of backfilled areas as specified in Section 31 20 00, Earthwork, for acceptance by the Engineer.
   b. Submit the qualifications of the firm(s) intended for use as an independent Testing and Inspection Agency to the Engineer for approval.

B. Regulatory Requirements:
   1. Remove each tank and its associated surface and subsurface piping and equipment according to applicable Federal, State, and Local requirements.
      a. Comply with the MDE COMAR 26.10.10 Out of Service UST Systems and Closure regulations, Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act (RCRA), and other Federal laws and regulations listed in Paragraph 1.02.B or applicable, and with State and Local laws and regulations, applicable to underground storage tank and dispenser removals.

2. Package or containerize, label, manifest, transport, and dispose of non-hazardous and potentially hazardous liquid and solid wastes in accordance with the provisions of applicable Local, State and Federal laws and regulations.
    a. Transport hazardous and non-hazardous waste in vehicles appropriately licensed, placarded, and operated by appropriately trained personnel.

C. Certifications:
1. Certificate of Destruction:
    a. For each tank decommissioned, and within 15 days of the tank's removal from the Site, submit a signed Certificate of Destruction to the Engineer.

D. Field Samples:
1. Waste Characterization Sampling and Analysis:
    a. To the extent required by the approved off-site disposal facility intended to receive the material being removed, have the Testing and Inspection Agency perform waste characterization sampling and analysis of the contaminated materials removed prior to transporting them off-site.
    b. Perform additional sampling and analysis required by others prior to transporting the potentially contaminated material.
    c. Conduct sampling and perform laboratory analysis of post-excavation closure assessment samples and all soil, sludge and fluid material being removed throughout the duration of excavation activities.
        1) Sample and test materials to determine if non-hazardous or hazardous contaminated materials disposal is required.
    d. Prepare, maintain, and submit to the Engineer documentation of the sampling and analysis, such as sample locations, rationale, chain-of-custody, test results, and similar information prior to removing tank contents.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Provide the equipment, personnel, and facilities necessary and suitable to remove, load, transport, unload, and dispose of or recycle the excavated soil materials, USTs and fuel pump dispensers, associated piping, tank contents, and other items demolished under this Section.
    a. If similar liquid wastes are compatible, they may be bulked for cost effective disposal.
2. Transport and manifest the liquids, residues, and rinsate removed to an approved disposal facility.
    a. Transport demolished and excavated materials off-site for disposal/treatment.
    b. Have the Engineer sign the manifest prior to transporting waste rinsate to an approved disposal facility.
    c. Secure the tanks on trucks for transportation to a storage or disposal facility with all accessible holes being plugged or capped.
        1) Provide one plug with a 1/8-inch vent hole, and locate this plug at the uppermost point on the tank to prevent the tank from being subject to excessive differential pressure caused by temperature changes.
            a) Position the tank so the vent plug is on the top of the tank during subsequent transport and storage of the tank, or until the tank is punctured preparatory to disposal.

B. Storage and Protection:
   1. Rinsate:
      a. Contain and label rinsate generated by tank, pipe, and appurtenance cleaning operations.
         1) At a minimum, label the rinsate with the date it was generated, the location of the tank it was removed from, and the type of liquid or residue,.
      b. Locate rinsate in above ground containers temporarily stored on-site away from traffic patterns as designated by the Engineer.
      c. Keep rinsate from cleaning operations separate from contaminated and uncontaminated surface runoffs, and from the tank contents.

1.08 PROJECT CONDITIONS

A. Information shown on the Contract Drawings is based on visual field examinations and existing record documents. While the information provided is believed to be correct, no assurance is implied relative to its total completeness or accuracy. The existing tank locations as shown on the Contract Drawings are approximate. The Contractor shall be responsible for verification of the exact location of the underground tanks and piping. Report discrepancies to the Engineer before disturbing existing installations.

B. The two 10,000-gallon diesel fuel USTs are located in an open area southeast of Building A, adjacent to a one-story metal shed. No design drawings exist specifying the dimensions or construction of the UST system, burial depths, and related petroleum dispensing system components. Based on photographs taken by WMATA during a site walkthrough, the two 10,000-gallon diesel fuel USTs are located adjacent to each other beneath a concrete slab. Standing water was observed inside of the fill port access manways for each tank. No free product was observed in tank field observation wells located at each corner of the USTs, although groundwater was observed inside of observation wells. No depths to groundwater were provided although notes on photographs indicate the depth to water to be “high”.

C. The remote two diesel fuel dispensers are located on a concrete pump island with a metal rim enclosure southwest of Building C, approximately 130 feet east of the UST basin. The pump island has four adjacent steel protective bollards, overhead lighting and steel vent lines. The system emergency shut-off switch is located on the exterior wall of Building C. The surrounding area is a concrete paved access road with a concrete curb and gutter system. Underground fuel lines connecting the two dispensers with the diesel fuel USTs are located beneath both concrete and asphalt surfaces.

PART 2 - PRODUCTS

2.01 Materials

A. The Contractor shall provide all materials that are required to complete the work included in this contract. Where equipment or materials are not specifically referenced herein, the Contractor shall provide all such equipment and materials that are necessary for, or incidental to, the performance of the work. All materials not used by the Contractor shall be his property and shall be removed from the job site at the completion of their use.

B. Backfill:
   1. Provide backfill materials complying with the requirements of Section 31 20 00, Earthwork.

C. Pavement Materials:
   1. Asphalt Paving Materials:
      a. Provide asphalt paving materials complying with the requirements of Section 32 12 16, Asphalt Paving.
   2. Portland Cement Concrete Paving Materials:
      a. Provide plain Portland cement concrete paving materials complying with the requirements of Section 32 13 13, Concrete Paving.

D. Materials needed or required for temporary protection include barricades, fences, enclosures, etc., may be pre-used construction materials of sound condition and reasonably clean. However, the condition of same materials shall meet or exceed the requirements of governing agencies or approving bodies as may be involved with or have jurisdiction over the work.

PART 3 - EXECUTION

3.01 GENERAL

A. All work shall be performed in strict accordance with the provisions of the Contract Documents and with the provisions of API RP 1604. If there is any discrepancy, the more stringent provisions will govern.

B. Safety Guidelines:
   1. Personnel working inside and within the general vicinity of the tanks shall be trained and thoroughly familiar with the safety precautions, procedures, and equipment required for controlling the potential hazards associated with this work.
   2. Personnel shall be trained and certified in accordance with OSHA 29 CFR 1910.120 and OSHA 29 CFR 1910.146 (permit required – confined spaces) and physically carry proof of certification at all times on the site.
   3. Personnel shall use proper protection and safety equipment during work in and around the tanks as specified in API STD 2217A, API RP 1604, and the Contract Documents.

C. The existing tanks shall become the property of the Contractor and transportation and disposal shall be in accordance with all federal, state, and local requirements. The Contractor shall remove these tanks from the site no later than 48 hours after proper cleaning was completed and authorized to do so by the Engineer.

D. All supply pipes, vents, fill pipes, and other appurtenances related to the fuel distribution system shall be removed by the Contractor no later than 48 hours after proper cleaning was completed and authorized to do so by the Engineer.

E. During the excavation, the Contractor shall maintain vehicular and pedestrian traffic flow safely through the parking lots. All labor, equipment, materials, signing, cones, barriers, steel plating, etc. required to maintain access through the facility shall be considered incidental to the applicable item(s) of work.

3.02 EXAMINATION

A. Prior to performance of the actual work, carefully inspect the entire site and locate USTs, dispensers, lines and related appurtenances designated to be removed. Locate existing

exposed and buried utilities and structures, and determine the requirement for their protection, or their disposition with respect to the UST removal work.

B. Turn off, secure, and label pump circuit breakers, and disconnect wiring to the pumps at the panel in accordance with OSHA 29 CFR 1910.147. Prohibit or mitigate all potential ignition sources within 25 feet of the work area or other zone as defined by NFPA 70. Potential ignition sources include open flames, spark producing equipment, and high temperature equipment such as internal combustion engines. The Contractor shall observe appropriate safety precautions such as installing vapor isolating barriers, vapor concentration monitoring, and using equipment listed for use in hazardous zones as mitigation.

3.03 PREPARATION

A. Protection:
   1. Prior to the commencement of work, the Contractor shall obtain necessary permits to perform the work from the appropriate agency in each jurisdiction, including completing the MDE 30-Day Written Notification for UST System Removal/Abandonment. The Contractor shall notify regulatory agencies of work to be performed, as necessary. The Contractor shall obtain necessary licenses, inspections, clearances, and approvals as required for the work described herein. These include, but are not limited to the following.
      a. Utility clearances, in accordance with the requirements of Miss Utility.
      b. Licensing and certifications from local and state agencies.
      c. Permit from local and state agencies.
   2. The Contractor shall retain the services of a qualified underground utility location service to perform a utility location survey to identify all underground utilities in the work area prior to excavation. The Contractor shall ensure that all existing utilities in the area to remain are protected from damage during the work.
   3. Contractor shall hand dig within 3 feet of all underground utilities. Exercise caution to avoid damaging existing underground fiberglass product and vent piping associated with the UST system, piping, sumps, tank walls, and electrical conduit. Test pit excavations may be required for location of electrical conduits and other utilities. It shall be the responsibility of the Contractor to determine the location of underground structures and utilities by the use of test pit excavation prior to excavation operations. Each pit shall be backfilled and compacted.
   4. The Contractor shall maintain a barrier/fence around all excavations to prevent unauthorized or accidental access to the work area. Concrete barriers shall be placed around excavations in vehicle travel areas. The Contractor shall maintain a barrier/fence around designated temporary stockpile areas and storage areas.
   5. Take precautions to work safely around the utility corridors identified, or have the utility services temporarily disconnected.
   6. Before beginning to excavate, place temporary erosion and sediment controls around proposed excavations in accordance with Section 01 57 00, Temporary Controls, to eliminate erosion and sedimentation problems caused by the Work of this Section.

B. Surface Preparation:
   1. Excavate around the tanks and piping to be removed, and uncover them to facilitate their removal.
      a. The Contractor shall saw cut and remove the existing reinforced concrete and asphalt pavement and place these materials directly into dump trucks for transport to a pre-approved disposal/recycling facility.

b. Excavate to the top the tanks and their appurtenances.
c. Manage surface water runoff, seepage, and infiltrating groundwater .

2. Provide temporary barriers around open excavations to protect workers and the public from injuries sustained from falling into the excavations.

C. Demolition/Removal:
1. Remove any existing water, fuel, or other fluids and residues in existing pipelines and appurtenances in a safe and proper way so that flammable, hazardous, toxic, or deleterious substance are not released into or on the land surface, waterways, or any other portion of the environment.
a. The Contractor shall remove and properly dispose of residual product and sludge and shall clean each tank interior.
b. Furnish only explosion-proof or air-driven pumps for removing liquids and residues from existing piping and equipment.
1) Bond the pump motors and suction hoses to pipe or otherwise ground these items to prevent electrostatic ignition hazards.
c. If vacuum trucks are furnished to remove liquids or residues from existing piping and equipment, comply with the requirements of API 2219.
1) Insure that the area the vacuum trucks operate in is free of flammable vapors.
a) Locate the vacuum trucks upwind from the tanks and outside the path of probable vapor travel.
2) Discharge vacuum pump exhaust gases through a hose of adequate size and length downwind of the truck and tank area.
d. Remove the residue on the interior of piping to the degree of cleanliness required by applicable regulations and by the requirements of the tank and piping disposal or recycling facilities.
1) Steam and/or detergent solvent solutions may be used to aid in removing the residue provided they are disposed of the same as the pipe and equipment contents and they do not introduce hazardous substances.
2. Perform inspections to ensure that the contents of existing pipelines and appurtenances are thoroughly drained into suitable containers having the capacity and integrity to contain them for storage until their proper disposal can take place.
a. Take care to drain all depressions, pockets, lines, and pumps.
3. Disconnect system lines from compartments and equipment.
a. Disconnect pumps, tightly seal their outlets, and remove the pumps.
b. Remove meters, air eliminators, and manifold valves from the tanks and piping to be removed.

3.04 REMOVING UNDERGROUND STORAGE TANKS, PIPING, AND APPURTENANCES

A. Perform all work to properly close, remove and dispose of underground storage tanks and all associated appurtenances including, but not limited to, concrete anchor pads, piping, vents, sumps, pumps, dispensers, tank gauges, tank monitoring equipment, and soil materials in areas specified on Demolition Plan, Drawing C-102.

B. Tank Degassing:
1. Degas the tanks prior to and during cleaning operations, and before initiating tank demolition to temporarily free the tank atmosphere of vapor, and to reduce the flammable and/or combustible tank atmosphere to a safe working level.
a. Remove flammable vapors using a method described in API 1604, except as follows:

1) Do not fill tanks with water.
2) If dry ice is employed, use a minimum of 1.5 pounds of dry ice per 100 gallons of tank volume.

b. Vent vapors from tanks at a minimum of 12 feet above grade to avoid creating a flammable and/or combustible hazard.
1) Existing vent pipes may be used for this purpose provided they are 12 feet above grade.
a) If an existing vent pipe is not 12 feet above grade or above the building roof line, attach an extension pipe.

2. Obtain and maintain atmospheric readings of 10 percent or less of the lower explosive limit (LEL) prior to and during the tank cleaning process.
a. Recognize that tanks can still become a source of flammable vapors even after the degassing procedures are followed.
b. Test the tank and pipeline atmosphere regularly for flammable or combustible vapor concentrations according to API 1604 until tank demolition is complete.
1) Use a properly calibrated combustible gas indicator (CGI) to determine the combustible atmosphere within the tank.
a) Properly calibrate combustible gas indicators according to the Manufacturer's instructions, and thoroughly check and maintain the calibration in accordance with the Manufacturer's Specifications.
2) If another approved method as described in API 1604 is proposed in lieu of CGI testing, it must be in accordance with State and Local fire codes.

C. Excavate and remove the UST.
1. Excavate soil/fill a minimum of 2 feet below the bottom of the tank and adjacent to the tank.
2. Excavation around the perimeter of the tanks shall be performed in a manner that will limit the amount of potentially contaminated soil that could be mixed with uncontaminated soil. Petroleum contaminated soil shall be reported immediately to the Engineer. Surface water shall be diverted to prevent direct entry into the excavation. Dewatering of the excavation will be limited to that necessary to assure adequate access to the tanks and piping and to assure a safe excavation.
3. The tanks shall be removed from the excavation and the exterior cleaned to remove all soil and inspected for signs of corrosion, structural damage, and leakage. All materials coming into contact with the tanks, or in the vicinity of the excavation, such as shovels, slings, and tools shall be of the non-sparking type. After removal from the excavation, the tanks shall be placed on a level surface adjacent to the tank excavation and secured with wood blocks to prevent movement.
4. Where present, demolish, remove and dispose of reinforced concrete anchor pad below the tank. Excavate soil/fill a minimum of 2 feet below the bottom of the anchor pad.

D. Tank Cleaning and Liquid Residue Removal:
1. Disconnect the tank and its associated piping.
2. Immediately following the tank degassing operation, clean the tank in accordance with the procedures in API 2015, and rinse it with a cleaning agent approved by the Engineer.
a. Ensure that residues in the tanks and piping remain in the tanks and piping during removal operations.
b. Submit Product Data for the cleaning agent to the Engineer for approval.
3. For removing liquids and residues from existing tanks, furnish only explosion-proof or air-driven pumps.

a. Bond the pump motors and suction hoses to pipe or otherwise ground these items to prevent electrostatic ignition hazards.

4. Excavate and remove all piping associated with the UST, including the vent piping. Where approved by the Engineer, piping may be abandoned-in-place underground only if the ends are securely capped and the piping is filled with grout.
5. Excavate and remove all conduit and wiring associated with the UST, including high voltage (power) and low voltage (control) conduits. Where approved by the AR, conduit may be abandoned in place only if wires are removed and the ends are securely capped and the conduit is filled with grout.
6. The existing pumps, dispensers, and tank observation wells shall be completely removed.

E. Tank Demolition:

1. Demolish tanks and their associated lines in accordance with API 2202 and API 2207.
   a. Cap or plug all accessible holes.
      1) Provide a 1/8-inch vent hole in one plug to prevent the tank from being subjected to excessive differential pressure caused by temperature changes.
         a) Keep the tank positioned with this vent plug on the top of the tank during subsequent transport and storage, or until they are punctured preparatory to disposal.
2. Label the tanks after demolition but prior to removal of the tank from the Site.
   a. Regardless of the condition of the tank, provide a warning label containing a warning against using the tank for storing certain types of refuse.
   b. Indicate each tank's former contents and the present vapor state, including vapor-freeing treatment.
   c. Provide a legend on the label similar to the following in lettering at least 2 inches high and legible:

> 1. Tank Has Contained Diesel Fuel Not Vapor Free.
> 2. Not Suitable for Storage of Food or Liquids Intended for Human or Animal Consumption.
> 3. Date of Removal: *mm/dd/yyyy*.

3. Remove the tanks from the Site as promptly as possible, preferably on the day of tank demolition.
   a. If the tanks remain at the Site overnight, test them with a CGI in accordance with State and Local regulations prior to removing them.
      1) If the testing indicates an atmosphere in excess of 10 percent of the LEL, evacuate the Engineer's and Contractor's personnel to a safe area, except those directly engaged in reducing the combustible atmosphere.
         a) Do not perform Work on or around the tanks until the combustible atmosphere in the each tank is less than 10 percent of the LEL.
         b) Provide appropriate ventilation, degassing, or other safety measures to reduce the combustible atmosphere in the each tank to less than 10 percent of the LEL prior to resuming Work.
4. Reduce the tanks to scrap at a Site specifically designated for this activity, and sell or dispose of the demolished tanks as scrap.
   a. Do not reuse the tanks or sell the tanks for reuse.

b. If it is not possible or feasible to reduce the tanks to scrap, render the tanks unfit for further use.
   1) Introduce a sufficient number of holes in the tanks to make their reuse impossible.
   2) Check the tanks with a CGI before and during this operation to prevent fire or explosive hazards.

F. Closure Assessment:
1. The Contractor shall observe and screen soil materials removed from the UST, dispenser and fuel line excavations, and separate these materials into stockpiles that are suspected to be petroleum impacted and that are suspected to be "clean" or not impacted by petroleum. Excavated soils will be further segregated from concrete and asphalt material. The procedures for separating these materials will be based on the results of on-site organic vapor screening to be performed by the Contractor using a photoionization detector (PID), visual indications of petroleum staining, or petroleum odors. If soil materials are suspected to be petroleum-impacted (generally PID readings greater than 100 ppm) , the Contractor will collect necessary soil samples for laboratory analysis to properly characterize the soil, for subsequent removal and off-site treatment/recycling according to the selected receiving facility's requirements as described in Section 3.06
2. After the UST, dispensers and fuel piping materials are removed from the excavations, the Contractor shall collect soil samples for the closure assessment and screen each soil sample for organic vapors using a PID. Soil samples will be collected using a stainless steel sample trowel or hand auger from undisturbed soil, approximately one foot below the bottom of the excavation areas. All soil samples will be discrete grab samples and not composite samples. Each sample point location will be established using a tape measure and reference points relative to Site features, with depth below the ground surface (bgs) recorded. Closure assessment soil samples will be collected as follows:
   a. USTs: One sample will be collected below the bottom of each tank directly beneath the fill connection and one sample below the bottom of each tank directly beneath the product delivery line connection.
   b. Tank Basin: One sample (total of 4) will be collected from a representative location along each of the four tank basin excavation sidewalls. The specific locations and depths selected will be based on PID readings, or other visual/olfactory indications of petroleum impact. If no indications of petroleum impact are present, the soil samples will be collected at the bottom or base of the excavation.
   c. Product Delivery Lines: One sample will be collected from within each piping trench below the product delivery line, directly below the connection with the associated tank and at 25-foot intervals along the remaining piping line. If possible, the product line soil samples should be collected at swing joints, flex connectors or pipe elbows, if they exist.
   d. Product Dispensers: One sample will be collected below each product dispenser.
   e. Where water or groundwater is encountered in the tank excavation, soil samples shall be collected from just above the soil-ground water interface. In addition, at least one water sample per tank (if encountered) will be collected and analyzed. Closure assessment laboratory analyses for soil and groundwater samples shall include the following parameters, based on the historic diesel fuel stored in the tanks:
      1) Total petroleum hydrocarbons-diesel range organics (TPH-DRO) and TPH-gasoline range organics (GRO) by USEPA method 8015 modified.
      2) Volatile organic compounds (VOCs) by USEPA method 8260.

f. Soil samples analyzed for VOCs and for TPH-GRO will be collected using an EnCore™ sampler or approved equal in accordance with USEPA Method 5035. All samples shall be placed in laboratory supplied bottles, handled using chain-of-custody procedures and express mail or courier delivered to the pre-approved laboratory for subsequent analysis. Laboratory analysis shall be performed using a rush 24 to 48-hr turn-around time. Analytical results for samples collected during UST closure that equal or exceed 100 mg/kg TPH (in soil) or 1.0 mg/L TPH (in groundwater) must be reported to the MDE within 24 hours of receipt of the results. Following receipt of laboratory results and confirmation from MDE, the UST basins can be backfilled.

G. UST Closure Report:
1. A UST Closure Report shall be prepared after completion of the UST system removals in accordance with MDE COMAR 26.10.10 and the related MDE Sample UST Closure Report Guidance document dated November 16, 2007. Provide one hard copy of the report and one electronic copy of the report in .pdf format. The text of the report shall also be provided in .doc format, and will include at a minimum:
   a. Completed UST Notification Form
   b. Description of work, including removal procedures, number of tanks removed, identification of tanks removed and disposed of, cubic yards of excavated soil, location of disposal sites, and dates of excavation.
   c. Site plan including location of tanks and piping, limits of excavation, sampling points, results of excavation, and depths.
   d. Laboratory testing reports, copies of data and test results from testing laboratory.
   e. Tank disposal paperwork, contaminated soil disposal paperwork, and contaminated water disposal paperwork.
   f. Certifications required by implementing agency.
   g. Building permit, inspection permits, and other permits required for underground tank removal, notifications, and inspection reports.
   h. Cumulative quantities of soil excavated, beginning with start date for each tank and associated piping, and completed disposal manifests.

3.05 CONTAMINATED SOIL EXCAVATION AND DISPOSAL

A. Contractor shall remove and properly dispose of all soil/fill materials. For bidding purposes, Contractor shall assume all soil/fill will be disposed of as non-contaminated soil. For soil that is found to be petroleum contaminated, Contractor shall segregate and dispose of the soil based on confirmatory laboratory analysis. Overexcavation of soil to remove petroleum contamination beyond which is required to remove the tank system components shall not occur without approval of the Engineer.

B. Based on MDE Cleanup Standards for Soil and Groundwater dated June 2008, excavated soil/material with a TPH concentration greater than 620 mg/kg must be disposed off-site at a facility licensed/permitted to accept petroleum impacted material. Soil with a TPH concentration less than 620 mg/kg may be reused on site. Soil with a TPH concentration less than 10 mg/kg is considered “clean fill” and may be reused without restrictions assuming there are no other chemicals of concern.

C. All excavated material shall be stored at a location on site as identified by the Engineer until receipt of soil testing results. Maintain separate stockpiles for (potentially) petroleum-contaminated soils/fill and non petroleum-contaminated soils/fill. Provide signage to identify soil stockpiles.

D. Place excavated soils/fill on impermeable lining (e.g., 20 mil polyethylene sheeting) and cover to prevent runoff of potential contaminants to the surrounding area. The sheeting shall be weighted with sand bags or other material to ensure that soils/fill will remain covered; native soils shall not be used to weight sheeting. Place straw bales between stockpiles and nearby drainage inlet structures to prevent soil and/or runoff from entering the facility's storm sewer system. Maintain soil stockpiles, including cover, throughout construction effort until disposal.

E. The Contractor shall collect representative soil samples from each temporary stockpile of excavated material; a minimum of two composite samples shall be collected from each stockpile. Contractor is responsible for the collection and laboratory analysis of all samples required by the disposal facility to characterize the soil. The stockpiled soil samples shall be analyzed within respective holding times for parameters specified by the Contractor's treatment/disposal facility. All material must be removed from the property within 72 hours after receipt of analytical results.

F. The Contractor shall maintain records relating to removal, transport, storage, treatment and disposal of all wastes, including contaminated wastes, and shall furnish copies of such records to Engineer. These records include sample analyses required for disposal, waste manifests, trip tickets and disposal receipts.

G. Should groundwater be encountered in the excavations, properly manage groundwater in accordance with this Section 3.06. Groundwater shall only be pumped from the excavation as required to remove the UST systems, not as a remediation measure. For bidding purposes, Contractor shall assume all water may be discharged to the storm sewer system in accordance with the Contractor-obtained temporary discharge permit.

3.06 CONTAMINATED WATER REMOVAL

A. Identifying, transporting, and treating contaminated groundwater shall be handled as described herein and in accordance with applicable federal, state, and local regulations.
   1. Dewatering: If removal of fluid is required to remove the UST or if Liquid Phase Hydrocarbons (LPH) is observed on the water surface, which requires removal, Contractor shall provide all necessary labor, equipment, and materials to pump fluids from the excavation and shall transport the fluid off-site for disposal at an approved disposal facility in accordance with all applicable state and federal requirements.
   2. The Contractor shall pump water from open excavations only, shall plug pipes, and shall divert other sources of water so that no liquid other than groundwater and precipitation collects in the project area.
   3. Groundwater Management. The Contractor shall manage groundwater pumped due to dewatering in the Project area. The Contractor may set up and maintain a groundwater treatment system designed to treat water for the presence of suspended solids, free product, and/or dissolved hydrocarbons. The Contractor may also elect to containerize the water for subsequent treatment and/or discharge or off-site disposal. Either groundwater management option shall have sufficient capacity to manage groundwater inflow into the open excavation. To the maximum extent practicable, the Contractor shall prevent the mixing of contaminated groundwater with uncontaminated groundwater in order to minimize the water volume requiring treatment or disposal. Any fluids removed from the site for off-site disposal shall be transported to a licensed facility permitted for acceptance of the specific waste material. Sampling and laboratory analysis may be required to meet the requirements of the disposal facility or to determine appropriate

permit requirements. All waste characterization sampling and analytical costs required for disposal are the responsibility of the Contractor.

4. It is the responsibility of the Contractor to ensure that all necessary permits pertaining to discharge are obtained.
5. It is the responsibility of the Contractor to report, contain, and clean up any spills occurring as a result of dewatering activities.

3.07 RESTORATION

A. Do not perform final backfilling of removed UST system excavation zones until authorized by the Engineer. The tank areas and any other excavations shall be backfilled only after the soil test results have been approved by the Engineer. The excavation shall be dewatered if necessary.

1. Following completion of the excavation, removal, and disposal of contaminated soil and water, and of the USTs, dispensers, and their appurtenances; backfill the voids left by the removals with the type of backfill material indicated on the Contract Drawings, and compact the backfill in accordance with the requirements of Section 31 20 00, Earthwork.
2. If required or indicated on the Contract Drawings, pave or re-pave disturbed areas with the type of paving indicated on the Contract Drawings, in accordance with the requirements of Section 32 12 16, Asphalt Paving, or Section 32 13 13, Concrete Paving, as appropriate.
3. Preserve, protect and maintain existing operable drains and sewers during excavation and grading operations. Upon completion of work, clean ditches and channels and remove all materials, including waste materials.

3.08 SITE QUALITY CONTROL

A. Site Tests:
   1. Have the Testing and Inspection Agency perform the testing required prior to proceeding with the final disposal of the tanks and other waste materials, and submit the testing records to the Engineer for approval, including the following:
      a. Chemical sampling and analysis of contaminated materials removed during UST or hydraulic lift removal activities prior to transporting these contaminated materials off-site as specified in Paragraph 1.06.D.1.
      b. Tests performed to comply with the requirements of each disposal facility as specified in Paragraph 1.06.D.1 and 3.06.A.1.
   2. Have the Testing and Inspection Agency test the compaction of the backfill placed, as specified in Section 31 20 00, Earthwork, and submit the testing records to the Engineer for approval.

B. Inspections:
   1. Have the Testing and Inspection Agency perform the inspections required by regulatory agencies, the disposal facilities, and API standards; and submit the inspection records to the Engineer for approval.

3.09 CLEANING

A. Waste Management and Disposal:

1. Follow the applicable regulatory requirements for disposing of removed underground storage tanks.
   a. In accordance with COMAR 26.10 and the Federal Resource Conservation and Recovery Act (RCRA), as amended and local laws and regulations, manage liquid and solid wastes according to the criteria set forth in those laws and regulations.
2. Pre-Disposal Documentation:
   a. Submit the following documentation for materials to be removed and disposed of to the Engineer prior to removing the materials from the Site:
      1) The names and locations of the disposal areas and facilities to be used for disposing and recycling the materials.
      2) Copies of the licenses, certifications, permits, and agreements required or issued for the disposal of materials.
      3) The equipment and methods to be used for removal and disposal operations.
3. Dispose of or recycle the tanks, piping, tank supports, liquid waste, solid waste, and appurtenances removed only at the disposal facilities listed in the approved Underground Storage Tank Removal Work Plan (USTWP).
   a. Dispose of removed underground storage tanks at an approved facility immediately after demolition.
   b. Reduce removed tanks to scrap at a site specifically designated for this activity, and sell or otherwise disposed of the tanks as scrap.
      1) Check the tanks with a combustible gas indicator (CGI) before and during this operation in order to prevent fire and explosive hazards.
   c. Under no circumstances allow the tanks to be reused or sold for reuse.
   d. If it is not possible or feasible to reduce the tanks to scrap, render the tanks unfit for further use by introducing a sufficient number of holes in the tanks to make their reuse impossible.
4. Disposal Operation Records:
   a. Maintain records of the inspections and tests performed to comply with the requirements of each disposal facility.
   b. Maintain detailed records of the entire disposal operation, including at a minimum the following information:
      1) Date of disposal operation.
      2) Tank number or identifier.
      3) Tank capacity.
      4) Tank dimensions.
      5) Product stored.
      6) Vapor purge method used.
      7) Amounts of product and other liquid removed, including rinsate.
      8) Disposal/recycling site of the tank and its appurtenances.
      9) Detailed log of contact with regulatory agencies and all personnel involved in the operation.
      10) Method used to render the tank unfit for the further use.
   c. Following shipment of contaminated materials to a disposal facility, submit to the Engineer a copy of each manifest evidencing the delivery of removed material to an approved licensed disposal facility, chain of custody records, weigh tickets, meter recordings, delivery tickets, and receipts required or issued for the disposal of materials:
      1) Prepare each manifest in accordance with the requirements of the applicable Federal, State, and local laws and regulations.
      2) Each manifest must list, but is not limited to, the following information:
         a) Surface runoff.

b) Tank contents.
c) Expended cleaning liquids and rinsate.
d) Structural components.
e) Tanks and piping.

3) Maintain and submit to the Engineer proper documentation for scrap metals recycling.

d. Maintain records of corrective actions taken to address any problems encountered during disposal operations.

e. Except as follows, within 15 calendar days of the final disposal of each tank submit the detailed records for the entire disposal operation to the Engineer for information.

1) Submit appropriate manifests and related documents for hazardous liquid and solid wastes to the Engineer within 2 working days of disposal.

END OF SECTION

SECTION 03 10 00

CONCRETE FORMS AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section covers the concrete formwork for construction of all concrete structures set forth on the Drawings and in these Specifications.

1.02 RELATED SECTIONS

A. Section 03 30 00: Cast-In-Place Concrete.

1.03 REFERENCES

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

B. Abbreviations and Acronyms:
   1. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.

C. American Concrete Institute (ACI):
   1. ACI 347, Guide to Formwork for Concrete.

D. U.S. Department of Commerce Product Standards:
   1. PS-1-95, Construction and Industrial Plywood.
   2. PS-20-94, American Softwood Lumber.

E. Western Wood Products Association (WWPA):
   1. Western Lumber Grading Rules 05.

F. APA-The Engineered Wood Association (APA):
   1. Panel Handbook & Grade Glossary.

G. Southern Pine Inspection Bureau (SPIB):
   1. Standard Grading Rules for Southern Pine Lumber.

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance wit the requirements of Special Provision 2.5 Contractor's Submittals:
   1. Product Data:

a. Form Coating: Submit manufacturer's descriptive product data and current specification covering named product.
b. Form Ties: Submit manufacturer's descriptive product data, current specification covering named product.

2. Certificates:
   a. Buy America Act Certification

1.05 DESIGN CRITERIA

A. Design the formwork and falsework in accordance with ACI 347 and with the following:
   1. Capacities:
      a. In the design, include assumed values of live load, dead load, weight of moving equipment operated on the formwork, temporary construction material, foundation pressures, stresses, lateral stability, and such other factors pertinent to safety of the structure during construction.
   2. Design the formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent construction.
   3. Design the formwork to conform to the concrete sections indicated on the Contract Drawings, and provide concrete within the following ACI 347 tolerances:
      a. Concrete Surfaces Exposed to Public View: Class A tolerance.
      b. Concrete Surfaces Not Exposed to Public View: Class C tolerance.
      c. Where stricter tolerances are indicated on the Contract Drawings, they supersede the ACI tolerances specified herein.
   4. Include the factors pertinent to the safety of personnel during construction in the design.
   5. Types of Formwork and Falsework Permitted:
      a. Exposed Finish Concrete:
         1) Design and furnish formwork of metal, fiberglass, or other materials that provide a smooth, uniform concrete surface texture.
         2) Do not design and furnish formwork of materials having a raised grain, torn surfaces, worn edges, or other defects that will impair the concrete surface texture.
      b. Unexposed Finish Concrete:
         1) Design and furnish formwork of plywood, lumber, metal, or another acceptable material.
      c. Earth forms are not permitted.

1.06 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:
   1. Buy America Act Certification
      a. Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
   1. Protect formwork materials before, during, and after erection to ensure acceptable finished concrete work. Also protect in-place materials and work of other trades in connection with concrete work.
   2. In event of damage to erected forms, make necessary repairs or replacements prior to concrete pours. Perform such corrective work at no increase in Contract Price.

PART 2 PRODUCTS

2.01 MATERIALS

A. Lumber:
   1. Form framing, sheathing, struts, braces, and shoring in conformance with WWPA Grading Rules or SPIB Grading Rules.
   2. Rough Structural and Dimension Lumber: Provide lumber of allowable species, surfaced four sides as applicable, and grade stamped with the appropriate WWPA or SPIB stamp indicating product compliance with PS-20-94.
   3. Use lumber free of material defects that would deform the finished concrete product.

B. Plywood:
   1. Form Sheathing and Panels: Not less than 5/8 inch thick Exterior Type B-B Plywood Class I and II conforming to U.S. Product Standard PS-1-95.
      a. Use Class II only on surfaces not exposed to view.

C. Steel:
   1. Metal Forms of a pre-engineered standard design, conforming to the concrete sections indicated on the Drawings, may be used in lieu of wood forms.

D. Form Ties:
   1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties conforming to ACI 347.
      a. Do not fabricate wire ties, flat bands, or form ties on the Site.
   2. Removable Ties:
      a. For ties that are designed to be completely removed, taper the ties over their full length that passes through the concrete.
         1) For building foundation walls where ground is located on one side only, install tapered ties so the large end of the taper is on the ground side of the concrete wall.
      b. Do not use removable type ties that leave holes larger than one inch in diameter.
      c. Do not use removable type ties to construct liquid-retaining concrete structures.
   3. Snap-off Metal Ties:
      a. Provide snap-off metal ties with ends that break at least 1½ inches from the face of the wall.
   4. Do not use wood spacers.
   5. To construct liquid-retaining structures and structures designed to exclude groundwater, use ties designed to prevent seepage or flow of water along the embedded tie.

E. Form Coatings:
   1. Provide commercial formulation VOC-compliant form-coating compounds that do not bond with, stain, or affect concrete surfaces.
      a. Provide form-coating compounds that do not impair subsequent treatment of concrete surfaces requiring bond or adhesion, or impede the wetting of surfaces to be cured with water or curing compounds.
   2. For surfaces designed to be in contact with potable water, do not use coating material that will add taste, odor, or toxic effects to the water.

PART 3 EXECUTION

3.01 INSPECTION

A. Prior to placement of concrete, inspect forms for cleanliness and accuracy of alignment.

3.02 PREPARATION

A. Apply form coatings in accordance with manufacturer's specifications.

B. Do not allow excess form coating material to accumulate in the forms.

C. Do not allow form coatings to come in contact with construction joints and reinforcing steel.

3.03 ERECTION

A. General: Construct forms in accordance with ACI 347 to required dimensions, plumb, straight, mortar tight, and paste tight where appearance is important.
   1. Securely brace and shore forms to prevent displacement, bowing and pillowing, and to safely support imposed concrete load.
   2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and such other features as required. Use selected materials to obtain above requirements.
   3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
   4. Form intersecting planes to provide true, clean-cut corners with edge grain of plywood not exposed to concrete.
   5. Build into forms, or otherwise secure in forms, items such as inserts, anchors, miscellaneous metal items, and such other embedded items as indicated on Drawings.
   6. Wet forms sufficiently to prevent joints in wood forms from opening prior to concrete pour.
   7. Do not use stay-in-place metal forms.

B. Openings: Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete.
   1. Securely brace temporary openings and set tightly to forms to prevent the loss of concrete mortar. Locate temporary openings on forms in as inconspicuous location as possible consistent with the requirements of the work.
   2. Provide openings in concrete formwork of the correct size and in the proper location to accommodate other items and operations of construction work passing through forms. Accurately place and securely support items to be built into forms.

C. Earth Forms: Earth forms are not permitted.

3.04 REMOVAL

A. Form Removal
   1. Remove forms in accordance with ACI 347 without damage to concrete and in a manner to ensure complete safety and serviceability of the structure.
      a. Do not cut form ties back from the face of the concrete.
      b. Concrete surface shall not contain residual form coating that will interfere with other materials or coatings to be applied.
      c. Concrete containing ground granulated blast furnace slag tends to develop strength slower than a concrete containing 100 percent Portland Cement.
   2. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the anticipated construction loads without distortion or excessive deflection. Consent to remove forms does not relieve the Contractor of the responsibility for the safety of the work.
   3. When the atmospheric temperature at the site has been continuously above 50 degrees F. from the time of the pour, the forms shall be removed at the earliest practical time within the limits set forth in this paragraph, and wet curing shall continue without delay.
      a. Forms for walls and other vertical faces may be carefully removed 24 hours after the last portion of concrete in the section involved has been placed, provided the concrete has sufficiently hardened to preclude damage resulting from form removal, and provided these members are not subjected to loads for a period of 14 days.
      b. Maintain horizontal forms in place for a minimum of 14 days or until the concrete, as determined by job-cured cylinders, has attained a compressive strength of 3,000 p.s.i.
      c. When a water-reducing retarder is used in the concrete mix, the normal time periods for removing forms may need to be increased.
   4. When the atmospheric temperature at the site drops below 50 degrees F., leave all forms in place for at least 5 days regardless of the temperature within the protective covering or enclosure.
   5. Notify the engineer upon removal of each concrete form so a review of the newly stripped surfaces may be made before patching takes place.

3.05 RE-USE OF FORMS

A. Forms for re-use shall meet new form requirements with respect to effect on poured concrete appearance and structural stability.

B. Do not delay or change the concrete pour schedule as a result of reusing forms compared to the schedule obtainable if all forms were new (in the case of wood forms) or if the total required forms were available (in the case of metal forms).

3.06 SITE QUALITY CONTROL

A. Inspections:
   1. Notify the engineer at least 10 days prior to scheduled concrete placement operations to allow sufficient time for the testing and inspection agency (Approved Agency) responsible

for performing code-required special inspections to schedule an inspection of the concrete formwork.

2. Prior to placement of concrete, inspect the forms for shape, location, and dimension of the concrete member being formed.
   a. Provide lumber free of material defects that would unacceptably deform the finished concrete product or cause visible imperfections on surfaces exposed to public view.
3. Prior to placement of concrete, verify the items to be embedded are properly placed and anchored.

B. Non-Conforming Work:
   1. If formwork is found to be out of alignment, or requires residual or other detrimental material to be removed from the forms or pour area, realign the forms and/or remove the detrimental material from the formwork before pouring concrete into the form.

3.07 WASTE MANAGEMENT AND DISPOSAL

A. Do not leave any wood, shavings, sawdust, or similar items on the ground or buried in backfill.
   1. Do not burn scrap on the Work Site.
      a. Do not burn scraps that have been pressure treated.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work specified in this Section consists of furnishing and installing reinforcement for concrete structures.

1.02 RELATED SECTIONS

A. Section 03 30 00: Cast-In-Place Concrete.

1.03 REFERENCES

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

B. American Concrete Institute (ACI):
   1. ACI 315; Details and Detailing of Concrete Reinforcement.
   2. ACI 318; Building Code Requirements for Structural Concrete.

C. American Welding Society (AWS):
   1. AWS D1.4/D1.4M Structural Welding Code – Reinforcing Steel.

D. American Society for Testing and Materials (ASTM):
   1. ASTM A 82/A 82M; Specification for Steel Wire, Plain, for Concrete Reinforcement.
   2. ASTM A 185/A 185M; Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement.
   3. ASTM A 496/A 496M; Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
   4. ASTM A 615/A 615M; Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   5. ASTM A 663/A 663M; Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
   6. ASTM A 706/A 706M; Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

E. Concrete Reinforcing Steel Institute (CRSI): Manual of Standard Practice.

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance wit the requirements of Special Provision 2.5 Contractor's Submittals:
   1. Shop Drawings and Product Data:

a. Prepare shop drawings of concrete reinforcement in accordance with American Concrete Institute's ACI 315.
b. Provide drawings showing all fabrication dimensions and locations for placing reinforcement and bar supports; indicate bending diagrams, splicing and lap of rods, shapes, dimensions and details of bar reinforcing and accessories.

2. Product Data: Submit manufacturer's descriptive product data and current specification for each product specified herein, include installation instructions.
3. Test Reports:
   a. Submit copies of reports showing the results of tests, conducted in accordance with the American Society for Testing and Materials Specifications.
   b. Test Requirements may be waived based upon certified copies of mill test reports.
4. Certificates:
   a. Buy America Act Certification

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage of Materials:
   1. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
      a. Store the reinforcement and accessories aboveground on platforms, skids, or other supports.
      b. Cover reinforcement and accessories.
   2. Identify bundles of reinforcing steel with tags wired to steel.
   3. Protect reinforcement from deforming, bending, kinking, and other injury.

1.06 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:
   1. Buy America Act Certification
      a. Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

1.07 PROJECT CONDITIONS

A. Protection: Protect in-place reinforcement from excessive construction traffic and other work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.

B. Reinforcing Steel:
   1. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.
   2. Weldable reinforcement bars: ASTM A 706.
   3. Wire: ASTM A 82.
   4. Welded Wire Reinforcement: ASTM A 185.
   5. Metal Accessories: CRSI Manual of Standard Practice.

C. Rebar Splicing Coupler: A two-piece splicing system manufactured from ASTM A 615 Grade 60 deformed rebar. A dowel bar splicer with integral nailing flange shall be threaded for a threaded dowel-in rebar such that the completed splice exceeds the tensile requirements of ACI 318.
   1. Internal Coupler Protector: Provide coupler manufacturer's plastic internal coupler protector where couplers are provided for anticipated future additions.
   2. Bar End Protectors: Plastic solid sleeve for placement over bar ends to protect threading from damage, contamination, and rust.
   3. Use Rebar Splicing Coupler only where shown on Drawings or where approved by the Engineer.
   4. Acceptable Manufacturers:
      a. Dayton Superior Corp.
      b. Or equal.

D. Slab Joint Dowel Bar (for shear transfer):
   1. Plain round bar conforming to requirements of ASTM A 663, Grade 70, 75, or 80 which is not burred, roughened, or deformed out-of-round so slippage is not hindered.
   2. Coat with curing compound to render surface bondless.
      a. Curing compound: Section 03 30 00.

E. Deformed Bar Anchors: Deformed anchor conforming to ASTM A 496 with minimum yield strength of 70 ksi and minimum ultimate tensile strength of 80 ksi. Bar anchor shall be low carbon steel with the following properties C -0.23 max, Mn – 0.90 max, P – 0.040 max, and S – 0.050 max.
   1. Anchors shall be similar to Nelson, flux-filled deformed bar anchor, Type D2L, by Nelson Stud Welding or equal.

F. Metal Accessories:
   1. Provide metal accessories in accordance with the requirements of the CRSI Manual of Standard Practice.

2.02 FABRICATION

A. General: Fabricate reinforcement to the dimensions indicated on the Drawings and within the tolerances given in ACI 315. Perform bending of steel reinforcement by the cold bending method.
   1. Do not use bars with kinks or bends not indicated on Drawings.
   2. Perform bar shape fabrication in a manner that will not injure the material or lessen the member strength.
   3. Use a designed bending machine, either hand- or power-operated.
   4. Do not field bend bars partially embedded in concrete unless approved by the Engineer.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:
   1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein.
   2. The Testing and Inspection Agency (Approved Agency) will perform the source testing specified in this Paragraph, unless the testing is not required as specified.
      a. The tests specified in Subparagraphs 2.03.A.3 through 2.03.A.9 may be waived if certified copies of mill test reports are submitted showing complete compliance with the specified requirements.
      b. If the certified mill test reports are not submitted the Testing and Inspection Agency must perform the specified tests.
   3. Deformed Steel Reinforcement Tests:
      a. Test Procedure:
         1) The following properties of the deformed steel bar reinforcement will be determined using the methods specified in ASTM A 615/A 615M:
            a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
            b) The tensile strength, yield strength, and percentage elongation.
         2) The bend test will be performed on the deformed steel bar reinforcement using the methods specified in ASTM A 615/A 615M.
      b. Acceptance Criteria:
         1) Deformed steel bar reinforcement that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A 615/A 615M, and that pass the bend test for the bar size, as specified in ASTM A 615/A 615M are acceptable.
   4. Deformed Weldable Reinforcement Tests:
      a. Test Procedure:
         1) The following properties of the low-alloy steel deformed bar reinforcement will be determined using the methods specified in ASTM A 706/A 706M:
            a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
            b) The tensile strength, yield strength, and percentage elongation.
         2) The bend test will be performed on the low-alloy steel deformed bar reinforcement using the methods specified in ASTM A 706/A 706M.
      b. Acceptance Criteria:
         1) Low-alloy steel deformed bar reinforcement that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified, and that pass the bend test for the bar size, as specified in ASTM A 706/A 706M are acceptable.
   5. Steel Welded Wire Reinforcement Tests:
      a. Test Procedure:
         1) The tensile strength, yield strength, and percent reduction of area will be determined, and the bend test for steel welded wire reinforcement will be performed in accordance with the methods specified in ASTM A 185/A 185M.
      b. Acceptance Criteria:
         1) Steel wire used to fabricate the steel welded wire reinforcement that exhibits the tensile strength, yield strength, and percent reduction of area within the ranges specified, and that passes the bend test for the wire size as specified in ASTM A 185/A 185M are acceptable.

6. Deformed Bar Anchor Tests:
   a. Test Procedure:
      1) The tensile strength and yield strength will be determined, and the bend test for steel deformed bar anchors will be performed in accordance with the methods specified in ASTM A 496/A 496M.
   b. Acceptance Criteria:
      1) Deformed bar anchors exhibiting the tensile strength and yield strength within the ranges specified in Subparagraph 2.01.E.1 are acceptable.
7. Rebar Splicing Coupler:
   a. Test Procedure:
      1) The following properties of the dowel bar used to fabricate the rebar splicer components will be determined using the methods specified in ASTM A 615/A 615M:
         a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
         b) The tensile strength, yield strength, and percentage elongation.
      2) The bend test will be performed on the dowel bar used to fabricate the dowel bar splicer components using the methods specified in ASTM A 615/A 615M.
   b. Acceptance Criteria:
      1) Rebar splicer components that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A 615/A 615M, and pass the bend test for the bar size as specified in ASTM A 615/A 615M are acceptable.
8. Slab Joint Dowel Bar Tests:
   a. Test Procedure:
      1) The chemical composition, tensile strength, yield point, and percent elongation of slab joint dowel bars will be determined in accordance with the methods specified in ASTM A 663/A 663M.
   b. Acceptance Criteria:
      1) Dowel bars exhibiting the tensile strengths, yield points, and percents elongation within the ranges as specified in ASTM A 663/A 663M for the Grade of bar tested are acceptable.
9. Non-Conforming Work:
   a. Do not use concrete reinforcement that fails testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Placing Concrete Reinforcement:
   1. Place metal concrete reinforcement accurately and in accordance with ACI 318.
      a. Do not lay metal reinforcement on formwork.
      b. Terminate reinforcement 2 inches from the face of expansion joints.
      c. Continue reinforcement across or through construction joints except for keyed control joints in slab-on-grade.
      d. Place additional concrete reinforcement around openings in slabs and walls as detailed on the Contract Drawings.
      e. Provide reinforcing accessories to securely brace the reinforcement against displacement outside of permitted tolerances.
   2. Slab Reinforcement Placement:

a. Install welded wire reinforcement (flat sheets or mats) as indicated, lapping joints eight inches with the overlap being measured between the outermost cross wires of each reinforcement sheet and securely wiring the joints together.
b. Extend welded wire reinforcement to within 2 inches of sides and ends of slabs.
c. To support slab reinforcement from the ground, place the reinforcement on concrete blocks of the correct height and having a compressive strength equal to or greater than the specified compressive strength of the concrete being placed.
    1) Use concrete blocks not larger than 3 inches by 3 inches and of a height equal to required bottom steel cover.
d. To support slab reinforcement from formwork, place the reinforcement on bar chairs made of plastic or metal.
    1) If the slab surface is exposed to view, provide supports with legs protected by plastic or stainless steel.

3. Field weld deformed bar anchors to slab edge steel bent plate as shown on the Contract Drawings.

B. Concrete Reinforcement Field Bends:
1. Do not field bend bars partially embedded in concrete.
2. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcement around it.
    a. Do not bend the reinforcement to clear the obstructions.

C. Shortening Concrete Reinforcement:
1. Shorten (trim) concrete reinforcement, if required, by shearing or sawing.
2. Shortening concrete reinforcement using an acetylene torch may be acceptable, but only if the location of the shortening is approved by the Engineer in writing in advance.

D. Welding Concrete Reinforcement:
1. Do not weld concrete reinforcement except when using ASTM A 706/A 706M weldable reinforcement, and only where indicated in the Contract Documents or approved in writing by the Engineer.
2. Select proper filler materials, preheat temperatures, and performance/procedures in accordance with the requirements specified in AWS D1.4/D1.4M.

E. Splicing Concrete Reinforcement:
1. Splice reinforcement in accordance with ACI 318 and as indicated on the Contract Drawings.
2. Secure reinforcement at intersections with not less than 16 gauge annealed wire or appropriately sized clips.
    a. Where bar spacing is less than 12 inches, tie alternate intersections.
    b. Do not tack-weld crossing bars.

F. Slab Joint Dowel Bar Installation:
1. Install one-half the length of the coated bar dowel into the slab to be poured.

3.02 SITE QUALITY CONTROL

A. A testing and inspection agency (Approved Agency) shall be engaged by Owner to perform code-required special inspections.

1. Written reports on all tests and inspections shall be provided immediately after work is performed. The reports shall state test specimens either comply with requirements or deviate from them.

B. Inspections:
   1. Notify the Engineer at least 10 days prior to scheduled concrete placement operations so the placement of reinforcement can be inspected.
   2. Prior to placing concrete, inspect the reinforcement size, location, spacing, clear distance between bars and to the outside face of the concrete, and the reinforcement will not be displaced during the placement of concrete.
      a. Verify the rebar splicer system is installed at the approved locations, is the correct type, and is installed in accordance with the manufacturer's guidelines.

3.03 CLEANING

A. Clean or otherwise protect metal reinforcement so that at the time the concrete is placed, the reinforcement is free from rust, scale, or other coatings that could destroy or reduce the concrete to steel bond.

3.04 PROTECTION

A. Provide protection for concrete reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Contract Drawings.

B. Protect in-place reinforcement from excessive construction traffic and other work.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work specified in this Section consists of designing mix, furnishing, placing, and curing Portland Cement concrete, reinforced and unreinforced, as indicated.

1.02 RELATED SECTIONS

A. Section 03 10 00: Concrete Forms and Accessories.

B. Section 03 20 00: Concrete Reinforcement.

1.03 REFERENCES

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

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO M 182 Burlap cloth made from Jute or Kenaf.

C. American Concrete Institute (ACI):
   1. ACI 117; Standard Specification for Tolerances for Concrete Construction and Materials.
   2. ACI 211.1; Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   3. ACI 301; Specifications for Structural Concrete.
   4. ACI 304R; Guide for Measuring, Mixing, Transporting and Placing Concrete.
   5. ACI 305R; Hot Weather Concreting.
   6. ACI 306R; Cold Weather Concreting.
   7. ACI 308; Guide to Curing Concrete.
   8. ACI 318; Building Code Requirements for Structural Concrete.
   9. ACI 360; Guide to Design of Slabs on Ground.

D. American Society for Testing and Materials (ASTM):
   1. ASTM C 31; Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   2. ASTM C 33; Specification for Concrete Aggregates.
   3. ASTM C 39; Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. ASTM C 42; Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   5. ASTM C 94; Specification for Ready-Mixed Concrete.
   6. ASTM C138; Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   7. ASTM C 143; Test Method for Slump of Hydraulic Cement Concrete.
   8. ASTM C 150; Specification for Portland Cement.

9. ASTM C 156; Test Method for Water Retention By Concrete Curing Materials.
10. ASTM C 171; Specification for Sheet Materials for Curing Concrete.
11. ASTM C 172; Standard Practice for Sampling Freshly Mixed Concrete.
12. ASTM C 173; Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
13. ASTM C 192; Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
14. ASTM C 231; Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
15. ASTM C 260; Specification for Air-Entraining Admixtures for Concrete.
16. ASTM C 309; Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
17. ASTM C 494; Specification for Chemical Admixtures for Concrete.
18. ASTM C 881; Specification for Epoxy–Resin Base Bonding Systems for Concrete.
19. ASTM C 882; Test Method for Bond Strength of Epoxy–Resin Systems used with Concrete by Slant Shear.
20. ASTM D 683; Test Method for Tensile Properties of Plastics.
21. ASTM D 695; Test Method for Compressive Properties of Rigid Plastics.
22. ASTM D 1751; Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
23. ASTM D 1752; Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
24. ASTM E 329; Specification for Agencies Engaged in the Testing and / or Inspection of Materials used in Construction.

E. U.S. Army Corps of Engineers Specifications:
1. Corps of Engineers CRD-C 572 Specifications for Polyvinylchloride Waterstop.

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance wit the requirements of Special Provision 2.5 Contractor's Submittals:
1. Product Data: Submit manufacturer's descriptive product data and current specifications for the concrete accessories specified herein. Include installation instructions.
2. Samples: Submit samples of materials being used when requested by the Engineer including names, sources, and descriptions.
3. Design Mix: Prior to production of concrete, submit for approval, on form attached at the end of this Section, all mix designs proposed for project. Include with the mix design a standard deviation analysis or trial mixture test data in accordance with ACI 301 Section 4.2.3. Use materials in such proposed design mix as specified herein. Make such adjustments in the proposed design mix as directed by the Engineer. Make such adjustments at no increase in contract price.
4. Water shall not be added to concrete mix at the project site unless it is withheld from the mix at the batch mixing plant. Indicate amounts of mix water to be withheld for later addition at project site.
5. Test Reports:
   a. Submit concrete test reports specified in Part 3 in this Specification.
6. Certificates:

a. Furnish certificates originated by the batch mixing plant certifying ready mixed concrete, as manufactured and delivered, to be in conformance with ASTM C 94.
b. Buy America Act Certification

7. Delivery Tickets: A delivery ticket shall accompany each load of concrete from the batch plant.
   a. Tickets must be signed by the Contractor's representative, noted as to time and place of pour, and kept in a record at the site. Make such records available for inspection upon request.
   b. Information presented on the ticket to include the tabulation covered by ASTM C 94, Section 16, as well as any additional information the local codes may require.
8. Schedule: Submit for approval schedule showing methods, construction joint locations, and sequence of pouring a minimum of 10 days prior to placing concrete.

1.05 QUALITY ASSURANCE

A. Independent Testing and Inspection Agency: An agency regularly performing work conforming to the American Society for Testing and Materials ASTM E 329.

B. Source Quality Control:
   1. Laboratory Tests: Materials stated herein require advance examination or testing according to methods referenced, or as required by the Engineer.
   2. Compression Test Cylinders: For laboratory trial batches, make in accordance with American Concrete Institute ACI 301. Test to consist of four compression test cylinders for each class of concrete with two broken at seven days and two broken at 28 days; ASTM C 192 and ASTM C 39.

C. Pre-Job Meeting: Prior to placement of concrete, a meeting shall occur on site to establish and coordinate procedures that will enable Contractor to provide the best possible product under anticipated field conditions. The meeting should be attended by representatives of organizations and material suppliers involved with the design and construction of concrete work.

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

1.06 PROJECT CONDITIONS

A. ACI Compliance: Cast-in-place concrete work shall conform to ACI 301 except as modified by these Specifications or the Drawings.

B. Concrete Encasement of Pipes and Conduits: Encase pipes under structures and buildings indicated by the Drawings to be encased in concrete for the full length of the pipe run under the structure.

C. Concrete Encasement of Conduits: Encase conduit runs as indicated and detailed on the Drawings as work of Division 26 – Electrical Sections.

D. Equipment Bases: Construct reinforced concrete bases for equipment and piping under this contract at no increase in contract price.

1.07 SEQUENCING

A. Where other construction work is relative to concrete pours, or must be supported by or embedded in concrete, those performing such related work must be given five days notice to introduce or furnish embedded items before concrete is placed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:
1. Portland Cement: ASTM C 150 Type I, Normal.
2. Only one brand and manufacturer of approved cement shall be used for exposed concrete.

B. Normal weight Concrete Aggregates: Process aggregate meeting requirements of ASTM C 33 and subject to the following limitations.
1. Coarse Aggregate Size: Maximum size of coarse aggregate shall not exceed the following requirements but in no case larger than 1½ inches.
   a. One-fifth narrowest dimension between sides of forms within which concrete is to be cast.
   b. Three-fourths of the minimum clear spacing between reinforcing bars.
   c. One-third the slab thickness for unreinforced slabs.
2. Reduced aggregate concrete containing aggregate with particle size not less than 1/8 inch nor more than 1/2 inch in any dimension and a maximum of 5 percent of particles passing a No. 8 sieve (for use in metal pan stairs only).

C. Ground Granulated Blast-Furnace Slab (GGBFS): Conform to ASTM C 989, Grade 120.
1. Use GGBFS at the rate of 25% (min) to 35% (max) of the total cementitious material.

D. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.

E. Concrete Admixtures:
1. Prohibited Admixtures: Use only non-corrosive, non-chloride admixtures.
2. Provide admixtures produced and serviced by established, reputable manufacturers and use in compliance with manufacturer's recommendations.
3. Air-Entraining Admixture: Use a product conforming to requirements of ASTM C 260.
4. Water-Reducing Admixture: Use a product conforming to requirements of ASTM C 494 Type A.
   a. Acceptable Manufacturers:
      1) Eucon WR-75; The Euclid Chemical Company.
      2) Pozzolith 210; BASF Admixtures.
      3) Plastocrete 161; Sika Corporation.
      4) Or approved equal.

5. Water-Reducing and Retarding Admixture: Use a product conforming to requirements of ASTM C 494, Type D.
   a. Acceptable Manufacturers:
      1) Eucon Retarder-100; The Euclid Chemical Company.
      2) Pozzolith 100XR; BASF Admixtures.
      3) Plastiment; Sika Corporation.
      4) Or approved equal.
6. Water-Reducing, and Acceleration Admixture: Use a product conforming to requirements of ASTM C 494, Types C or E.
   a. Acceptable Manufacturers:
      1) Accelguard 80; The Euclid Chemical Company.
      2) Pozzutec 20+; BASF Admixtures.
      3) Plastocrete 161 FL; Sika Corporation.
      4) Or approved equal.
7. High-Range, Water-Reducing Admixture: Use a Product Conforming to Requirements of ASTM C 494, Type F.
   a. Acceptable Manufacturers:
      1) Eucon 1037; The Euclid Chemical Company.
      2) Glenium 3030NS; BASF Admixtures.
      3) Sikament 686; Sika Corporation.
      4) Or approved equal.
8. Store admixtures in a manner to prevent contamination, evaporation, moisture penetration, or damage. Do not use products, which have been stored longer than 6 months.
9. Prior to the mix design review by the Engineer, provide written conformance to the specified requirements of the admixture.

F. Preformed Expansion Joint Fillers:
1. Nonextruding and Resilient Bituminous Types (for exterior use in pavements and sidewalks only): ASTM D 1751.
2. Sponge Rubber and Cork Type: ASTM D 1752.
3. Self Expanding Cork Type: ASTM D 1752.
4. Acceptable Manufacturers:
   a. Tamms Industries, Inc.
   b. W.R. Meadows, Inc.
   c. Or approved equal.

G. Curing Materials. Use curing materials that will not stain or affect concrete finish or lessen the concrete strength and comply with the following requirements:
1. Burlap: Materials conforming to AASHTO M 182.
2. Sheet Materials: Material conforming to ASTM C 171.
3. Liquid Membrane-Forming Curing Compound.
   a. Use curing compounds which are nontoxic and free of taste, odor and complies with low V.O.C. requirements.
   b. Where a finish material is to be applied over concrete with architectural finish, provide certification by the product manufacturer stating the curing compound as non-detrimental to the bond of the finish material.
   c. Use material meeting the requirements of ASTM C309, Type 1.
   d. Acceptable Manufacturers:
      1) L&M Cure; L&M Construction Chemicals, Inc.
      2) Clear Resin Cure; Dayton Superior
      3) Or approved equal.
4. Clear Curing and Sealing Compound:

a. Provide a liquid clear curing and sealing compound conforming to the requirements for Type 1, Class A, specified in ASTM C 1315.
b. Provide liquid clear curing and sealing compounds which are nontoxic and have a maximum volatile organic compound (VOC) rating of 350 grams per liter in compliance with the requirements of the U.S. Environmental Agency.
c. Manufacturers:
   1) Euclid Chemical Co., Super Diamond Clear VOX, www.euclidchemical.com.
   2) L&M Construction Chemical, Inc., Lumiseal WB Plus. www.lmcc.com.
   3) Approved equal.

H. Epoxy Bonding Compound: A high-modulus, low-viscosity, moisture-insensitive epoxy adhesive:
1. Compressive Properties, ASTM D 695 at 28 days;
   a. Compressive Strength: 8,000 psi. min.
2. Tensile Properties, ASTM D 638 at 14 days.
   a. Tensile Strength: 4,000 psi. min.
   b. Elongation at Break: One to three percent.
   c. Modulus of Elasticity: 3×10^5 psi.
3. Bond Strength, ASTM C 882:
   a. Plastic concrete to hardened concrete at 14 days (moist cure): 1,700 psi. min.
4. Mixed epoxy resin adhesive shall conform to ASTM C 881, Type II, Grade 2, Class B and C.
5. Acceptable Manufacturers:
   a. Sikadur 32 Hi-Mod; Sika Corporation.
   b. Euco Epoxy #452 ; Euclid Chemical Company.
   c. Or approved equal.

I. Epoxy Adhesive (for grouting dowels): A high-modulus, moisture insensitive epoxy adhesive of thick (Gel) consistency having the following properties:
1. Compressive Properties, ASTM D 695.
   a. Compressive Strength: 10,000 psi. min. at 28 days.
2. Tensile Properties, ASTM D 638.
   a. Tensile Strength: 3,000 psi. min. at 14 days.
3. Bond Strength, ASTM C 882, hardened concrete to hardened concrete:
   a. 14-day, moist cure: 2,000 psi. min.
4. Adhesive complying with the requirements for Type IV Grades 2 and 3, Classes A, B, and C, except for gel times, as specified in ASTM C 881.
5. Acceptable Manufacturers:
   a. Hilti Hit-RE 500-SD.
   b. Simpson Set XP.
   c. Or approved equal.

J. Surface Applied Waterstop: A specially formulated joint sealant, which swells upon contact with water. Provide waterstop packaged in continuous length coils. Material composition as follows:
1. Chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.
2. Waterstop shall have a coating formulated to inhibit initial expansion due to moisture presence in the fresh concrete.
3. Size: Dual extrusion design; 10 mm by 20 mm.

4. Waterstop shall be secured to hardened concrete with the waterstop manufacturer's standard adhesive binder.
5. Acceptable Manufacturers:
   a. Greenstreak; Hydrotite VCJ.
   b. ADEKA; Ultra Seal.
   c. Or equal.

K. Construction Joint Device: Integral galvanized steel formed to tongue and groove profile for slab-on-grade construction.
1. For exposed concrete areas, provide plastic joint cap strip that can be removed for placement sealant.
2. Acceptable Manufacturers:
   a. Heckman Building Products, Inc.
   b. Or approved equal.

L. Contraction Joint Insert: Two-piece plastic preassembled preformed contraction joint; depth of embedment equal to one-quarter of the slab thickness.
1. Acceptable Manufacturers:
   a. W.R. Meadows: Speed – E – Joint.
   b. Or approved equal.

M. Construction and Control Joint Filler for Slab-on-Grade: A two-component epoxy joint filler.
1. Acceptable Manufacturers:
   a. Sika Corporation: Sikadur 51 SL.
   b. Euclid Chemical Company: Euco 700.
   c. Or approved equal.

N. Under slab Vapor Barrier:
1. Basis-of-Design Product: The design is based on Stego Wrap (15 mil) Vapor Barrier by Stego Industries LLC. Subject to compliance with requirements, provide either the named product or a comparable product.
   a. Vapor Barrier must have the following qualities:
      1) WVTR of 0.006 gr/ft^2/hr or less as tested by ASTM E 96.
      2) ASTM E 1745 Class A.
2. Vapor Barrier Accessories:
   a. Vapor Retarding Seam Tape with the following qualities:
      1) Water Vapor Transmission Rate: ASTM E 96 0.3 perms or lower.
   b. Vapor Proofing Mastic with the following qualities:
      1) Water Vapor Transmission Rate: ASTM E 96 0.3 perms or lower.
   c. Pipe Boots:

2.02 MIXES

A. Selection of Proportions of Normal Weight Concrete: ACI 211.1.

B. Proportions of Ingredients: Establish proportions, including water cement ratio on the basis of either laboratory trial mixture tests or standard deviation analysis, with the materials specified herein.
1. Laboratory Trial Mixture Test: ACI 301, Section 4.2 and ACI 318, Section 5.3.
2. Standard Deviation Analysis: ACI 301, Section 4.2 and ACI 318, Section 5.3.

C. Water-Cement Ratio:
1. Class A Concrete shall have a maximum water-cement ratio of 0.45.
2. Class B Concrete shall have a maximum water-cement ratio of 0.55.
3. Proportion Class C Concrete to meet the strength requirement.

D. Slump: Proportion and produce concrete to a slump as indicated below. The slump ranges apply when vibration is used to consolidate the concrete.

TYPES OF CONSTRUCTION	SLUMP, IN.	
	Maximum*	Minimum
Reinforced foundation walls and footings	3	1
Building piers	4	1
Pavements and slabs-on-grade	3	1

* May be increased 1 in. for methods of consolidation other than vibration.
1. Pumped concrete shall have a 5-inch maximum slump, measured prior to pumping.
2. Concrete containing high-range water-reducing admixture shall have an 8-inch maximum slump after admixture is added to concrete with a 2 to 4-inch slump.

2.03 ADMIXTURES

A. Air Entraining: Provide air-entrained concrete for each concrete pour except for interior slabs or where indicated otherwise on the Drawings or specified herein. Total air content required as follows:

1.

Maximum-size coarse aggregate, inches:	Air content percent by volume:
1 1/2	5 +/- 1
3/4 or 1	6 +/- 1

B. Water-Reducing Admixture: Unless high temperatures occur or placing conditions dictate a change, use concrete containing a water-reducing admixture.

C. Water-Reducing and Retarding Admixture: When high temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) may be replaced with a water-reducing and retarding admixture (Type D). Notify the Engineer of such change and submit product data prior to placement of concrete.

D. Water-Reducing and Accelerating Admixture: When low temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) can be replaced with a water-reducing and accelerating admixture. Notify the Engineer of such change and submit product data prior to placement of concrete.

2.04 SOURCE QUALITY CONTROL

A. General Requirement: Provide only Class A concrete in the project except for those cases where indicated otherwise on the Drawings or specified otherwise.
1. Where in-ground encasement of piping is required, provide Class B concrete.

2. Where in-ground encasement of conduit runs is required provide Class B concrete.
3. Where reaction backings and backfilling of over excavated foundation area, foundation voids, and cavities are required, provide Class B concrete.
4. For backfilling of over excavated foundation area, foundation voids, and cavities, provide Class B concrete.

B. Classes of Concrete:
1. Class A: 4,000 psi minimum compressive strength at 28 days; 564 pounds per cubic yard minimum cement content.
2. Class B: 3,000 psi minimum compressive strength at 28 days; 517 pounds per cubic yard minimum cement content.
3. Class C: 2,000 psi minimum compressive strength at 28 days; minimum cement content per cubic yard in accordance with current ready-mix plant standard practice.

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect work to receive cast-in-place concrete for deficiencies, which would prevent proper execution of the finished work. Do not proceed with placing until such deficiencies are corrected to the satisfaction of the Engineer.

3.02 PREPARATION

A. Joints
1. General: Only the locations of critical joints throughout the structures are indicated on the Drawings. Select additional joint locations in walls and footings subject to the Engineer's approval. Submit requests for approval of joint locations ten days prior to scheduled concrete pours. Do not make concrete pours unless joint locations have been approved by the Engineer.
a. Place walls and slabs allowing at least two days elapsed time before concrete is placed against an adjacent vertical joint.

2. Control Joints and Construction Joints in Slab-on-Grade:
a. Provide control joint spacing at the following maximum spacing unless noted otherwise:
1) 15 feet maximum each way
b. Where contraction joint insert is used, press straight edge cutting tool into wet concrete to part aggregate. Place insert into separation until top of insert lays on surface of wet concrete. Remove top section of insert and float concrete to fill voids adjacent to the insert and finish concrete surface.
c. Sawcutting is permitted for control joints. Cut concrete as soon as it has hardened sufficiently; complete sawing within 12 hours after placement. Saw a continuous straight slot to a depth of one-fourth the thickness of the slab.
1) Submit detailed procedure plans for review and acceptance.
d. Fill all control joints with Control Joint Filler.
e. Where concreting is interrupted long enough for the placed concrete to harden, construction joint should be provided.

3. Bonding to New Concrete: Bond fresh concrete with hardened previously poured new concrete in accordance with the following:
   a. Roughen and clean hardened concrete to foreign matter and laitance and dampen with water.
   b. Place new concrete on grout before it has attained its initial set.
   c. Other bonding methods must be approved by Engineer prior to use.

B. Embedded Items:
1. Embedded Pipes and Conduits: Material not harmful to concrete may be permitted to be embedded in concrete upon approval by the Engineer. Items embedded shall satisfy the following:
   a. Maximum outside dimension not greater than one-third the overall thickness of the member in which it is embedded.
   b. Minimum spacing between items not less than 3 widths on center or 3 inches clear between items.
   c. Item shall not impair strength of member.
   d. Provide 2-inch minimum clearance to face of slab.
   e. Cutting, bending, or displacement of reinforcement will not be allowed.
2. Anchor Rod Placement:
   a. Install anchor rods accurately, vertically and horizontally, in the foundations as shown on the Contract Drawings.
   b. Insure rods are firmly held in the correct position and elevation by suitable templates during placement of concrete.
   c. The variation in location of anchor rods and other embedded items from the dimensions shown on the Contract Drawings shall meet the tolerances listed in “Code of Standard Practice for Steel Buildings and Bridges (March 2005).”
3. Surface Applied Waterstop Installation: Install surface applied waterstop at such location indicated on the Drawings.
   a. Install the waterstop in strict accordance with the manufacturer’s installation instructions.
   b. Use continuous lengths without splices where possible.

C. Anchoring Reinforcement Dowels into Existing Concrete.
1. Drill holes for each dowel to the size and depth indicated on the Drawings with carbide tip bit or star bit, core drilling not permitted. Do not drill into or cut or otherwise damage existing reinforcement bars. If existing reinforcement bars are encountered during the drilling operation, relocate the hole to clear the existing reinforcement as directed by the Engineer.
2. Blow clean each finished hole with an oil free air jet and then flush with a jet of clean water.
3. Immediately prior to the grouting operation, remove all water from the hole and from the walls of the hole.
4. Mix and place the epoxy adhesive completely around the dowel bar in strict accordance with the manufacturer’s recommendations, with particular attention given to manufacturer’s specified time limit within which the material must be placed after mixing. Do not retemper grout that has begun to stiffen; discard such grout.

D. Installation of Vapor Barriers
1. General: Extend vapor barriers to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor barriers to cover miscellaneous voids in insulated

substrates, including those filled with loose-fiber insulation. Installation shall be in accordance with manufacturer's instructions and ASTM E 1643-98.

2. Installation of under slab vapor barriers:
   a. Install vapor barrier under slab on grade areas.
   b. Unroll vapor barrier with the longest dimension parallel with the direction of the pour.
   c. Lap vapor barrier over footings and seal to foundation walls.
   d. Overlap joints 6 inches and seal with manufacturer's tape.
   e. Coordinate installation of vapor barrier with installation of water stops.
   f. Seal all penetrations (including pipes) per manufacturer's instructions.
   g. No penetration of the vapor barrier shall be allowed except for reinforcing steel and permanent utilities.
   h. Repair damaged areas immediately before concealment by other work by cutting patches of vapor barrier overlapping damaged area 6 inches and taping all four sides with tape.

3.03 CONSTRUCTION

A. Production of Concrete
   1. Ready-Mixed Concrete:
      a. Batched, mixed, and transported in accordance with ASTM C 94.
      b. Add admixtures to the mix in accordance with ACI 301.
      c. Plant equipment and facilities conforming to the "Checklist for Certification of Ready-Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.
      d. Do not add water to concrete mix at the work site unless it has been withheld from the mix at the batch mixing plant.
         1) Indicate amount of water withheld for later addition on the approval form.
         2) If approval to add water at site is received, perform additional revolutions at the mixing speed.

B. Placing
   1. General: Conduct placement work in accordance with ACI 304R and such additional requirements as specified herein.
      a. Complete discharge of the concrete within 1½ hours or before the mixing drum has revolved 300 revolutions; whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates.
   2. Preparation:
      a. Prepare formwork in advance and remove snow, ice, water, and debris from within forms.
      b. Pre-position reinforcement in advance of concrete pours.
      c. Pre-position waterstops, expansion joint materials, anchors and embedded items in advance of concrete pours.
      d. Sprinkle subgrades sufficiently to eliminate water loss from concrete in accordance with ACI 301 Chapter 11.
         1) Subgrade shall be moist with no free water and no muddy or soft spots.
      e. Do not place concrete on frozen surfaces.
      f. Place vapor barrier under slabs-on-grade.

3. Conveying:
   a. Handle concrete from mixer to final deposit rapidly by methods, which will prevent segregation or loss of ingredients to maintain required quality of concrete.
   b. Do not convey concrete through aluminum or aluminum alloy.
   c. Do not place concrete by pumps or other similar devices without prior written approval of the Engineer.
   d. Placing concrete by pumping methods shall conform to the applicable requirements of ACI 304R, Chapter 9, and ACI 304.2R.
4. Depositing:
   a. Do not drop concrete freely where reinforcing will cause segregation, nor more than four (4) feet.
   b. Deposit concrete in approximately horizontal layers of 12 to 18 inches.
   c. Do not allow concrete to flow laterally more than three feet.
   d. Place concrete at such a rate that concrete which is being integrated with fresh concrete is still plastic.
   e. Do not deposit concrete on concrete, which has hardened sufficiently to cause the formation of seams or planes of weakness within sections.
   f. Do not use concrete, which has partially hardened or has been contaminated by foreign materials.
   g. Do not subject concrete to procedures which will cause segregation.
   h. Do not place concrete in forms containing standing water.
   i. Make placement within sections continuously to produce monolithic unit.
   j. Do not bend reinforcement out of position when placing concrete.
5. Consolidation:
   a. Consolidate concrete by vibration, spading, rodding, or other manual methods. Work concrete around reinforcement, embedded items and into corners; eliminate all air or stone pockets and other causes of honeycombing, pitting, or planes of weakness.
   b. Use vibration equipment of internal type and not the type attached to forms and reinforcement.
   c. Use vibrators capable of transmitting vibration to concrete in frequencies sufficient to provide satisfactory consolidation.
   d. Do not leave vibrators in one spot long enough to cause segregation. Remove concrete segregated by vibrator operation.
   e. Do not use vibrators to spread concrete.
   f. Have sufficient reserve vibration equipment to guard against shutdown of work occasioned by failure of equipment in operation.
6. Cold Weather Concreting: Perform cold weather concrete work in accordance with ACI 306R and the following additional requirements:
   a. Temperatures of the subbase and other surfaces that come in contact with concrete must be above freezing. The subbase and concrete forms surface must be free of snow and ice.
   b. Do not place concrete around any embedment, which has a temperature below freezing.
   c. Provide equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. Do not use foreign materials or materials containing snow or ice.
      1) When using artificial heat, vent exhaust gases to the outside.
7. Hot Weather Concreting: Perform hot weather concrete work in accordance with ACI 305R and the following additional requirements.
   a. Temperature of concrete delivered at the job-site shall not exceed 90 degrees F.

b. Cool ingredients before mixing to prevent temperature in excess of 90 degrees F.
c. Make provisions for windbreaks, shading, fog spraying, sprinkling or wet cover when necessary.

C. Finishing:
1. General: Finish concrete in the various specified manners either to remain as natural concrete or to receive an additional applied finish or material.
a. Concrete containing ground granulated blast furnace slag may have longer time of set compared to 100 percent Portland Cement concrete.
2. Formed Surfaces: Provide one or more of the following finishes to the surfaces of the concrete after removal of forms. The locations where these finishes are required are listed herein or specified on the Drawings. Allowable surface irregularities are designed as either "abrupt" or "gradual." Check gradual irregularities using 5-foot straightedges.
a. "Rough Form" finish: Surface may include roughness and irregularities not to exceed 1/2 inch, but tie holes and defects shall be patched.
b. "Ordinary Wall" finish: Surface that is true and uniform without any conspicuous offsets or bulges. Gradual irregularities not to exceed 1/2 inch and abrupt irregularities not to exceed ¼ inch.
c. "Plywood" finish: Similar to the ordinary wall finish. Construct the surface of the forms using ⅝-inch plywood or boards lined with tempered hardboard not less than $^{3}/_{16}$ inch thick. Place the plywood or liner sheets in an orderly and symmetrical arrangement using sheets as large as practicable. Do not use sheets showing torn grain, worn edges, patches of holes from previous use, or other defects, which will impair the texture of the concrete surfaces. Remove gradual irregularities exceeding ½ inch and abrupt irregularities exceeding ⅛ inch. Completely remove all fins on the surface. Rub all surfaces, which cannot meet these requirements.
d. "Rubbed" finish: Apply to a freshly hardened "plywood" finish. Complete rubbing within one day of removal of forms. Wet surfaces and rub with a carborundum brick or other abrasive until all form marks, projections, and irregularities have been removed and a smooth uniform surface, texture, and color are produced. Wash the surface clean after rubbing.
3. Unformed Surfaces: In concrete having unformed surfaces, use just sufficient mortar to avoid the necessity for excessive floating. Slope exposed unformed surfaces to provide quick, positive drainage and to avoid puddles in low spots. Slope all surfaces exposed to weather 1/4 inch per foot for drainage unless noted otherwise on Drawings.
a. Floor Flatness/Levelness Tolerances:
1) F_f (Flatness F-Number) defines relative smoothness of a floor slab; F_L (Levelness F-Number) defines relative conformity of floor surface to horizontal plane.
2) Floor tolerance measurements (F_f and F_L) shall be tested in accordance with ASTM E 1155.
3) Overall F_f and F_L Numbers represent test surface defined as total floor area of one building level.
4) Local F_f and F_L Numbers represent a test section within the concrete pour. Each test section shall not exceed 2,500 square feet.
5) Floor Overall F-Numbers shall conform to the following floor surface classifications defined in ACI 117:
a) Mechanical and Electrical areas: Moderately Flat - SOF_f 25 / SOF_L 20.

b) Area not defined above: Flat - SOF_f 35 / SOF_L 25.
   1) Minimum Local F-Number tolerances shall be ⅔ of specified Overall F-Number tolerances.
   2) F_L tolerances do not apply to unshored steel framed construction.

a) Allowable variations from top of slab elevations identified on Contract Drawings: Plus/Minus ⅜ inch.
   1) Floor tolerance compliance tests shall be performed within 24 hours after placement and reported to Construction Manager within 72 hours.

b. "Floated" Finish: Placed, consolidate, strike-off, and level concrete eliminating high spots and low spots; do not work further until ready for floating. Begin floating when water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. Refloat slab immediately to a uniform sandy texture. Produce a finish that will meet tolerances listed in this specification.

c. "Steel Trowel" Finish: Obtained by working a floated finish with a steel trowel. First troweling shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings by hand after the surface has hardened sufficiently. Perform final troweling when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate surface by hand trowel operations. Produce finished surface essentially free of trowel marks, uniform in texture and appearance. Produce a finish that will meet tolerances listed in this specification. Do not steel trowel finish air entrained concrete.

d. "Broom or Belt" Finish: Immediately after concrete has received a floated finish, give surface a coarse transverse scored texture by drawing a broom or burlap across the surface.

4. Application for Finishes: Except where the type of finish is indicated on the drawings or under “Special Finish,” all concrete surfaces shall be finished as indicated below.

a. "Rough Form" Finish:
   1) All surfaces to be covered by earth.

b. "Ordinary Wall" Finish:
   1) Interior and exterior wall surfaces not exposed to view.

c. "Plywood" Finish:
   1) All surfaces to be painted.

d. "Rubbed" Finish:
   1) All interior and exterior surfaces exposed to view, which are not to be painted.
   2) All exterior surfaces to a point 6 inches below finished ground.
   3) Equipment pads.

e. "Floated" Finish:
   1) All unformed surfaces unless otherwise specified.

f. “Steel Trowel" Finish:
   1) Interior floors of structure except where architectural finish is to be applied. (See Architectural Drawing Floor Finish Schedule.)
   2) Tops of exposed walls.

g. Broom or Belt Finish
   1) Exterior concrete ramp/sidewalks/aprons.

3.04 CURING AND PROTECTION

A. General: Immediately after placement and finishing, protect concrete from premature drying, excessive hot or cold temperatures and mechanical injury. Perform curing by water curing, sheet form curing, or liquid membrane forming methods in accordance with ACI 308. Cure concrete continuously for a minimum of seven days at ambient temperatures above 40 degrees F.

B. Hot Weather Curing: See Hot Weather Concreting this Section.

C. Cold Weather Curing: See Cold Weather Concreting this Section.

D. Application of Liquid Membrane-Forming Curing Compound:
1. Finishing operations must be completed prior to application. Apply compound as soon as the free water on the surface disappears and no water sheen is visible. Surface shall be capable of taking walking workmen without being marred. Apply compound in two (2) applications following the manufacturer's recommendations.
2. Do not apply curing compound to construction joint surfaces. Protect exposed reinforcement during application of curing compound. Water cure those areas not coated with compound.
3. Do not use liquid membrane-forming curing compound when the ambient air temperature during placement and for 24 hours after placement is or will fall below 35 degrees F.
4. Do not use liquid membrane-forming curing compounds on concrete surfaces which will receive later treatments, such as hardeners, special finishes, protective coating, dampproofing, waterproofing, future grout, grout fill, or coatings.

E. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.05 FIELD QUALITY CONTROL TESTING

A. Perform the following field tests:
1. Determine slump of the concrete sample for each truckload upon arrival at site and whenever consistency of concrete appears to vary. Test according to ASTM C 143.
2. Determine temperature of concrete sample for each truckload.

3.06 FIELD QUALITY ASSURANCE TESTING

A. General
1. During the entire period when concrete is being placed, testing services shall be provided.
2. Failure to detect defective work will not prevent later rejection when defect is discovered nor shall it obligate the Engineer and Owner for final acceptance.
3. Routine testing of materials shall be the duty of the Quality Assurance Agency.
4. Additional testing of materials because of changes in materials or proportions requested by Contractor and testing required by failure of material to meet specifications shall be at Contractor's expense.
5. Agency performing testing services shall meet the requirements of ASTM C 1077.

B. Testing Services by Quality Assurance Agency

1. Test check the Contractor's proposed materials for compliance with the specifications.
2. Review and check test the contractor's proposed mix design.
3. Secure production samples of materials at plants or stockpiles during the course of the work and test for compliance with the specifications.
4. Conduct strength tests of the concrete in accordance with the following procedures:
   a. The responsible contractor shall secure composite samples in accordance with ASTM C 172. Each strength test shall be obtained from a different batch of concrete on a representative, truly random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placement. When pumping or pneumatic equipment is used, samples shall be taken at the truck and discharge end. Concrete test cylinders shall be made by the responsible contractor under observation of the Quality Assurance Agency. Set of five cylinders shall be molded, and twenty-four (24) hour initial curing provided, in strict compliance with ASTM C 31. Immediately thereafter a responsible representative of the Quality Assurance Agency shall pack them in a sturdy container, furnished by the responsible contractor, and as approved by the Quality Assurance Agency, surround them with wet sand or sawdust, protect them from freezing and transport them to the laboratory where they shall be cured in strict compliance with ASTM C 31 until time of test. The cylinders shall be sequentially numbered and a record of date made and date transported to the laboratory. A copy of this record shall be forwarded to the Engineer. Unless this record reflects any exceptions, it will be assumed that these procedures have been followed to the mutual satisfaction of the contractor, the testing laboratory, and the Engineer. Above-mentioned record shall also include results of slump tests and temperature for each sample.
   b. Specimens shall be tested in accordance with ASTM C 39. Two specimens shall be tested at 28 days for acceptance and two shall be tested at 7 days for information. The acceptance test results shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding, or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. Should both specimens in a test show any of the above defects, the entire test shall be discarded. The fifth cylinder shall be held for 56-day test, if required.
   c. Samples for strength tests of each class of concrete (each concrete mix design) shall be taken not less than once a day or once for each 50 cu. yd. of concrete or for each 3000 sq. ft. of surface area placed. Not less than five (5) strength tests shall be conducted for each concrete mix design.
5. The air content of concrete shall be determined on a regular and frequent basis in accordance with ASTM C 231, ASTM C 173, or ASTM C 138.

C. Responsibilities and Duties of Contractor:
   1. To facilitate testing services, the Contractor shall:
      a. Advise the Quality Assurance Agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.

b. Provide and maintain for the sole use of the Quality Assurance Agency adequate facilities for safe storage and proper curing of concrete test cylinders on the project site.
c. Provide containers for transporting concrete test cylinders to the testing laboratory. The containers shall be constructed in accordance with the laboratory's instructions and shall be the property of the Contractor.

3.07 EVALUATION OF CONCRETE STRENGTH

A. Evaluation of Test Results:
1. Test results for standard molded and standard cured test cylinders shall be evaluated separately for each specified concrete mix design.
2. For evaluation of potential strength and uniformity, each specified mix design shall be represented by at least five tests.

B. Satisfactory Strength Level of Concrete: The strength level of the concrete will be considered satisfactory so long as the average of all sets of three consecutive strength test results equal or exceed the specified strength f'c and no individual strength test result falls below the specified strength f'c by more than 500 psi.

C. Testing of Concrete in Place:
1. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by the Engineer to determine relative strengths at various locations in the structure as an aid in revaluating concrete strength in place or for selecting areas to be cored. Such tests shall not be used as a basis for acceptance or rejections.
2. Core Tests:
a. Where required, cores at least 3 inches in diameter shall be obtained and tested in accordance with ASTM C 42. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for 7 days before test and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42.
b. At least three representative cores shall be taken from each member or area of concrete in lace that is considered potentially deficient. The location of cores shall be determined by the Engineer so as to least impair the strength of the structure. If, before testing, one or more of the cores shows evidence of having been damaged subsequent to or during removal from the structure, it shall be replaced.
c. Concrete in the area represented by a core test will be considered adequate if the average strength of the cores is equal to at least 85 percent of, and if no single core is less than 75 percent of, the specified strength f'c.
d. Core holes shall be filled solid with low slump concrete.

3.08 ACCEPTANCE OF STRUCTURE

A. General
1. Completed concrete work which meets all applicable requirements will be accepted without qualification.

2. Completed concrete work which fails to meet one or more requirements but which has been repaired to being it into compliance will be accepted without qualification.
3. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these specifications.

B. Concrete Compressive Strength: If the concrete fails to meet the compressive strength requirements additional curing as specified by the Engineer may be required and modifications including change in the concrete mix design may be required for the remaining concrete work, all at the expense of the Contractor.

C. Dimensional Tolerances:
1. Formed surfaces resulting in concrete outlines smaller than amount exceeding the requirements permitted by the tolerances of ACI 117 shall be considered deficient in strength and subject to the provisions of Paragraph 3.8E.
2. Formed surfaces resulting in concrete outlined larger than required, by an amount exceeding the requirements of ACI 117 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance.
3. Concrete members cast in the wrong location may be rejected if the strength, appearance, or function of the structure is adversely affected or the misplaced items interfere with other construction.
4. Inaccurately formed concrete surfaces exceeding the requirements of ACI 117 and which are exposed to view may be rejected. Section shall be repaired or removed and replaced if required.
5. Finished flatwork exceeding the allowable tolerances may be repaired provided that strength or appearance is not adversely affected. High spots may be removed with a terrazzo grinder, low spots filled in with an approved patching compound, or other remedial measure performed as permitted.

D. Appearances:
1. Concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired, if possible. If, in the opinion of the Engineer, the defect cannot be repaired, the concrete may be accepted or rejected as provided in these specifications.
2. Concrete not exposed to view is not subject to rejection for defective appearance.

E. Strength of Structure – Potential Deficiency:
1. The strength of the structure in place will be considered potentially deficient if it fails to comply with any requirements, which control the strength of the structure, including but not necessarily limited to the following conditions:
    a. Low concrete strength.
    b. Reinforcing steel size, quantity, strength, position, or arrangement at variance, which the requirements of the contract documents.
    c. Concrete, which differs from the required dimensions or location in such a manner as to reduce the strength.
    d. Curing less than that specified.
    e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.

f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
g. Poor workmanship likely to result in deficient strength.

2. Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.
3. Core tests may be required when the strength of the concrete in place is considered potentially deficient.

F. Failure to Meet Requirements:

1. Owner and the Engineer reserve the right to reject any or all items which do not meet the requirements of the plans and specifications. The Contractor will replace these items veering all expenses in connection with such replacements.
2. If strength tests of concrete fail to meet the minimum requirements as specified herein, the concrete represented by such tests shall be considered questionable and shall be subject to further testing at the expense of the Contractor.
3. Additional tests of questionable concrete shall be conducted in accordance with ASTM C 42 as deemed necessary by the Owner and/or the Engineer.
4. Additional tests of the hardened concrete may be required by the Owner and/or the Engineer, if, in their opinion, there is cause for concern over the adequacy of the structure regardless of the results of any previous tests. If initial tests requirements had been met, the Contractor shall not be required to bear the costs of such additional tests unless their results confirm the concrete in place is deficient.
5. If core tests fail to demonstrate strengths adequate for the intended purpose of the member or members in question or are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required. The results shall be evaluated in accordance with ACI 318.
6. Concrete work judged inadequate by the Engineer based on structural analysis or by results of a load test shall be reinforced with additional construction if so directed by the Engineer or shall be replaced, at the Contractor's expense.
7. Except as provided earlier in this paragraph, the Contractor shall pay all costs incurred in providing the additional testing and/or analysis required by this section.

3.09 REPAIR OF DEFECTIVE CONCRETE

A. The Engineer will determine the extent and manner of action to be taken for the correction of defective concrete as may be revealed by surface defects or otherwise.

1. Prior to repair of defects, Contractor shall submit proposed material and repair methods to the Engineer for approval.
2. Obtain approval from the Engineer before performing repair work other than the removal of imperfect texture, filling pin holes and insert holes.

B. As soon as the forms have been stripped and the concrete surfaces exposed, remove fins and other projections, fill recesses left by the removal of form ties, and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining word stained by leakage of concrete to the satisfaction of the Engineer.

C. Hammer jack tie holes and other small cavities with a stiff mortar of the same material, but somewhat leaner that that in the concrete. Clean the cavity and the area wetted before mortar is placed.

D. Repair and patch defective areas with cement mortar of mix proportions and materials identical to those used in the surrounding concrete. Produce a finish on the patch that is indistinguishable from the surrounding concrete.

E. Where the honeycomb or voids are not excessive and repairs are authorized by the Engineer, outline removal area in a square shape with a ½- to ¾-inch deep saw cut and chip remaining at depth to sound solid concrete with a depth not less than 2-inches. When chipping is necessary, make edges perpendicular to concrete surface or slightly undercut to provide a key at the edge of the patch. Before placing cement mortar, thoroughly clean, dampen, and brush coat area to be patched with neat cement grout. Other patching materials may be used if accepted by Engineer in writing prior to start of repair work. The patch should be kept damp for seven days at a temperature above 50 degrees.

END OF SECTION

FINAL CONCRETE MIX DESIGN SUBMITTAL FORM

(One for each required mix design)

PROJECT: _____ Location: _____
General Contractor: _____
Mix design no.: _____ Design strength: _____

USE (Describe): _____
Mix Design Preparation: Based on Standard Deviation Analysis: _____
(check one) or Based on Trial Mixture Test Data: _____

MATERIALS:
Aggregates: (Provide size, type, source, specification)
Coarse: _____
Fine: _____

Cement Type/Source: _____

Admixtures: (Provide product, manufacturer)
Water Reducer: _____
Air Entraining: _____
Accelerator: _____
Other: _____

CONCRETE PROPERTIES

Water/Cement Ratio: _____
Slump: _____ inches
Entrained Air: ____ %
Density _____ pcf

SPECIFIC GRAVITIES

Fine Aggregate: _____
Coarse Aggregate: _____

ADMIXTURES

Accelerator _____ oz. per 100# cement
W. R. _____ oz. per 100# cement
A. E. _____ oz. per 100# cement
Other _____ oz. per 100# cement

MIX PROPORTIONS

	Weight (lbs)	Absolute Volume (cubic feet)
Cement:	_____	_____
Fine Aggregate:	_____	_____
Coarse Aggregate:	_____	_____
Water:	_____	_____
Entrained Air:	_____	_____
Other:	_____	_____
TOTAL	_____	_____

TEST RESULTS SUBMITTAL FORM

METHOD 1 - STANDARD DEVIATION ANALYSIS (ACI 318-02 SECTION 5.3.2.1):

Number of Test Cylinders Evaluated: _____ Standard Deviation: _____
(Attach Copy of All Test Results)
Mix Designs Proportioned to Achieve Both of the Following:

$f'_{cr} = f'_c + 1.34s$ = _____ psi
$f'_{cr} = f'_c + 2.33s - 500$ = _____ psi
Actual f'_c = _____ psi ($<= f'_{cr}$)
Slump =_____ Air Content = _____ %

METHOD 2 - TRIAL MIXTURE TEST DATA (ACI 318-02 SECTION 5.3.2.2):

Age (days)	Mix 1 (comp. str.)	Mix 2 (comp. str.)	Mix 3 (comp. str.)
7	_____	_____	_____
28	_____	_____	_____
28	_____	_____	_____
28-day avg.	_____	_____	_____

Mix Design Proportioned to Achieve the Following:

$f'_{cr} = f'_c + 1200$ psi (for f'c <= 5000 psi)
or $f'_{cr} = f'_c + 1400$ psi (for f'c > 5000 psi)

Slump = _____ in. Air Content = _____ %

REMARKS: _____
_____
_____

Note: Fill in all blank spaces. Use -0- (zero) or N.A. (not applicable). See Design and Control of Concrete Mixtures, Portland Cement Association, for assistance in filling out this form.

SUBMITTED BY:

Ready-Mix Supplier: Name _____
Address _____
Phone Number _____

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED SECTIONS

A. Section 03 30 00: Cast-In-Place Concrete.

1.03 REFERENCES

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

B. American Concrete Institute (ACI):
   1. ACI 305R, Hot Weather Concreting.
   2. ACI 306R, Cold Weather Concreting.
   3. ACI 306.1, Standard Specification for Cold Weather Concreting.
   4. ACI 308, Standard Specification for Curing Concrete.
   5. ACI 351.1R, Grouting between Foundations and Bases for Support of Equipment and Machinery.

C. American Society for Testing and Materials (ASTM):
   1. ASTM C 33, Standard Specification for Concrete Aggregate.
   2. ASTM C 109, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using two-inch or 50-mm Cube Specimens).
   3. ASTM C 150, Standard Specification for Portland Cement.
   4. ASTM C 827, Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
   5. ASTM C 1090, Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic Cement Grout.
   6. ASTM C 1107, Specification for Packaged Dry, Hydraulic Cement Grout (Non-Shrink).

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance wit the requirements of Special Provision 2.5 Contractor's Submittals:
   1. Product Data:
      1) Non-shrink metallic grout.
      2) Non-shrink non-metallic grout.
   2. Certificates:
      1) Grout manufacturer non-shrink certification.
   3. Informational Submittals:

4. Submit the following to the Construction Manager for information:
   a. Manufacturer's Instructions:
      1) Manufacturer's placing instructions.
5. Certificates:
   a. Buy America Act Certification.

1.05 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 C 827.
   2. Hardened height change of 0.0% to 0.3% according to ASTMC 1090.
   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 C 109 modified in accordance with the requirements of ASTM C 1107.
   4. Placement time based on initial set of not less than 60 minutes at 70 degrees F.

1.06 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:
   1. Buy America Act Certification
      a. Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

1.07 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.

1.08 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

2.01 MATERIALS

A. Non-Shrink Metallic Grout:
   1. A factory-premixed material containing no corrosive irons, aluminums, chemicals, or gypsums that meets ASTM C 1107 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 Section 03 30 00.
      d. 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. US Grout, LLC.
      c. Or approved equal.

B. Non-Shrink Non-Metallic Grout:
   1. A factory-premixed material containing no corrosive irons, aluminums, chemicals, or gypsums.
      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 Section 03 30 00.
   2. Acceptable manufacturers for non-shrink non-metallic grout include the following:
      a. Five Star Products, Inc.
      b. US Grout, LLC.
      c. Or approved equal.

C. Portland Cement:
   1. Portland Cement conforming to the requirements of ASTM C 150 Type I or Type II as specified.

D. Aggregates:
   1. Fine aggregate conforming to the material quality requirements of ASTM C 33.

2.02 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

3.01 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 that 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.

3.02 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 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.

C. 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.

3.03 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 C 109/C 109M modified in accordance with the requirements of ASTM C 1107.

b. Acceptance Criteria:
1) Grout meeting the requirements specified in subparagraph 2.01.A.1.c will be acceptable.

3. Inspections:
a. All grout placement will be visibly 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.

END OF SECTION

SECTION 04 05 11

MASONRY MORTARING AND GROUTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mortar for masonry.

B. Grout for masonry.

1.02 RELATED REQUIREMENTS

A. Section 04 20 02 - Single-Wythe Unit Masonry: Installation of mortar and grout.

1.03 REFERENCE STANDARDS

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

B. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures; American Concrete Institute International; 2009.

C. ASTM C 5 - Standard Specification for Quicklime for Structural Purposes; 2010.

D. ASTM C 91 - Standard Specification for Masonry Cement; 2005.

E. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2011.

F. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar; 2004.

G. ASTM C 150 - Standard Specification for Portland Cement; 2011.

H. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2006.

I. ASTM C 270 - Standard Specification for Mortar for Unit Masonry; 2010.

J. ASTM C 387/C 387M - Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete; 2011.

K. ASTM C 476 - Standard Specification for Grout for Masonry; 2010.

L. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2010.

M. ASTM C 1019 - Standard Test Method for Sampling and Testing Grout; 2011.

1.04 SUBMITTALS

A. See Special Provisions, for submittal procedures.

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

C. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C 270 is to be used. Also include required environmental conditions and admixture limitations.

D. Reports: Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C 270 and test and evaluation reports per ASTM C 780.

E. Reports: Submit reports on grout indicating conformance of component grout materials to requirements of ASTM C 476 and test and evaluation reports to requirements of ASTM C 1019.

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

G. Manufacturer's Instructions: Submit packaged dry mortar manufacturer's installation instructions.

1.05 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. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 MORTAR AND GROUT APPLICATIONS

A. At Contractor's option, mortar and grout may be field-mixed from packaged dry materials, made from factory premixed dry materials with addition of water only, or ready-mixed.

B. Mortar Color: Natural gray unless otherwise indicated.

C. Mortar Mix Designs: ASTM C 270, Property Specification.
   1. Interior, Non-loadbearing Masonry: Type O.

2.02 MATERIALS

A. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C 387/C 387M and capable of producing mortar of the specified strength in accordance with ASTM C 270 with the addition of water only.
   1. Color: Standard gray.

B. Packaged Dry Material for Grout for Masonry: Premixed cementitious materials and dried aggregates; capable of producing grout of the specified strength in accordance with ASTM C 476 with the addition of water only.

C. Portland Cement: ASTM C 150.
   1. Type: Type I - Normal.
   2. Color: Standard gray.

D. Masonry Cement: ASTM C 91.
   1. Type: Type N.

E. Hydrated Lime: ASTM C 207, Type S.

F. Quicklime: ASTM C 5, non-hydraulic type.

G. Mortar Aggregate: ASTM C 144.

H. Water: Clean and potable.

I. Bonding Agent: Latex type.

2.03 MORTAR MIXING

A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C 270 and in quantities needed for immediate use.

B. Maintain sand uniformly damp immediately before the mixing process.

C. Do not use anti-freeze compounds to lower the freezing point of mortar.

D. If water is lost by evaporation, re-temper only within two hours of mixing.

2.04 GROUT MIXING

A. Mix grout in accordance with ASTM C 94/C 94 M.

B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.

PART 3 EXECUTION

3.01 PREPARATION

A. Apply bonding agent to existing concrete surfaces.

B. Plug clean-out holes for grouted masonry with brick masonry units. Brace masonry to resist wet grout pressure.

3.02 INSTALLATION

A. Install mortar and grout to requirements of section(s) in which masonry is specified.

B. Work grout into masonry cores and cavities to eliminate voids.

C. Do not install grout in lifts greater than 16 inches without consolidating grout by rodding.

D. Do not displace reinforcement while placing grout.

E. Remove excess mortar from grout spaces.

3.03 GROUTING

A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of contract documents.

B. Low-Lift Grouting:
   1. Limit height of pours to 12 inches.
   2. Limit height of masonry to 16 inches above each pour.
   3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
   4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.

C. High-Lift Grouting:
   1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
   2. Place grout for spanning elements in single, continuous pour.

3.04 FIELD QUALITY CONTROL

A. Test and evaluate mortar in accordance with ASTM C780 procedures.

B. Test and evaluate grout in accordance with ASTM C1019 procedures.

END OF SECTION

SECTION 04 20 02

SINGLE-WYTHE UNIT MASONRY

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 03 20 00 - Concrete Reinforcing: Reinforcing steel for grouted masonry.

B. Section 04 05 11 - Masonry Mortaring and Grouting: Mortar and grout for single wythe unit masonry.

C. Section 07 84 00 - Firestopping: Firestopping at penetrations of masonry work.

D. Section 07 90 05 - Joint Sealers: Rod and sealant at control joints.

1.02 REFERENCE STANDARDS

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

B. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 2007.

C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

D. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2009b.

E. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units; 2006.

F. ASTM C140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units; 2011.

G. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data for Concrete masonry units.

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

1.04 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. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years of documented experience.

1.05 MOCK-UP

A. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar and accessories in mock-up.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.07 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

B. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.

C. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 x 8 inches and nominal depths as indicated on the drawings for specific locations.
   2. Non-Loadbearing Units: ASTM C129.
      a. Hollow block, as indicated.

2.02 MORTAR AND GROUT MATERIALS

A. Mortar and Grout: As specified in Section 04 05 11.

2.03 REINFORCEMENT AND ANCHORAGE

A. Manufacturers of Joint Reinforcement and Anchors:
   1. Blok-Lok Limited: www.blok-lok.com.
   2. Hohmann & Barnard, Inc. (including Dur-O-Wal brand): www.h-b.com.
   3. WIRE-BOND: www.wirebond.com.

B. Reinforcing Steel: Type specified in Section 03 20 00; size as indicated on drawings; galvanized finish.

C. Reinforcing Steel: ASTM A615/A615M Grade 40 (280) deformed billet bars; galvanized.

D. Joint Reinforcement: Use ladder type joint reinforcement where vertical reinforcement is involved and truss type elsewhere, unless otherwise indicated.

E. Single Wythe Joint Reinforcement: Truss type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.

F. Strap Anchors: Bent steel shapes configured as required for specific situations, 1-1/4 in width, 0.105 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A 153/A 153M, Class B.

G. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face.
   1. Steel frame: Crimped wire anchors for welding to frame, 0.25 inch thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.

2.04 ACCESSORIES

A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
   1. Manufacturers:
      a. Blok-Lok Limited: www.blok-lok.com.
      b. Hohmann & Barnard, Inc (including Dur-O-Wal brand): www.h-b.com.
      c. WIRE-BOND: www.wirebond.com.

B. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.05 LINTELS

A. Precast Concrete Lintels: Single wythe type, 8x8 inch size, 4,000 psi strength at 28 days.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive masonry.

B. Verify that related items provided under other sections are properly sized and located.

C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 PREPARATION

A. Direct and coordinate placement of metal anchors supplied for installation under other sections.

B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

3.03 COURSING

A. Establish lines, levels, and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

C. Concrete Masonry Units:
   1. Bond: Running.
   2. Coursing: One unit and one mortar joint to equal 8 inches.
   3. Mortar Joints: Concave.

3.04 PLACING AND BONDING

A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.

B. Lay hollow masonry units with face shell bedding on head and bed joints.

C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.

D. Remove excess mortar as work progresses.

E. Interlock intersections and external corners.

F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

H. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.

I. Isolate masonry partitions from vertical structural framing members with a control joint.

J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.05 REINFORCEMENT AND ANCHORAGE

A. Install horizontal joint reinforcement 16 inches on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Lap joint reinforcement ends minimum 6 inches.

E. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Space anchors at maximum of 24 inches horizontally and 16 inches vertically.

F. Install anchors to structural framing at not more than 16 inches on center.

3.06 LINTELS

A. Install loose steel lintels over openings.

B. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.
   1. Openings to 42 inches: Place two, No. 3 reinforcing bars 1 inch from bottom web.
   2. Openings from 42 inches to 78 inches: Place two, No. 5 reinforcing bars 1 inch from bottom web.
   3. Openings over 78 inches: Reinforce openings as detailed.
   4. Do not splice reinforcing bars.
   5. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
   6. Place and consolidate grout fill without displacing reinforcing.
   7. Allow masonry lintels to attain specified strength before removing temporary supports.

C. Maintain minimum 8 inch bearing on each side of opening.

3.07 GROUTED COMPONENTS

A. Reinforce bond beams with 2, No. 3 bars, 1 inch from bottom web.

B. Lap splices in reinforcing bars by minimum 24 bar diameters.

C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.

D. Place and consolidate grout fill without displacing reinforcing.

E. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.08 CONTROL AND EXPANSION JOINTS

A. Do not continue horizontal joint reinforcement through control and expansion joints.

B. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.

C. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

D. Size control joint in accordance with Section 07 90 05 for sealant performance.

3.09 BUILT-IN WORK

A. As work progresses, install built-in metal door frames and other items to be built into the work and furnished under other sections.

B. Install built-in items plumb, level, and true to line.

C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
   1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.

D. Do not build into masonry construction organic materials that are subject to deterioration.

3.10 TOLERANCES

A. Maximum Variation from Alignment of Columns: 1/4 inch.

B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.

C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft.

D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.

F. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.

G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.11 CUTTING AND FITTING

A. Cut and fit for chases, pipes, conduit, and sleeves. Coordinate with other sections of work to provide correct size, shape, and location.

B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.12 FIELD QUALITY CONTROL

A. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140 for conformance to requirements of this specification.

3.13 CLEANING

A. Remove excess mortar and mortar smears as work progresses.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.14 PROTECTION

A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED SECTIONS

A. Section 03 60 00: Grout.

B. Section 09 90 00: Paints and Coatings.

1.03 REFERENCES

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

B. American Institute of Steel Construction (AISC):
   1. Specification for Structural Steel Buildings (AISC 360).
   2. Code of Standard Practice for Steel Buildings and Bridges.
   3. Specification for Structural Joints Using High-Strength Bolts (approved by Research Council on Structural Connections, December 2009).

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

D. American Society for Testing and Materials (ASTM):
   1. ASTM A36, Specification for Carbon Structural Steel.
   2. ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   3. ASTM A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   4. ASTM A320, Alloy-Steel Bolting Materials for Low Temperatures Service.
   5. ASTM A325, Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi minimum Tensile Strength.
   6. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   8. ASTM A572, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   9. ASTM A992, Specifications for Structural Steel Shapes.
   10. ASTM E164, Practice for Ultrasonic Contact Examination of Weldments.
   11. ASTM E709, Guide for Magnetic Particle Examination.
   12. ASTM F436, Specification for Hardened Steel Washers.
   13. ASTM F959, Specification for Compressible-Washer-Type Direct Tension Indicators for use with Structural Fasteners.
   14. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.
   15. ASTM F1852, Specification for “Twist Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

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

F. The Society for Protective Coatings
   1. Steel Structures Painting Manual (SSPC).

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance wit the requirements of Special Provision 2.5 Contractor's Submittals:
   1. Structural Steel Shop Drawings:
      a. 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.
      b. Provide easy-to-read markings on shop and erection drawings for shop assemblies which require markings for erection identification.
      c. Note on shop drawings variations in tolerances or clearances between various products.
      d. Use standard welding symbols of the American Welding Society on shop drawings; show size, length, and type of each weld.
      e. Provide shop drawings prepared under the supervision of and sealed by a Professional Engineer registered in the State of Maryland experienced in structural engineering.
   2. Working Drawings:
      a. Furnish setting diagrams, templates, and directions for the installation of structural framing anchor bolts, bearing plates, and other embedded items.
   3. Project Standards:
      a. 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 registered in the State of Maryland.
   4. Temporary Support and Connection Calculations:
      a. Design all connections in accordance with AISC Specifications for Structural Steel Buildings Using Allowable Strength Design.
      b. Submit calculations prepared and sealed by a Professional Engineer, registered in the State of Maryland and experienced in structural engineering.
      c. Use type of shop and field connections shown or, in absence of such indication, use the most appropriate type. Connections shall safely withstand the combined effects of shears, direct forces, moments, and torques at applicable design stresses.
      d. Connection details shown on the Drawings are illustrative only.
      e. Design and detail connections so interference does not occur with architectural clearance lines and finishes.
      f. One-sided or other eccentric connections are not permitted unless detailed on the Contract Drawings.
   5. Product Data:
      a. Submit data for approval related to the following:
         1) High-strength bolts
         2) Paint primer.
   6. Welding Certifications:
      a. 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.
   b. 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.
   c. 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.
7. Test Results:
   a. Submit reports signed by the manufacturer certifying their products comply with requirements specified.
   b. Submit test reports certifying material conforms to ASTM specification.
   c. Submit guarantee showing all steel used for this project is American-made.
   d. Submit written affidavits from steel manufacturer indicating the percentage of post-industrial recycled content (90% min.) and post-consumer recycled content (75% min.)
8. Qualification Statement:
   a. Submit qualification statement denoting the requirements of this specification are met by the following:
      1) Structural steel fabricator qualifications
      2) Structural steel erector qualifications
9. An Independent Testing and Inspection Agency (Approved Agency) shall submit inspection and testing reports required by this Section.
10. Certificates:
   a. Buy America Act Certification.

1.05 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 must participate in the AISC Quality Certification Program and be designated an AISC Certified Plant with Category STD at time of bid.
      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.

B. Comply with applicable provisions listed in those references stated in Article 1.03 of this specification unless otherwise indicated.

1.06 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.

1.07 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:
   1. Buy America Act Certification
      a. Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

1.08 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

2.01 MATERIALS

A. Steel
   1. Structural Steel Pipe: ASTM A53, Grade B.

B. Fasteners
   1. High-Strength Bolted Connections:
      a. High Strength Bolts: ASTM A325.
      b. Carbon and Alloy Steel Nuts: ASTM A563.
      c. 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. Anchor Rods:
      a. Rods: ASTM F1554, Grade 36, 55, 105 as noted on drawings.
      b. Nuts: ASTM A563.
      c. Washers: ASTM F436.
   3. Bolt Lubricant: Molybdenum disulfide base lubricant.

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.
   2. Finish Coat: See Section 09900.

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

2.02 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 A 325 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.

2.03 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 per 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 09 90 00.

C. Finish Coat:
   1. Apply finish coats of paint to structural steel in accordance with the requirements of Section 09 90 00.

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

2.04 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 E 164 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 E 709 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 length 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

3.01 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.

3.02 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. Temporary supports shall be installed per the Contractor's approved temporary shoring plan throughout column replacement.
   1. Leave temporary bracing in place as long as required for safety.
   2. Column replacement shall not be performed with snow or live load on the roof of the structure.

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.

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 A 325 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 A 325 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 decking, clean all heavy rust, mill scale, dirt, or other material from the unpainted top flanges of supporting beams.

3.03 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, including special tolerances for AESS; 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 proper fastening component used.
      b. Verify proper fabrication of connected elements.

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 E 164:
         2) Inspect the entire length of fillet welds in accordance with the requirements for the Magnetic Particle Method specified in ASTM E 709 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 proper fastening component used.
      b. Verify proper fabrication of connected elements.

3.04 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.

C. Apply touch-up paint to exposed areas using material as specified in Section 09 90 00.

END OF SECTION

SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Formed steel stud interior wall framing.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood blocking and miscellaneous framing.

B. Section 07 21 00 - Thermal Insulation: Insulation within framing members.

C. Section 07 90 05 - Joint Sealers.

D. Section 09 21 16 - Gypsum Board Assemblies: Lightweight, non-load bearing metal stud framing.

E. Section 09 51 00 - Acoustical Ceilings: Ceiling suspension system.

1.03 REFERENCE STANDARDS

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

B. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. (replaced SG-971)

C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

D. ASTM C955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases; 2010.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide manufacturer's data on factory-made framing connectors, showing compliance with requirements.

D. Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention.

1.05 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. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in Maryland.

C. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years of experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Framing, Connectors, and Accessories:
1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com.
2. Marino\Ware: www.marinoware.com.
3. The Steel Network, Inc: www.SteelNetwork.com.

2.02 FRAMING SYSTEM

A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.

2.03 FRAMING MATERIALS

A. Studs and Track: ASTM C955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.
1. Gage and depth: As indicated on the drawings.

2.04 ACCESSORIES

A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.

2.05 FASTENERS

A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.

B. Anchorage Devices: Power actuated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION OF STUDS

A. Install components in accordance with manufacturers' instructions and ASTM C1007 requirements.

3.03 TOLERANCES

A. Maximum Variation from True Position: 1/16 inch.

B. Maximum Variation of any Member from Plane: 1/8 inch in 10'.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Placement of metal fabrications in concrete.

B. Section 04 20 02 - Single-Wythe Unit Masonry: Placement of metal fabrications in masonry.

C. Section 09 90 00 - Painting and Coating: Paint finish.

1.02 REFERENCE STANDARDS

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

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association; 1998.

C. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels; 2002.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2008.

E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2010.

F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2009.

G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

H. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2003 (Reapproved 2007).

I. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength; 2010.

J. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2009a.

K. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2009.

L. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2010a.

M. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2007.

N. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

O. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.

P. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2007.

Q. ASTM B211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire; 2003.

R. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2008.

S. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2007.

T. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2007.

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

V. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; American Welding Society; 2003, and Errata 2004.

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

X. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

Y. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 1982 (Ed. 2004).

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
   1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

D. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

1.04 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. Design miscellaneous metal fabrications under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in Maryland.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Steel Sections: ASTM A36/A36M.

B. Steel Tubing: ASTM A500, Grade B cold-formed structural tubing.

C. Plates: ASTM A283.

D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.

E. Slotted Channel Framing: ASTM A653, Grade 33.

F. Slotted Channel Fittings: ASTM A1011/A1011M.

G. Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, galvanized to ASTM A153/A153M where connecting galvanized components.

H. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

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

J. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 MATERIALS - ALUMINUM

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.

B. Sheet Aluminum: ASTM B209 (ASTM B209M), 5052 alloy, H32 or H22 temper.

C. Bolts, Nuts, and Washers: Stainless steel.

D. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

2.03 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. 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.

D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 FABRICATED ITEMS

A. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.

B. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to Structural Framing: For support of metal decking; prime paint finish.

C. Lintels: As detailed; prime paint finish.

D. Door Frames for Overhead Door Openings and Wall Openings: Channel sections; prime paint finish.

2.05 FINISHES - STEEL

A. Prime paint all steel items.
   1. Exceptions: Galvanize items to be embedded in concrete or masonry.
   2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.

B. Prepare surfaces to be primed in accordance with SSPC-SP2.

C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

D. Prime Painting: One coat.

E. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements.

F. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

2.06 FINISHES - ALUMINUM

A. Exterior Aluminum Surfaces: Class I color anodized.

B. Interior Aluminum Surfaces: Class I natural anodized.

C. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

2.07 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

3.01 EXAMINATION

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

3.02 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.

3.03 INSTALLATION

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

B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Obtain approval prior to site cutting or making adjustments not scheduled.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

SECTION 05 52 13

PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall mounted handrails.

1.02 RELATED REQUIREMENTS

A. Section 09 21 16 - Gypsum Board Assemblies: Placement of backing plates in stud wall construction.

B. Section 09 90 00 - Painting and Coating: Paint finish.

1.03 REFERENCE STANDARDS

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

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association; 1998.

C. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2008.

D. ASTM E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings; 2000 (Reapproved 2006).

1.04 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.

1.05 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Handrails and Railings:
   1. C. R. Laurence Co., Inc: www.crlaurence.com.
   2. KaneSterling: www.sterlingdula.com.
   3. The Wagner Companies: www.wagnercompanies.com.

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

C. Dimensions: See drawings for configurations and heights.
   1. Top Rails and Wall Rails: 1-1/2 inches diameter, round.
   2. Intermediate Rails: 1-1/2 inches diameter, round.
   3. Posts: 1-1/2 inches diameter, round.

D. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.

E. Provide slip-on non-weld mechanical fittings 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.

2.03 ALUMINUM MATERIALS

A. Non-Weld Mechanical Fittings: Slip-on cast aluminum, for Schedule 40 pipe, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.

B. Exposed Fasteners: No exposed bolts or screws.

2.04 FABRICATION

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

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.

2.05 ALUMINUM FINISHES

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 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.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-structural dimension lumber framing.

B. Roof-mounted curbs.

C. Roofing nailers.

D. Miscellaneous framing and sheathing.

E. Concealed wood blocking, nailers, and supports.

1.02 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications: Miscellaneous steel connectors and support angles for wood framing.

B. Section 09 21 16 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.03 REFERENCE STANDARDS

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

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

D. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce); 2005.

E. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc.; 2002.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide technical data on wood preservative materials and application instructions.

D. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

1.06 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.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. Species: Douglas Fir-Larch, unless otherwise indicated.
   2. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
   3. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

B. Lumber fabricated from old growth timber is not permitted.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).

B. Sizes: Nominal sizes as indicated on drawings, S4S.

C. Moisture Content: S-dry or MC19.

D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
   1. Lumber: S4S, No. 2 or Standard Grade.
   2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

A. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.04 ACCESSORIES

A. Fasteners and Anchors:
   1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

3.03 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to code authorities may be used in lieu of solid wood blocking.

C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.

D. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.

E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.

F. Specifically, provide the following non-structural framing and blocking:
1. Cabinets and shelf supports.
2. Wall brackets.
3. Handrails.
4. Grab bars.
5. Towel and bath accessories.
6. Wall-mounted door stops.
7. Chalkboards and marker boards.

3.04 ROOF-RELATED CARPENTRY

A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.

B. Provide wood curb at all roof openings except where specifically indicated otherwise. Form corners by alternating lapping side members.

3.05 INSTALLATION OF CONSTRUCTION PANELS

A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
3. Install adjacent boards without gaps.
4. Size: 48 by 96 inches, installed horizontally at ceiling height.

3.06 TOLERANCES

A. Framing Members: 1/4 inch from true position, maximum.

B. Variation from Plane (Other than Floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.07 CLEANING

A. Waste Disposal:
1. Comply with applicable regulations.
2. Do not burn scrap on project site.
3. Do not burn scraps that have been pressure treated.
4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 06 41 00

ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specially fabricated cabinet units.

B. Countertops.

C. Cabinet hardware.

D. Factory finishing.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Support framing, grounds, and concealed blocking.

1.03 REFERENCE STANDARDS

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

B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2009.

C. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; 2010 (ANSI/BHMA A156.9).

D. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; Hardwood Plywood & Veneer Association; 2004 (ANSI/HPVA HP-1).

E. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Minimum Scale of Detail Drawings: 1-1/2 inch to 1 foot.
   2. Provide the information required by AWI/AWMAC/WI Architectural Woodwork Standards.
   3. Include certification program label.

D. Product Data: Provide data for hardware accessories.

E. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.

1.05 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. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect units from moisture damage.

1.07 FIELD CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Single Source Responsibility: Provide and install this work from single fabricator.

2.02 CABINETS

A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI//AWMAC/WI Architectural Woodwork Standards for Premium Grade.

B. Wood Veneer Faced Cabinets: Premium grade.
1. Exposed Surfaces: Grade AA, Red Oak, plain sliced, slip-matched.
2. Semi-Exposed Surfaces: Grade A, Black Walnut, rotary cut, random-matched.

C. Cabinets:
1. Finish - Concealed Surfaces: Manufacturer's option.
2. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
3. Door and Drawer Front Retention Profiles: Fixed panel.
4. Casework Construction Type: Type A - Frameless.
5. Grained Face Layout for Cabinet and Door Fronts: Style and Rail, all Grades.
   a. Doors: Vertical grain.
6. Adjustable Shelf Loading: 50 lbs. per sq. ft..
   a. Deflection: L/144.
7. Cabinet Style: Flush overlay.
8. Cabinet Doors and Drawer Fronts: Flush style.
9. Drawer Side Construction: Multiple-dovetailed.
10. Drawer Construction Technique: Dovetail joints.

2.03 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

2.04 LAMINATE MATERIALS

A. Manufacturers:
1. Formica Corporation: www.formica.com.
2. Panolam Industries International, Inc\Nevamar: www.nevamar.com.
3. Wilsonart International, Inc: www.wilsonart.com.

B. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

C. Provide specific types as scheduled.

1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, through color, colors as scheduled, finish as scheduled.
2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, colors as scheduled, finish as scheduled.
3. Cabinet Liner: CLS, 0.020 inch nominal thickness, through color, colors as scheduled, finish as scheduled.
4. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.05 COUNTERTOPS

A. Plastic Laminate Countertops: Medium density fiberboard substrate covered with HPDL, conventionally fabricated and self-edge banded.

2.06 ACCESSORIES

A. Adhesive: Type recommended by fabricator to suit application.

B. Ventilation Grilles:
1. Manufacturer: Global Industrial, Inc., www.globalindustrial.com, or approved equal
2. Size: 1/2" x 1/2" cells x 1/2" thick
3. Model: WBB Series, sheet sizes as required.
4. Material: Satin finish annodized aluminum.

C. Brush Type Wireway Management Devices:
1. Manufacturer: Doug Mockett and Company, Inc., www.mockett.com, or approved equal
2. Model: Max 1B,C/-94, 14" and 27" wide, satin annodized finish.

D. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
1. Color: As selected by Engineer from manufacturer's standard range.
2. Use at all exposed plywood edges.
3. Use at all exposed shelf edges.

2.07 HARDWARE

A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.

B. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.

C. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers.

D. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.

E. Catches: Magnetic.

F. Drawer Slides:
1. Type: Standard extension.
2. Static Load Capacity: Heavy Duty grade.
3. Mounting: Side mounted.
4. Stops: Integral type.
5. Features: Provide self closing/stay closed type.
6. Products:
   a. Accuride International, Inc: www.accuride.com.
   b. Grass America Inc: www.grassusa.com.
   c. Knape & Vogt Manufacturing Company: www.knapeandvogt.com.

G. Hinges: European style concealed self-closing type, steel with polished finish.
   1. Products:
      a. Grass America Inc: www.grassusa.com.
      b. Hardware Resources: www.hardwareresources.com.
      c. Julius Blum, Inc: www.blum.com.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 FABRICATION

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.

E. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

2.09 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. For opaque finishes, apply wood filler in exposed nail and screw indentations and sand smooth.

C. On items to receive transparent finishes, use wood filler matching or blending with surrounding surfaces and of types recommended for applied finishes.

D. Finish work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, Section 5 - Finishing for Grade specified and as follows:
   1. Transparent:
      a. System - 1, Lacquer, Nitrocellulose.
      b. Stain: As selected by Engineer.
      c. Sheen: Flat.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

B. Use fixture attachments in concealed locations for wall mounted components.

C. Use concealed joint fasteners to align and secure adjoining cabinet units.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.

E. Secure cabinets to floor using appropriate angles and anchorages.

3.03 ADJUSTING

A. Adjust installed work.

B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

SECTION 06 61 00

SIMULATED STONE FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cast plastic washroom vanities, washroom vanities with integral sink, and counter top.

1.02 RELATED REQUIREMENTS

A. Section 06 41 00- Architectural Woodwork: Cabinetry

1.03 REFERENCE STANDARDS

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

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

1.04 DESIGN REQUIREMENTS

A. Design all countertops with sufficient strength for handling and placement stresses.

1.05 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Shop Drawings: Indicate dimensions, thicknesses, required clearances, tolerances, materials, colors, finishes, fabrication details, field jointing, adjacent construction, design load parameters, methods of support, integration of plumbing components, and anchorages.

D. Product Data: Provide data on specified component products, electrical characteristics and connection requirements.

E. Samples: Submit two samples representative of vanity top, 6x6 inch in size, illustrating color, texture, and finish.

F. Manufacturer's Installation Instructions: Indicate preparation of opening required, rough-in sizes; provide templates for cast-in or placed frames or anchors; tolerances for item placement, temporary bracing of components.

G. Maintenance Data: Indicate list of approved cleaning materials and procedures required; list of substances that are harmful to the component materials.
   1. Include instructions for stain removal, surface and gloss restoration.

H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in The Authority's name and registered with manufacturer.

I. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Polishing Cream: 16 oz.

1.06 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. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.07 WARRANTY

A. Provide five year manufacturer warranty for all countertops.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cast Plastic Fabrications:
   1. Basis of Design: Corian or approved equal..
   2. Integral sinks; Product Model 810.

2.02 MATERIALS

A. Provide finished products having flame spread index of 35 and smoke developed index of 15, when tested in accordance with ASTM E84 in thickness of 3/4 inch.

B. Resin: Polyester type, with integral coloring, stain resistant to domestic chemicals and cleaners.

C. Polishing Cream: Compatible polishing cream to achieve specified sheen to gel coat.

D. Core Framing: Softwood lumber, clear and free of knots.

E. Adhesive: as recommended by manufacturer.

2.03 FABRICATION

A. Fabricate components by mold to achieve shape and configuration.

B. Gel coat the finish exposed surfaces smooth and polish to a gloss sheen.

C. Radius corners and edges.

D. Cure components prior to shipment, except sheet materials requiring site handling.

2.04 FINISH

A. Color: as selected.

B. Exposed to View Surface Visual Texture: From manufacturer's complete standard finishes.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that joint preparation and affected dimensions are acceptable.

C. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 PREPARATION

A. Provide anchoring devices for installation and embedding.

B. Provide templates and rough-in measurements.

3.03 INSTALLATION

A. Install components in accordance with shop drawings and manufacturer's instructions.

B. Align work plumb and level.

C. Rigidly anchor to substrate to prevent misalignment.

3.04 TOLERANCES

A. Maximum Variation From True Dimension: 1/8 inch.

B. Maximum Offset From True Position: 1/8 inch.

3.05 CLEANING

A. Clean and polish fabrication surfaces in accordance with manufacturer's instructions.

3.06 PROTECTION

A. Do not permit construction near unprotected surfaces.

END OF SECTION

SECTION 07 21 00

THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Batt insulation and vapor retarder in exterior wall, ceiling, and roof construction.

B. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED REQUIREMENTS

A. Section 05 40 00 - Cold-Formed Metal Framing: Board insulation as wall sheathing.

B. Section 06 10 00 - Rough Carpentry: Supporting construction for batt insulation.

C. Section 07 24 00 - Exterior Insulation and Finish System: Board insulation on exterior side of walls, finished with weatherproof coating.

D. Section 09 21 16 - Gypsum Board Assemblies: Acoustic insulation inside walls and partitions.

1.03 REFERENCE STANDARDS

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

B. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2007.

C. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2010a.

D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2006.

E. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2006.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2010.

H. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

1.04 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.

1.05 SUBMITTALS

A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

B. Certifications:
   1. Buy America Act Certification:

a. Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

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

1.06 FIELD CONDITIONS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.

B. Insulation Above Lay-In Acoustical Ceilings: Batt insulation with no vapor retarder.

2.02 FOAM BOARD INSULATION MATERIALS

A. Expanded Polystyrene Board Insulation: ASTM C578; with the following characteristics:
1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
3. Board Size: 48 x 96 inch.
4. Board Thickness: 2 inches.
5. Board Edges: Square.
6. Water Absorption: 4 percent by volume, maximum, when tested In accordance with ASTM D2842.
7. Board Density: 0.7 lb/cu ft.
8. Compressive Resistance: 5 psi.
9. Thermal Conductivity (k factor) at 25 degrees F: 0.28.

2.03 BATT INSULATION MATERIALS

A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option.

B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
3. Combustibility: Non-combustible, when tested in accordance with ASTM E136.
4. Facing: Aluminum foil, one side.
5. Manufacturers:
   a. CertainTeed Corporation: www.certainteed.com.
   b. Johns Manville Corporation: www.jm.com.
   c. Owens Corning Corp: www.owenscorning.com.

C. Mineral Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
1. Provide foil facing on one side; with flame spread index of 25 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.

2.04 ACCESSORIES

A. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.

B. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate,

capable of securely and rigidly fastening insulation in place.

C. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT FOUNDATION PERIMETER

A. Install boards horizontally on foundation perimeter.

B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BATT INSTALLATION

A. Install insulation in accordance with manufacturer's instructions.

B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.

C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

E. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over member face.

F. Tape seal tears or cuts in vapor retarder.

G. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane. Tape seal in place.

3.04 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION

SECTION 07 24 00

EXTERIOR INSULATION AND FINISH SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Composite wall cladding of rigid insulation and reinforced finish coating ("Class PB").

1.02 RELATED REQUIREMENTS

A. Section 05 40 00 - Cold-Formed Metal Framing: Sheathing on metal studs.

B. Section 07 90 05 - Joint Sealers: Perimeter and penetration sealants.

1.03 REFERENCE STANDARDS

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

B. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2009.

C. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2010a.

D. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster; 2008.

E. ASTM C1397 - Standard Practice for Application of Class PB Exterior Insulation and Finish Systems (EIFS) and EIFS with Drainage; 2009.

F. ASTM D968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive; 2005 (Reapproved 2010).

G. ASTM D2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity; 2011.

H. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2000 (Reapproved 2005).

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

J. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2009).

K. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials; 2004 (Reapproved 2010).

L. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials; 2005a.

M. ICC-ES AC219 - Acceptance Criteria for Exterior Insulation and Finish Systems; 2009.

N. NFPA 259 - Standard Test Method for Potential Heat Building Materials; 2009.

O. NFPA 268 - Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source; 2007.

P. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2006.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on system materials, product characteristics, performance criteria, and system limitations.

1.05 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. Maintain copy of specified installation standard and manufacturer's installation instructions at project site at all times during installation.

1.06 MOCK-UP

A. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to project site in manufacturer's original, unopened containers with labels intact. Inspect materials and notify manufacturer of any discrepancies.

B. Storage: Protect adhesives and finish materials from freezing and temperatures in excess of 90 degrees F.
   1. Protect Portland cement based materials from moisture and humidity. Store under cover off the ground in a dry location.
   2. Protect insulation materials from exposure to sunlight.

1.08 FIELD CONDITIONS

A. Do not prepare materials or apply EIFS during inclement weather unless areas of installation are protected. Protect installed EIFS areas from inclement weather until dry.

B. Do not install coatings or sealants when ambient temperature is below 40 degrees F.

C. Do not leave installed insulation board exposed to sunlight for extended periods of time.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Parex USA, Inc.: www.parex.com.
   2. BASF Wall Systems (Senergy, Finestone, Acrocrete, SonoWall): www.wallsystems.basf.com.
   3. Sto Corp; Product : www.stocorp.com.

2.02 EXTERIOR INSULATION AND FINISH SYSTEM

A. Exterior Insulation and Finish System: BARRIER type; reinforced finish coating on insulation board adhesive-applied direct to substrate; provide a complete system that has been tested to show compliance with the following characteristics; include all components of specified system and substrate in tested samples.

B. Fire Characteristics:
   1. Flammability: Pass, when tested in accordance with NFPA 285.
   2. Ignitibility: No sustained flaming when tested in accordance with NFPA 268.
   3. Potential Heat of Foam Plastic Insulation Tested Independently of Assembly: No portion of the assembly having potential heat that exceeds that of the insulation sample tested for flammability (above), when tested in accordance with NFPA 259 with results expressed in Btu per square foot.

C. Water Penetration Resistance: No water penetration beyond the plane of the base coat/insulation board interface after 15 minutes, when tested in accordance with ASTM E331 at 6.24 psf differential pressure with tracer dye in the water spray; include in tested sample at least two vertical joints and one horizontal joint of same type to be used in construction; disassemble sample if necessary to determine extent of water penetration.

D. Salt Spray Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 300 hours exposure in accordance with ASTM B117, using at least three samples matching intended assembly, at least 4 by 6 inches in size.

E. Freeze-Thaw Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating when viewed under 5x magnification after 10 cycles, when tested in accordance with ICC-ES AC 219 or 235.

F. Weathering Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating when viewed under 5x magnification after 2000 hours of accelerated weathering conducted in accordance with ASTM G153 Cycle 1 or ASTM G155 Cycle 1, 5, or 9.

G. Water Degradation Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 14 days exposure, when tested in accordance with ASTM D2247.

H. Mildew Resistance: No growth supported on finish coating during 28 day exposure period, when tested in accordance with ASTM D3273.

I. Abrasion Resistance Of Finish: No cracking, checking or loss of film integrity when tested in accordance with ASTM D968 with 500 liters of sand.

2.03 MATERIALS

A. Finish Coating Top Coat: Water-based, air curing, acrylic or polymer-based finish with integral color and texture.
   1. Texture: match existing.

B. Base Coat: Fiber-reinforced, acrylic or polymer-based product compatible with insulation board and reinforcing mesh.

C. Reinforcing Mesh: Balanced, open weave glass fiber fabric, treated for compatibility and improved bond with coating, weight, strength, and number of layers as required to meet required system impact rating.

D. Insulation Board: Molded, expanded polystyrene board; ASTM C578, Type I; with the following characteristics:

1. Board Size: 24 by 48 inches.
2. Board Size Tolerance: plus/minus 1/16 inch from square and dimension.
3. Board Thickness: match existing inches.
4. Thickness Tolerance: plus/minus 1/16 inch maximum.
5. Board Edges: Square.
6. Thermal Resistance (R factor per 1 in (25.4 mm)) at 75 degrees F: 3.60.
7. Board Density: 0.9 lb/cu ft.
8. Compressive Resistance: 10 psi.
9. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, when tested in accordance with ASTM E84.

2.04 ACCESSORY MATERIALS

A. Insulation Adhesive: Type required by EIFS manufacturer for project substrate.

B. Trim: EIFS manufacturer's standard PVC or galvanized steel trim accessories, as required for a complete project and including starter track, and drainage accessories.

C. Sealant Materials: As recommended by EIFS manufacturer.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with EIFS manufacturer's instructions and ASTM C1397.

B. Where different requirements appear in either document, comply with the most stringent.

C. Neither of these documents supercedes the provisions of the Contract Documents that define the contractual relationships between the parties or the scope of work.

3.02 EXAMINATION

A. Verify that substrate is sound and free of oil, loose materials, or protrusions that could interfere with EIFS installation and is of a type and construction that is acceptable to EIFS manufacturer. Do not begin work until substrate and adjacent materials are complete and thoroughly dry.

B. Verify that substrate surface is flat, with no deviation greater than 1/4 in when tested with a 10 ft straightedge.

3.03 PREPARATION

A. Install self-furring metal lath over solid substrates that are deemed unacceptable to receive adhesively applied insulation. Install in accordance with ASTM C1063, except for butt-lapping instead of overlapping..

3.04 INSTALLATION - INSULATION

A. Install in accordance with manufacturer's instructions.

B. Rasp irregularities off surface of installed insulation board.

C. Adhesive Attachment: Use method recommended by EIFS manufacturer.

3.05 INSTALLATION - FINISH

A. Base Coat: Apply in thickness as necessary to fully embed reinforcing mesh, wrinkle free, including back-wrap at all terminations of the EIFS. Install reinforcing fabric as recommended by EIFS manufacturer.
   1. Lap reinforcing mesh edges and ends a minimum of 2-1/2 inches.
   2. Allow base coat to dry a minimum of 24 hours before next coating application.

B. Apply finish coat after base coat has dried not less than 24 hours, embed finish aggregate, and

finish to a uniform texture and color.

C. Apply sealant at finish perimeter and expansion joints in accordance with Section 07 90 05.

3.06 CLEANING

A. Clean EIFS surfaces and work areas of foreign materials resulting from EIFS operations.

3.07 PROTECTION

A. Protect completed work from damage and soiling by subsequent work.

END OF SECTION

SECTION 07 41 13

METAL ROOF PANELS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Roof sheathing.

B. Section 07 21 00 - Board and Batt Insulation: Rigid roof insulation.

C. Section 07 42 13 - Metal Wall Panels: Preformed wall panels.

D. Section 07 90 05 - Joint Sealers: Field-installed sealants.

1.02 REFERENCE STANDARDS

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

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

D. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2005.

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Storage and handling requirements and recommendations.
   2. Installation methods.
   3. Specimen warranty.

D. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
   1. Show work to be field-fabricated or field-assembled.

E. Test Reports: Indicate compliance of preformed metal roofing system to specified requirements.

F. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in The Authority's name and are registered with manufacturer.

1.04 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. Manufacturer Qualifications: Company specializing in the manufacture of roofing systems similar to those required for this project, with not less than 5 years of documented experience.

C. Installer Qualifications: Company trained and authorized by roofing system manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.06 WARRANTY

A. See Procurement Documents, for additional warranty requirements.

B. Finish Warranty: Provide manufacturer's special warranty covering failure of factory-applied exterior finish on metal roof panels and agreeing to repair or replace panels that show evidence of finish degradation, including significant fading, chalking, cracking, or peeling within specified warranty period of 5 year period from date of final substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Design is based on, manufactured by American Building Sysytems.

B. Acceptable manufacturers are:
1. Architectural Building Components: www.archmetalroof.com.
2. ATAS International, Inc: www.atas.com.
3. Petersen Aluminum Corporation: www.pac-clad.com.

2.02 STRUCTURAL ROOF PANELS

A. Engineering: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed 1/180 of the span when tested in accordance with ASTM E1592.

B. Performance Requirements: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for conformance to the following minimum standards:
1. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.

C. Metal Roofing: Factory-formed panels with mill finish.
1. Steel Panels:
   a. Zinc-coated SS (structural steel) sheet conforming to ASTM A653/A653M; minimum G60 galvanizing.
   b. Steel Thickness: Minimum 0.024 inch.
2. Profile: Standing seam, with minimum 1.0 inch seam height; concealed fastener system for field seaming with special tool.
3. Texture: Smooth.
4. Width: Maximum panel coverage of 16 inches.
5. Mill-Finish Steel Panels: Treat with passivating chemical prior to shipment, to inhibit formation of corrosion.

2.03 ATTACHMENT SYSTEM

A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.04 ACCESSORIES AND MISCELLANEOUS ITEMS

A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, and equipment curbs of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
   1. Downspouts: Open face, rectangular profile.

B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish or combination steel and closed-cell foam.

C. Sealants: As specified in Section 07 90 05.
   1. Exposed sealant must cure to rubber-like consistency.
   2. Concealed sealant must be non-hardening type.

D. Thermal Insulation: Provide flexible blanket, rigid, or semi-rigid type, faced with white, flexible, non-dusting vapor retarder tested for maximum flame-spread rating of 50, per ASTM E84; for installation using spacer blocks.
   1. Thickness: As indicated.

2.05 FABRICATION

A. Panels: Fabricate panels and accessory items at factory, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to assure that the completed roof will be free of leaks.

B. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by roof panel manufacturer.

C. Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.03 INSTALLATION

A. Overall: Install roofing system in accordance with approved shop drawings and panel manufacturer's instructions and recommendations, as applicable to specific project conditions. Anchor all components of roofing system securely in place while allowing for thermal and structural movement.
   1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
   2. Minimize field cutting of panels. Where field cutting is absolutely required, use methods that will not distort panel profiles. Use of torches for field cutting is absolutely prohibited.

B. Accessories: Install all components required for a complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.

C. Roof Panels: Install panels in strict accordance with manufacturer's instructions, minimizing transverse joints except at junction with penetrations.

1. Form weathertight standing seams incorporating concealed clips, using an automatic mechanical seaming device approved by the panel manufacturer.

D. Insulation: Install insulation between roof covering and supporting members to present a neat appearance. Fold, staple, and tape seams unless otherwise approved by Engineer.

END OF SECTION

SECTION 07 42 13

METAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured metal panels for walls, with insulation, liners, related flashings, and accessory components. Panels are for infilling openings on an existing structure.

1.02 RELATED REQUIREMENTS

A. Section 05 40 00 - Cold-Formed Metal Framing: Wall panel substrate.

B. Section 06 10 00 - Rough Carpentry: Wall panel substrate.

C. Section 07 21 00 - Thermal Insulation.

D. Section 07 90 05 - Joint Sealers.

1.03 REFERENCE STANDARDS

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

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

C. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2010.

D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2006.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Shop Drawings: Indicate dimensions, layout, joints, construction details, methods of anchorage.

D. Samples: Submit two samples of wall panel, 6 inch by 6 inch in size illustrating finish color, sheen, and texture.

1.05 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. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

1.06 MOCK-UP

A. Construct mock-up, 4 feet long by 4 feet wide; include panel system, attachments to building frame, associated vapor retarder and air seal materials, weep drainage system, sealants and seals, and related insulation.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.

B. Store prefinished material off ground and protected from weather. Prevent twisting, bending, or abrasion, and provide ventilation to stored materials. Slope metal sheets to ensure drainage.

C. Prevent contact with materials that may cause discoloration or staining of products.

1.08 WARRANTY

A. See Procurement Documents, for further warranty requirements.

B. Correct defective work within a five year period after final substantial completion for degradation of panel finish, including color fading caused by exposure to weather.

C. Correct defective Work within a five year period after final substantial completion, including defects in water tightness.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. American Buildings, Inc..

B. Other Acceptable Manufacturers:
1. Centria: www.centria.com.
2. MBCI: www.mbci.com.
3. Petersen Aluminum Corporation: www.pac-clad.com.

2.02 MANUFACTURED METAL PANELS

A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
1. Provide exterior panels, interior liner panels, and subgirt framing assembly.
2. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall.
3. Design Pressure: In accordance with applicable codes.
4. Maximum Allowable Deflection of Panel: 1/90 of span.
5. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
6. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
7. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or

defects; pieces of longest practical lengths.

8. Corners: Factory-fabricated in one continuous piece with minimum 18 inch returns.
9. Exterior Panel Back Coating: Panel manufacturer's standard polyester wash coat.
10. Interior Panel Finish: Panel manufacturer's standard polyester coating, top coat over recommended primer.

B. Exterior Panels:
   1. Profile: Vertical; Match Existing style.
   2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.
   3. Material: Precoated steel sheet, minimum Match existing gage thick.
   4. Panel Width: Match existing.
   5. Color: As selected by Engineer from manufacturer's standard line.

C. Liner Panels:
   1. Profile: Vertical; Match existing.
   2. Side Seams: Interlocking, sealed with continuous bead of sealant.
   3. Material: Precoated steel sheet, minimum Match existing gage thick.
   4. Panel Width: Match existing.
   5. Color: As selected by Engineer from manufacturer's standard line.

D. Subgirts:
   1. Match existing thickness of formed steel sheet.
   2. Match existing profile; to attach panel system to building.

E. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

F. Anchors: Galvanized steel.

2.03 MATERIALS

A. Precoated Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M Structural Steel (SS) or Forming Steel (FS), with G90/Z275 coating; continuous coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

B. Insulation: Glass fiber type specified in Section 07 21 00.
   1. 6 inch thick.
   2. Thermal resistance R of 19.

2.04 ACCESSORIES

A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.

B. Sealants: As specified in Section 07 90 05.

C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized. Fastener cap same color as exterior panel.

D. Field Touch-up Paint: As recommended by panel manufacturer.

E. Bituminous Paint: Asphalt base.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building framing members are ready to receive panels.

B. Verify that water-resistive barrier has been installed over substrate completely and correctly.

3.02 PREPARATION

A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane. Space at intervals indicated.

3.03 INSTALLATION

A. Install panels on walls in accordance with manufacturer's instructions.

B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint. Allow to dry prior to installation.

C. Fasten panels to structural supports; aligned, level, and plumb.

D. Locate joints over supports. Lap panel ends minimum 2 inches.

E. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.04 TOLERANCES

A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.

B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.05 CLEANING

A. Remove site cuttings from finish surfaces.

B. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

END OF SECTION

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fabricated sheet metal items, including flashings, counterflashings, gutters, and downspouts.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood nailers.

B. Section 07 72 00 - Roof Accessories: Roof-mounted units.

C. Section 07 90 05 - Joint Sealers.

D. Section 08 62 00 - Unit Skylights: Metal curbs.

E. Section 09 90 00 - Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS

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

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association; 1998.

C. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2005.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.

F. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2007.

G. ASTM D4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007.

H. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2003.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.05 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. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.

C. Maintain one copy of each document on site.

D. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 5 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 0.02 inch thick base metal.

B. Aluminum: ASTM B209 (ASTM B209M); 0.032 inch thick; anodized finish of color as selected.
1. Clear Anodized Finish: AAMA 611 AA-M12C22A41 Class I clear anodic coating not less than 7 mils thick.

C. Pre-Finished Aluminum: ASTM B209 (ASTM B209M); 0.032 inch thick; plain finish shop pre-coated with fluoropolymercoating.
1. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system.
2. Color: As selected by Engineer from manufacturer's standard colors.

2.02 ACCESSORIES

A. Fasteners: Galvanized steel, with soft neoprene washers.

B. Primer: Zinc chromate type.

C. Protective Backing Paint: Zinc molybdate alkyd.

D. Sealant:Specified in Section 07 90 05.

E. Plastic Cement: ASTM D4586, Type I.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest possible lengths.

C. Hem exposed edges on underside 1/2 inch; miter and seam corners.

D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

E. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.

F. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.04 DOWNSPOUT FABRICATION

A. Downspouts: Rectangular profile.

B. Downspouts: Size to match existing.

C. Accessories: Profiled to suit downspouts.
   1. Anchorage Devices: In accordance with SMACNA requirements.
   2. Downspout Supports: Brackets.

D. Downspout Boots: Cast iron.

E. Seal metal joints.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION

A. Conform to drawing details.

B. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

C. Apply plastic cement compound between metal flashings and felt flashings.

D. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

E. Secure gutters and downspouts in place using fasteners.

F. Connect downspouts to downspout boots. Grout connection watertight.

3.04 FIELD QUALITY CONTROL

A. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION

SECTION 07 72 00

ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured curbs, equipment rails, and pedestals.

1.02 RELATED REQUIREMENTS

A. Section 07 41 13 - Metal Roof Panels.

B. Section 07 62 00 - Sheet Metal Flashing and Trim: Roof accessory items fabricated from sheet metal.

1.03 REFERENCE STANDARDS

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

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Manufacturer's data sheets on each product to be used.
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
   4. Maintenance requirements.

1.05 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.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 MANUFACTURED CURBS

A. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies:
   1. AES Manufacturing Inc.: www.aescurb.com.
   2. The Pate Company: www.patecurbs.com.

3. Roof Products & Systems (RPS) by Commercial Products Group of Hart & Cooley, Inc: www.rpscurbs.com.

B. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies: Factory-assembled hollow sheet metal construction with fully mitered and welded corners, integral counterflashing, internal reinforcing, and top side and edges formed to shed water.
1. Sheet Metal: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33 ; G60 coating designation; 18 gage, 0.048 inch thick.
2. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing insulation; 1:1 slope; minimum cant height 4 inches.
3. Manufacture curb bottom and mounting flanges for installation directly on roof deck, not on insulation; match slope and configuration of roof deck.
4. Provide the layouts and configurations shown on the drawings.

C. Curbs Adjacent to Roof Openings: Provide curb on all sides of opening, with top of curb horizontal for equipment mounting.
1. Provide preservative treated wood nailers along top of curb.
2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
3. Height Above Finished Roof Surface: 8 inches, minimum.
4. Height Above Roof Deck: 14 inches, minimum.

D. Equipment Rails: Two-sided curbs in straight lengths, with top horizontal for equipment mounting.
1. Provide preservative treated wood nailers along top of rails.
2. Height Above Finished Roof Surface: 6 inches, minimum.
3. Height Above Roof Deck: 14 inches, minimum.

E. Pipe, Duct, and Conduit Mounting Pedestals: Vertical posts, minimum 8 inches square unless otherwise indicated.
1. Provide sliding channel welded along top edge with adjustable height steel bracket, manufactured to fit item supported.
2. Height Above Finished Roof Surface: 6 inches, minimum.
3. Height Above Roof Deck: 14 inches, minimum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

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

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing weather integrity.

3.04 CLEANING

A. Clean installed work to like-new condition.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before final substantial completion.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS

A. Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

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

B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2011.

C. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2011a.

D. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

E. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.

D. Product Data: Provide data on product characteristics, performance ratings, and limitations.

E. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

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

1.05 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. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.

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

D. Installer Qualifications: Company specializing in performing the work of this section and:

1.06 MOCK-UP

A. Install one firestopping assembly representative of each fire rating design required on project.
   1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.

B. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.07 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements.
   1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E814 that has F Rating equal to fire rating of penetrated assembly and T Rating Equal to F Rating and that meets all other specified requirements.

2.02 MATERIALS

A. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
   1. Manufacturers:
      a. A/D Fire Protection Systems Inc: www.adfire.com.
      b. 3M Fire Protection Products: www.3m.com/firestop.
      c. Hilti, Inc: www.us.hilti.com.

B. Foam Firestoppping: Single component silicone foam compound.
   1. Manufacturers:
      a. 3M Fire Protection Products: www.3m.com/firestop.
      b. Hilti, Inc: www.us.hilti.com.
      c. Specified Technologies, Inc: www.stifirestop.com.

C. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers.
   1. Manufacturers:
      a. A/D Fire Protection Systems Inc: www.adfire.com.
      b. USG: www.usg.com.
      c. Or approved equal.

D. Firestop Devices - Wrap Type: Mechanical device with incombustible filler and sheet stainless steel jacket, intended to be installed after penetrating item has been installed.
   1. Manufacturers:
      a. RectorSeal: www.rectorseal.com.
      b. 3M Fire Protection Products; Product ____: www.3m.com/firestop.
      c. Hilti, Inc: www.us.hilti.com.

E. Firestop Devices - Cast-In Type: Sleeve and sealing material, intended to be cast in concrete floor forms or in concrete on metal deck, not requiring any additional materials to achieve penetration seal.
   1. Manufacturers:
      a. 3M Fire Protection Products: www.3m.com/firestop.
      b. Hilti, Inc: www.us.hilti.com.
      c. Or approved equal.

F. Intumescent Putty: Compound that expands on exposure to surface heat gain.
   1. Manufacturers:
      a. RectorSeal: www.rectorseal.com.
      b. 3M Fire Protection Products: www.3m.com/firestop.
      c. Hilti, Inc: www.us.hilti.com.

G. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION

A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

3.04 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 07 90 05

JOINT SEALERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sealants and joint backing.

B. Precompressed foam sealers.

1.02 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping: Firestopping sealants.

B. Section 08 62 00 - Unit Skylights: Structural and weatherseal sealants and accessories.

C. Section 08 80 00 - Glazing: Glazing sealants and accessories.

D. Section 09 21 16 - Gypsum Board Assemblies: Acoustic sealant.

E. Section 09 30 00 - Tiling: Sealant used as tile grout.

1.03 REFERENCE STANDARDS

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

B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2008.

C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2011.

D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2010.

E. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2007.

F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, and limitations.

D. Manufacturer's Installation Instructions: Indicate special procedures.

1.05 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. Maintain one copy of each referenced document covering installation requirements on site.

C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

D. Applicator Qualifications: Company specializing in performing the work of this section with minimum 3 years experience.

1.06 FIELD CONDITIONS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.07 WARRANTY

A. See Procurement Documents, for additional warranty requirements.

B. Correct defective work within a five year period after Date of Substantial Completion.

C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Silicone Sealants:
1. Bostik Inc: www.bostik-us.com.
2. Pecora Corporation: www.pecora.com.
3. BASF Construction Chemicals-Building Systems: www.buildingsystems.basf.com.

B. Polyurethane Sealants:
1. Bostik Inc: www.bostik-us.com.
2. Pecora Corporation: www.pecora.com.
3. BASF Construction Chemicals-Building Systems: www.buildingsystems.basf.com.

2.02 SEALANTS

A. Sealants and Primers - General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

B. General Purpose Exterior Sealant: Polyurethane; ASTM C920, Grade NS, Class 25, Uses M, G, and A; single component.
1. Color: Match adjacent finished surfaces.
2. Applications: Use for:
   a. Control, expansion, and soft joints in masonry.
   b. Joints between concrete/ masonry and other materials.
   c. Joints between metal frames and other materials.
   d. Joints between casework and wall surfaces.
   e. Other interior or exterior joints for which no other sealant is indicated.

C. Acoustical Sealant for Concealed Locations: Permanently tacky non-hardening butyl sealant.

D. Silicone Sealant: ASTM C920, Grade NS, Class 25, Uses NT, A, G, M, O; single component, solvent curing, non-sagging, non-staining, fungus resistant, non-bleeding.
1. Color: Match adjacent finished surfaces.
2. Movement Capability: Plus and minus 25 percent.
3. Service Temperature Range: -65 to 180 degrees F.
4. Shore A Hardness Range: 15 to 35.

2.03 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean and prime joints in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Protect elements surrounding the work of this section from damage or disfigurement.

3.03 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C1193.

C. Perform acoustical sealant application work in accordance with ASTM C919.

D. Install bond breaker where joint backing is not used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tool joints concave.

3.04 CLEANING

A. Clean adjacent soiled surfaces.

3.05 PROTECTION

A. Protect sealants until cured.

END OF SECTION

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-fire-rated steel doors and frames.

B. Steel frames for wood doors.

C. Fire-rated steel doors and frames.

D. Thermally insulated steel doors.

E. Steel glazing frames.

1.02 RELATED REQUIREMENTS

A. Section 08 71 00 - Door Hardware.

B. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.

C. Section 09 90 00 - Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS

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

B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2003.

C. ANSI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames; 2003.

D. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 1998 (R2004).

E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

F. ASTM C1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus; 2005.

G. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames; 2006.

H. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 2007.

I. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2010.

J. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.

K. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

B. Certifications:

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

C. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.

D. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.

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

C. Maintain at the project site a copy of all reference standards dealing with installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in accordance with NAAMM HMMA 840.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Steel Doors and Frames:
   1. Assa Abloy Ceco, Curries, or Fleming: www.assaabloydss.com.
   2. Republic Doors: www.republicdoor.com.
   3. Steelcraft: www.steelcraft.com.

2.02 DOORS AND FRAMES

A. Requirements for All Doors and Frames:
   1. Accessibility: Comply with ANSI/ICC A117.1.
   2. Door Top Closures: Flush with top of faces and edges.
   3. Door Edge Profile: Beveled on both edges.
   4. Door Texture: Smooth faces.
   5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
   6. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
   7. Galvanizing for Units in Wet Areas: All components hot-dipped zinc-iron alloy-coated (galvannealed), manufacturer's standard coating thickness.
   8. Finish: Factory primed, for field finishing.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 STEEL DOORS

A. Exterior Doors:
   1. Grade: ANSI A250.8 Level 3, physical performance Level A, Model 2, seamless.
   2. Core: Polystyrene foam.
   3. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness.
   4. Insulating Value: U-value of 0.50, when tested in accordance with ASTM C1363.
   5. Weatherstripping: Separate, see Section 08 71 00.

B. Interior Doors, Non-Fire-Rated:
   1. Grade: ANSI A250.8 Level 1, physical performance Level C, Model 1, full flush.
   2. Thickness: 1-3/4 inches.

C. Interior Doors, Fire-Rated:
   1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 1, full flush.
   2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure").
      a. Provide units listed and labeled by UL.
      b. Attach fire rating label to each fire rated unit.

2.04 STEEL FRAMES

A. General:
   1. Comply with the requirements of grade specified for corresponding door, except:
      a. ANSI A250.8 Level 1 Doors: 16 gage frames.
      b. ANSI A250.8 Level 3 Doors: 14 gage frames.
      c. ANSI A250.8 Level 4 Doors: 12 gage frames.
      d. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 1, 18 gage
   2. Finish: Same as for door.
   3. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
   4. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.

B. Exterior Door Frames: Face welded, seamless with joints filled.
   1. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness.
   2. Weatherstripping: Separate, see Section 08 71 00.

C. Interior Door Frames, Non-Fire-Rated: Knock-down type.

D. Interior Door Frames, Fire-Rated: Knock-down type.
   1. Fire Rating: Same as door, labeled.

E. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

2.05 ACCESSORY MATERIALS

A. Glazing: As specified in Section 08 80 00, factory installed.

B. Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.

C. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.

D. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.06 FINISH MATERIALS

A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.

B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

3.02 PREPARATION

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.

B. In addition, install fire rated units in accordance with NFPA 80.

C. Coordinate frame anchor placement with wall construction.

D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

E. Coordinate installation of hardware.

F. Coordinate installation of glazing.

3.04 TOLERANCES

A. Clearances Between Door and Frame: As specified in ANSI A250.8.

B. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.05 ADJUSTING

A. Adjust for smooth and balanced door movement.

END OF SECTION

SECTION 08 14 16

FLUSH WOOD DOORS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 08 11 13 - Hollow Metal Doors and Frames.

B. Section 08 71 00 - Door Hardware.

C. Section 08 80 00 - Glazing.

D. Section 09 21 16 - Gypsum Board Assemblies: Bullet-resistant sheathing and wallboard for bullet-resistant partitions and walls.

E. Section 09 90 00 - Painting and Coating: Site finishing of doors.

1.02 REFERENCE STANDARDS

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

B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2009.

C. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

D. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2010.

E. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association; 2008.

F. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.

G. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.

D. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
   1. Provide the information required by AWI/AWMAC/WI Architectural Woodwork Standards.

E. Specimen warranty.

F. Samples: Submit two samples of door construction, 6 by 6 inch in size cut from top corner of door.

G. Samples: Submit two samples of door veneer, 6 by 6 inch in size illustrating wood grain, stain color, and sheen.

H. Manufacturer's Installation Instructions: Indicate special installation instructions.

I. Warranty, executed in The Authority's name.

1.04 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. Maintain one copy of the specified door quality standard on site for review during installation and finishing.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

D. Installed Fire Rated Door and Transom Panel Assembly: Conform to NFPA 80 for fire rated class as indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package, deliver and store doors in accordance with specified quality standard.

B. Accept doors on site in manufacturer's packaging. Inspect for damage.

C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.06 WARRANTY

A. See Procurement Documents, for additional warranty requirements.

B. Interior Doors: Provide manufacturer's warranty for the life of the installation.

C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Wood Veneer Faced Doors:
   1. Graham Wood Doors: www.grahamdoors.com.
   2. Eggers Industries: www.eggersindustries.com.
   3. Haley Brothers: www.haleybros.com.

2.02 DOORS

A. All Doors: See drawings for locations and additional requirements.
   1. Quality Level: Premium Grade, in accordance with AWI/AWMAC/WI Architectural Woodwork Standards.
   2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.

B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
   1. Provide solid core doors at all locations.
   2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with NFPA 252, UL 10B, or UBC Standard 7-2-94 ("neutral pressure"); UL or WH (ITS) labeled without any visible seals when door is open.
   3. Wood veneer facing with factory transparent finish where indicated on drawings.

2.03 DOOR CORES

A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated above.

B. Fire Rated Doors: Mineral core, Type FD, plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.04 DOOR FACINGS

A. Wood Veneer Facing for Transparent Finish: Red oak, veneer grade as specified by quality standard, rotary cut, book matched veneer match, running assembly match; unless otherwise indicated.
   1. Vertical Edges: Any option allowed by quality standard for grade.

2.05 ACCESSORIES

A. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.

2.06 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.

B. Cores Constructed with stiles and rails:

C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
   1. Exception: Doors to be field finished.

E. Provide edge clearances in accordance with the quality standard specified.

2.07 FACTORY FINISHING - WOOD VENEER DOORS

A. Finish work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, Section 5 - Finishing for Grade specified and as follows:
   1. Transparent:
      a. System - 1, Lacquer, Nitrocellulose.
      b. Sheen: Semigloss.

B. Factory finish doors in accordance with approved sample.

C. Seal door top edge with color sealer to match door facing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

A. Install doors in accordance with manufacturer's instructions and specified quality standard.

B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.

C. Use machine tools to cut or drill for hardware.

D. Coordinate installation of doors with installation of frames and hardware.

E. Coordinate installation of glazing.

3.03 TOLERANCES

A. Conform to specified quality standard for fit and clearance tolerances.

B. Conform to specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

A. Adjust doors for smooth and balanced door movement.

B. Adjust closers for full closure.

3.05 SCHEDULE - See Drawings

END OF SECTION

SECTION 08 31 00

ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall access door and frame units.

B. Ceiling access door and frame units.

1.02 RELATED REQUIREMENTS

A. Section 09 21 00:Gypsum Board Assemblies

B. Section 09 90 00 - Painting and Coating: Field paint finish.

1.03 REFERENCE STANDARDS

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

B. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.

D. Shop Drawings: Indicate exact position of all access door units.

E. Manufacturer's Installation Instructions: Indicate installation requirements.

F. Project Record Documents: Record actual locations of all access units.

1.05 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.

PART 2 PRODUCTS

2.01 WALL AND CEILING UNITS

A. Manufacturers:
   1. Acudor Products Inc: www.acudor.com.
   2. Karp Associates, Inc: www.karpinc.com.
   3. Milcor by Commercial Products Group of Hart & Cooley, Inc: www.milcorinc.com.

B. Door and Frame Units: Factory fabricated, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies units are to be installed in.
   1. Material: Steel.
   2. Frames and flanges: 0.058 inch steel.
   3. Door panels: 0.070 inch double sheet with integral non-combustible insulation filler.
   4. Units in Fire Rated Assemblies: Fire rating equivalent to the fire rated assembly in which they are to be installed.
      a. Provide certificate of compliance from authority having jurisdiction indicating approval of fire rated doors.
   5. Size: As required.
   6. Hardware:
      a. Hinge, Fire-Rated-Units: 175 degree steel hinges with non-removable pin.
      b. Hinge: Non-Fire-Rated Units: 175 degree steel hinges with removable pin.
      c. Lock: Screw driver slot for quarter turn cam lock.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install frames plumb and level in openings. Secure rigidly in place.

C. Position units to provide convenient access to the concealed work requiring access.

END OF SECTION

SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Overhead coiling doors, operating hardware, non-fire-rated and exterior, electric operation.

B. Wiring from electric circuit disconnect to operator to control station.

1.02 RELATED REQUIREMENTS

A. Section 08 33 26 - Overhead Coiling Grilles.

B. Section 08 71 00 - Door Hardware: Cylinder cores and keys.

C. Section 26 05 00 -Common Work Results for Electrical].

D. Section 26 05 19 -Low-Voltage Electrical Power Conductors and Cables].

1.03 REFERENCE STANDARDS

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

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2008.

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2009.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

F. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2005).

G. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.

H. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.

I. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures..

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

C. Product Data: Provide general construction, component connections and details, electrical equipment, .

D. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.

E. Samples: Submit two slats, 6x6 inch in size illustrating shape, color and finish texture.

F. Manufacturer's Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.

G. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

1.05 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. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Overhead Coiling Doors:
   1. Alpine Overhead Doors, Inc: www.alpinedoors.com.
   2. The Cookson Company: www.cooksondoor.com.
   3. Wayne-Dalton, a Division of Overhead Door Corporation: www.wayne-dalton.com.

2.02 COILING DOORS

A. Exterior Coiling Doors: Steel slat curtain.
   1. Capable of withstanding positive and negative wind loads of 20 psf, without undue deflection or damage to components.
   2. Sandwich slat construction with insulated core of polystyrene type insulation; insulation (u-) value: 0.50 BTU/hr sq ft deg F
   3. Nominal Slat Size: 2 inches wide x required length.
   4. Finish: Factory painted, color as selected.
   5. Guides: Angles; galvanized steel.
   6. Hood Enclosure: Manufacturer's standard; primed steel.
   7. Electric operation.
   8. Mounting: Within framed opening.
   9. Exterior lock and latch handle.

2.03 MATERIALS

A. Curtain Construction: Interlocking slats.
   1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
   2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
   3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.

B. Steel Slats: Minimum 20 gage ASTM A653/A653M galvanized steel sheet.
   1. Galvanizing: Minimum G90/Z275 coating.

C. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

D. Steel Guides: Formed from galvanized steel sheet, complying with ASTM A653/A653M.
   1. Galvanizing: Minimum G90/Z275 coating.
   2. Prime paint.

E. Hood Enclosure: Internally reinforced to maintain rigidity and shape. Enclosure for doors and grills should be common to both.

F. Hardware:
   1. Lock Cylinders: Specified in Section 08 71 00.
   2. Latching: Inside mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position.
   3. Latch Handle: Interior and exterior handle.

G. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.04 ELECTRIC OPERATION

A. Electric Operators:
   1. Mounting: Side mounted.
   2. Motor Enclosure:
      a. Exterior doors: NEMA MG 1 Type 4; open drip proof.
   3. Motor Rating: 1/3 hp; continuous duty.
   4. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
   5. Controller Enclosure: NEMA 250 Type 1.
   6. Opening Speed: 12 inches per second.
   7. Brake: Adjustable friction clutch type, activated by motor controller.
   8. Manual override in case of power failure.

B. Control Station: Standard three button (OPEN-STOP-CLOSE) momentary control for each operator.
   1. 24 volt circuit.
   2. Surface mounted.

C. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with electrical specifications.

F. Complete wiring from disconnect to unit components.

G. Install perimeter trim and closures.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch.

C. Maximum Variation From Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

END OF SECTION

SECTION 08 33 26

OVERHEAD COILING GRILLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Overhead coiling metal grilles and operating hardware, manual and electric operation.

B. Wiring from electric circuit disconnect to operator to control station.

1.02 RELATED REQUIREMENTS

A. Section 08 33 23 - Overhead Coiling Doors.

B. Section 08 71 00 - Door Hardware: Cylinder cores and keys.

C. Section 26 05 00 -Common Work Results for Electrical].

D. Section 26 05 19 -Low-Voltage Electrical Power Conductors and Cables].

1.03 REFERENCE STANDARDS

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

B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2009.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

D. ASTM B169/B169M - Standard Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar; 2010.

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2008.

F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2007.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

H. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2005).

I. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.

J. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

B. Certifications:
   1. Buy America Act Certification:

a. Provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

C. Product Data: Provide general construction, component connections and details, electrical equipment, .

D. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.

E. Samples: Submit two grille members, 6x6 inch in size illustrating shape, color and finish texture.

F. Manufacturer's Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.

G. Maintenance Data: Indicate lubrication requirements and frequency.

1.05 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.

1.06 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Overhead Coiling Grilles:
1. Alpine Overhead Doors, Inc: www.alpinedoors.com.
2. The Cookson Company: www.cooksondoor.com.
3. Wayne-Dalton, a Division of Overhead Door Corporation: www.waynedalton.com.

2.02 GRILLE AND COMPONENTS

A. Grille: Aluminum; horizontal bar curtain, coiling on overhead counterbalanced shaft.
1. Finish: Anodized, color as selected.
2. Lock: Inside cylinder lock.
3. Manual hand chain lift operation.
4. Electric operation.
5. Mounting: Within framed opening.

B. Curtain: Round horizontal bars connected with vertical links.
1. Horizontal bars: 5/16 inch diameter.
2. Bar spacing: 1 1/2 inch on center.
3. Tube spacers: 1/2 inch diameter.
4. Spacer spacing: 3 1/4 inch on center.
5. Vertical links: 5/16 inch diameter.
6. Link spacing: 6 inch on center.
7. Bar Ends: Provide with nylon runners for quiet operation.
8. Bottom Bar: Back-to-back angles with tubular resilient cushion.

C. Guides: Extruded aluminum angles, of profile to retain grille in place with snap-on trim, mounting brackets of same metal.

D. Hood Enclosure: galvanized steel sheet; internally reinforced to maintain rigidity and shape. Enclosure for doors and grills should be common to both.
   1. Finish: Factory painted, color as selected.

E. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.03 MATERIALS

A. Aluminum: ASTM B221 (ASTM B221M).

B. Galvanized Steel Sheet: ASTM A653/A653M, galvanized to minimum G90/Z275 coating.

2.04 ELECTRIC OPERATION

A. Electric Operators:
   1. Mounting: Side mounted.
   2. Motor Enclosure:
      a. Exterior grilles: NEMA MG 1 Type 4; open drip proof.
   3. Motor Rating: 1/3 hp; continuous duty.
   4. Motor Voltage: single phase, 60 Hz.
   5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
   6. Controller Enclosure: NEMA 250 Type 1.
   7. Opening Speed: 12 inches per second.
   8. Brake: Adjustable friction clutch type, activated by motor controller.
   9. Manual override in case of power failure.

B. Control Station: Standard three button (OPEN-STOP-CLOSE) momentary control for each operator.
   1. 24 volt circuit.
   2. Surface mounted.

C. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Install grille unit assembly in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical work with Section 26 05 00.

F. Complete wiring from disconnect to unit components.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch.

C. Maximum Variation From Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING

A. Adjust grille, hardware and operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Clean grille and components.

B. Remove labels and visible markings.

END OF SECTION

SECTION 08 43 13

ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

B. Aluminum doors and frames.

C. Weatherstripping.

D. Door hardware.

E. Perimeter sealant.

1.02 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications: Steel attachment devices.

B. Section 07 90 05 - Joint Sealers: Perimeter sealant and back-up materials.

C. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.

D. Section 08 80 00 - Glazing: Glass and glazing accessories.

E. Section 09 90 00 - Painting and Coating: Field painting of interior surface of infill panels.

F. Section 12 21 13 - Horizontal Louver Blinds: Attachments to framing members.

1.03 REFERENCE STANDARDS

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

B. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2004.

C. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association; 1998.

D. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; American Architectural Manufacturers Association; 2009.

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2008.

F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2007.

G. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004.

H. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2002 (Reapproved 2010).

I. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2009).

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, internal drainage details.

D. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

E. Design Data: Provide framing member structural and physical characteristics, dimensional limitations.

F. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

G. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

H. Warranty: Submit manufacturer warranty and ensure forms have been completed in The Authority's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at Maryland.

B. Manufacturer and Installer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.07 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.08 WARRANTY

A. See Procurement Documents, for additional warranty requirements.

B. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

C. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Kawneer; Product Tri-Fab Series.

B. Other Acceptable Manufacturers:
   1. YKK AP America Inc: www.ykkap.com.
   2. Manko Window Systems, Inc: www.mankowindows.com.
   3. Oldcastle BuildingEnvelope: www.oldcastlebe.com.
   4. Tubelite, Inc.; T14000, 2 inch by 4-1/2 inch, Thermal, Flush Center Glaze: www.tubeliteinc.com.

2.02 STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   1. Glazing Position: Centered (front to back).
   2. Water Leakage Test Pressure Differential: 6.00 lbf/sq ft.
   3. Air Infiltration Test Pressure Differential: 1.57 psf.
   4. Finish: Class I natural anodized.

B. Performance Requirements:
   1. Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
      a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
   2. Movement: Accommodate movement between storefront and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.
   3. Air Infiltration: Limit air infiltration through assembly to 0.06 cu ft/min/sq ft of wall area, measured at specified differential pressure across assembly in accordance with ASTM E283.
   4. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
   5. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.

2.03 COMPONENTS

A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
   1. Framing members for interior applications need not be thermally broken.

B. Doors: Glazed aluminum.
   1. Thickness: 1-3/4 inches.
   2. Top Rail: 4 inches wide.
   3. Vertical Stiles: 4-1/2 inches wide.
   4. Glazing Stops: Square.
   5. Finish: Same as storefront.

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Fasteners: Stainless steel.

C. Perimeter Sealant: Type specified in Section 07 90 05.

D. Glass: As specified in Section 08 80 00.
   1. Glass in Exterior Framing: Type 1" insulating glass sealed units.
   2. Glass in Interior Framing: Type 1/4" float glass.

3. Glass in Doors: Type 1/4" tempered.

E. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

F. Glazing Accessories: As specified in Section 08 80 00.

2.05 FINISHES

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating or AAMA 612 clear anodic coating with electrolytically deposited organic seal; not less than 0.7 mils thick.

2.06 HARDWARE

A. Door Hardware: Storefront manufacturer's standard type to suit application.
1. Finish on Hand-Contacted Items: Polished chrome.
2. Include for each exterior door weatherstripping, sill sweep strip, threshold, butt hinges, push handle, pull handle, narrow stile handle latch, and closer. For interior doors, weatherstripping is not required.

2.07 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

E. Arrange fasteners and attachments to conceal from view.

F. Reinforce components internally for door hardware.

G. Reinforce framing members for imposed loads.

H. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies.
1. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.

H. Coordinate attachment and seal of perimeter air and vapor barrier materials.

I. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

J. Set thresholds in bed of mastic and secure.

K. Install hardware using templates provided.

L. Install glass and infill panels in accordance with Section 08 80 00, using glazing method required to achieve performance criteria.

M. Install perimeter sealant in accordance with Section 07 90 05.

N. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.02 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.03 ADJUSTING

A. Adjust operating hardware and sash for smooth operation.

3.04 PROTECTION

A. Protect installed products from damage during subsequent construction.

END OF SECTION

SECTION 08 51 13

ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Extruded aluminum windows with fixed sash, operating sash, and infill panels.

B. Factory glazing.

C. Operating hardware.

D. Insect screens.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood perimeter shims.

B. Section 07 90 05 - Joint Sealers: Perimeter sealant and back-up materials.

C. Section 08 80 00 - Glazing.

1.03 REFERENCE STANDARDS

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

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association; 1998.

C. AAMA 612 - Voluntary Specification, Performance Requirements and Test Procedures for Combined Coatings of Anodic Oxide and Transparent Organic Coatings on Architectural Aluminum; 2002.

D. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2004.

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2008.

F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2007.

G. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.

H. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2004.

I. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2002 (Reapproved 2010).

J. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2000 (Reapproved 2008).

K. ASTM E1332 - Standard Classification for Rating Outdoor-Indoor Sound Attenuation; 2010.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide component dimensions, information on glass and glazing, internal drainage details, and descriptions of hardware and accessories.

D. Shop Drawings: Indicate opening dimensions, elevations of different types, framed opening tolerances, method for achieving air and vapor barrier seal to adjacent construction, anchorage locations,, and installation requirements.

E. Samples: Submit two samples, 12 x 12 inch in size illustrating typical corner construction, accessories, and finishes.

F. Submit two samples of operating hardware.

G. Certificates: Certify that windows meet or exceed specified requirements.

H. Manufacturer's Installation Instructions: Include complete preparation, installation, and cleaning requirements.

1.05 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. Manufacturer and Installer Qualifications: Company specializing in fabrication of commercial aluminum windows of types required, with not fewer than 5 years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of AAMA CW-10.

B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.07 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F.

B. Maintain this minimum temperature during and 24 hours after installation of sealants.

1.08 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

B. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

C. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Aluminum Windows:

1. YKK AP America Inc: www.ykkap.com.
2. TRACO: www.traco.com.
3. Wausau Window and Wall Systems: www.wausauwindow.com.

2.02 WINDOWS

A. Windows: Tubular aluminum sections, factory fabricated, factory finished, thermally broken, vision glass, related flashings, anchorage and attachment devices.
   1. Frame Depth: Match existing.
   2. Air Infiltration: Limit air infiltration through assembly to 0.1 cu ft/min/sq ft of wall area, measured at a specified differential pressure across assembly in accordance with ASTM E283.
   3. Water Infiltration Test Pressure Differential: 15 pounds per square foot.
   4. Thermal Movement: Resists thermal movement caused by 180 degrees F surface temperature without buckling stress on glass, joint seal failure, damaging loads on structural elements, damaging loads on fasteners, reduction in performance or other detrimental effects.
   5. Condensation Resistance Factor: 63 minimum.
   6. Overall U-value, Including Glazing: 0.45, maximum.
   7. Acoustical Performance: ASTM E90 and E1332; STC 31 and OITC 31 (fixed).
   8. Life Cycle Requirements: No damage to fasteners, hardware parts or other components that would render operable windows in operable and not reduction in air and water infiltration resistance when tested according to AAMA 910.

B. Fixed, Non-Operable Type:
   1. Construction: Thermally broken.
   2. Glazing: Double; clear; transparent.
   3. Exterior Finish: Class I natural anodized.
   4. Interior Finish: Class I natural anodized.

2.03 COMPONENTS

A. Frames: thermally broken with interior portion of frame insulated from exterior portion; flush glass stops of snap-on type.

B. Fasteners: Stainless steel.

2.04 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.

2.05 FABRICATION

A. Fabricate components with smallest possible clearances and shim spacing around perimeter of assembly that will enable window installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices.

D. Arrange fasteners and attachments to ensure concealment from view.

E. Prepare components with internal reinforcement for operating hardware.

F. Provide steel internal reinforcement in mullions as required to meet loading requirements.

G. Provide internal drainage of glazing spaces to exterior through weep holes.

H. Factory glaze window units.

2.06 FINISHES

A. Class I Natural Finish or Anodized Plus Natural Anodized 2-step Finish:
   1. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.
   2. Anodized Plus Natural Anodized Finish: AAMA 612 clear anodic coating with electrolytically deposited organic seal not less 0.7 mils thick; color as scheduled.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that wall openings and adjoining air and vapor seal materials are ready to receive aluminum windows.

3.02 INSTALLATION

A. Install windows in accordance with manufacturer's instructions.

B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.

C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.

D. Install sill and sill end angles.

E. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

F. Coordinate attachment and seal of perimeter air barrier and vapor retarder materials.

3.03 TOLERANCES

A. Maximum Variation from Level or Plumb: 1/16 inches every 3 ft non-cumulative or 1/8 inches per 10 ft, whichever is less.

3.04 FIELD QUALITY CONTROL

A. Test installed windows for compliance with performance requirements for water penetration, in accordance with ASTM E1105 using uniform pressure and the same pressure difference as specified for laboratory testing.
   1. Test 5 windows.
   2. If any window fails, test additional windows at Contractor's expense.

B. Replace windows that have failed field testing and retest until performance is satisfactory.

3.05 ADJUSTING

A. Adjust hardware for smooth operation and secure weathertight closure.

3.06 CLEANING

A. Remove protective material from factory finished aluminum surfaces.

B. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.

C. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.

3.07 SCHEDULE

A. See building elevations and window types.

END OF SECTION

SECTION 08 62 00

UNIT SKYLIGHTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preformed plastic skylights with integral metal frame.

B. Integral insulated curb.

1.02 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications: Miscellaneous steel framing for rough opening.

B. Section 06 10 00 - Rough Carpentry: Wood support curbs.

C. Section 07 62 00 - Sheet Metal Flashing and Trim: Skylight counterflashing.

D. Section 07 72 00 - Roof Accessories: Manufactured curbs for installation of unit skylights.

1.03 REFERENCE STANDARDS

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

B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2008.

C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2007.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide structural, thermal, and daylighting performance values.

D. Shop Drawings: Indicate configurations, dimensions, locations, fastening methods, and installation details.

E. Manufacturer's Installation Instructions: Indicate special procedures.

1.05 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. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.

1.06 WARRANTY

A. Provide five year manufacturer warranty for including leakage due to defective skylight materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Unit Skylights:
   1. Bristolite Skylights: www.bristolite.com.
   2. Oldcastle Building Envelope: www.oldcastlebe.com/.
   3. Wasco Products, Inc: www.wascoproducts.com.

2.02 UNIT SKYLIGHTS

A. Unit Skylights: Factory-assembled glazing in aluminum frame, free of visual distortion, weathertight.
   1. Shape: Rectangular dome.
   2. Glazing: Double.

B. Performance Requirements:
   1. Design to withstand live loads as calculated in accordance with IBC code.
   2. Allow for expansion and contraction within system components caused by a cycling surface temperature range of 170 degrees F without causing detrimental effects to system or components.

2.03 COMPONENTS

A. Double Glazing: Polycarbonate plastic; factory sealed.

B. Frames: ASTM B221 (ASTM B221M) Extruded aluminum thermally broken, reinforced and welded corner joints, integral curb frame mounting flange and counterflashing to receive roofing flashing system, with integral condensation collection gutter, glazing retainer; clear anodized finish.

2.04 ACCESSORIES

A. Anchorage Devices: Type recommended by manufacturer, exposed to view.

B. Counterflashings: Same metal type and finish as skylight frame.

C. Protective Back Coating: Zinc molybdate alkyd.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that openings and substrate conditions are ready to receive work of this section.

3.02 PREPARATION

A. Apply protective back coating on aluminum surfaces of skylight units that will be in contact with cementitious materials or dissimilar metals.

3.03 INSTALLATION

A. Install aluminum curb assembly, fastening securely to roof decking. Flash curb assembly into roof system.

B. Place skylight units and secure to curb assembly. Install counterflashing as required.

C. Apply sealant to achieve watertight assembly.

3.04 CLEANING

A. Remove protective material from prefinished aluminum surfaces.

B. Wash down exposed surfaces; wipe surfaces clean.

C. Remove excess sealant.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hardware for wood, hollow steel, and aluminum doors.

B. Hardware for fire-rated doors.

C. Electrically operated and controlled hardware.

D. Lock cylinders for doors for which hardware is specified in other sections.

E. Thresholds.

F. Weatherstripping, seals and door gaskets.

1.02 RELATED REQUIREMENTS

A. Section 08 11 13 - Hollow Metal Doors and Frames.

B. Section 08 14 16 - Flush Wood Doors.

C. Section 08 33 23 - Overhead Coiling Doors: Lockable coiling doors.

D. Section 08 33 26 - Overhead Coiling Grilles: Lockable coiling grilles.

E. Section 08 43 13 - Aluminum-Framed Storefronts: Hardware for doors in storefront, including:

1.03 REFERENCE STANDARDS

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

B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2003.

C. BHMA A156.1 - American National Standard for Butts and Hinges; Builders Hardware Manufacturers Association, Inc.; 2006 (ANSI/BHMA A156.1).

D. BHMA A156.2 - American National Standard for Bored and Preassembled Locks & Latches; Builders Hardware Manufacturers Association; 2003 (ANSI/BHMA A156.2).

E. BHMA A156.3 - American National Standard for Exit Devices; Builders Hardware Manufacturers Association; 2001 (ANSI/BHMA A156.3).

F. BHMA A156.5 - American National Standard for Auxiliary Locks & Associated Products; Builders Hardware Manufacturers Association; 2001 (ANSI/BHMA A156.5).

G. BHMA A156.6 - American National Standard for Architectural Door Trim; Builders Hardware Manufacturers Association; 2005 (ANSI/BHMA A156.6).

H. BHMA A156.7 - American National Standard for Template Hinge Dimensions; Builders Hardware Manufacturers Association; 2003 (ANSI/BHMA A156.7).

I. BHMA A156.8 - American National Standard for Door Controls - Overhead Stops and Holders; Builders Hardware Manufacturers Association, Inc.; 2005 (ANSI/BHMA A156.8).

J. BHMA A156.13 - American National Standard for Mortise Locks & Latches; Builders Hardware Manufacturers Association; 2005 (ANSI/BHMA A156.13).

K. BHMA A156.16 - American National Standard for Auxiliary Hardware; Builders Hardware Manufacturers Association; 2002 (ANSI/BHMA A156.16).

L. BHMA A156.21 - American National Standard for Thresholds; Builders Hardware Manufacturers Association; 2009 (ANSI/BHMA A156.21).

M. BHMA A156.22 - American National Standard for Door Gasketing and Edge Seal Systems, Builders Hardware Manufacturers Association; 2005 (ANSI/BHMA A156.22).

N. BHMA A156.31 - Electric Strikes and Frame Mounted Actuators; 2001 (ANSI/BHMA A156.31).

O. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames; 2006.

P. BHMA A156.115W - Hardware Preparation in Wood Doors with Wood or Steel Frames; 2006.

Q. 36 CFR 1191 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities; Final Rule; current edition; (ADAAG - Americans with Disabilities Act, Accessibility Guidelines).

R. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; Door and Hardware Institute; 2004.

S. DHI WDHS.3 - Recommended Locations for Architectural Hardware for Flush Wood Doors; Door and Hardware Institute; 1993; also in WDHS-1/WDHS-5 Series, 1996.

T. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2010.

U. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the manufacture, fabrication, and installation of products onto which door hardware will be installed.

B. Convey The Authority's keying requirements to manufacturers.

C. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project.

D. Hardware Schedule: Detailed listing of each item of hardware to be installed on each door. Use door numbering scheme as included in the Contract Documents. Identify electrically operated items and include power requirements.

E. Keying Schedule: Submit for approval of The Authority.

F. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

G. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

H. Keys: Deliver with identifying tags to The Authority by security shipment direct from hardware supplier.

I. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in The Authority's name and registered with manufacturer.

J. Maintenance Materials and Tools: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Lock Cylinders: Ten for each master keyed group.

1.06 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. Standards for Fire-Rated Doors: Maintain one copy of each referenced standard on site, for use by Engineer and Contractor.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

D. Hardware Supplier Qualifications: Company specializing in supplying commercial door hardware with 5 years of experience.

E. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

1.08 WARRANTY

A. See Procurement Documents for additional warranty requirements.

PART 2 PRODUCTS

2.01 SUPPLIERS

2.02 MANUFACTURERS- BASIS OF DESIGN

A. As specified in this section for other products.

B. Other Products: As specified in this section.

2.03 DOOR HARDWARE - GENERAL

A. Provide all hardware specified or required to make doors fully functional, compliant with applicable codes, and secure to the extent indicated.

B. Provide all items of a single type of the same model by the same manufacturer.

C. Provide products that comply with the following:
   1. Applicable provisions of federal, state, and local codes.
   2. Fire-Rated Doors: NFPA 80.

3. All Hardware on Fire-Rated Doors: Listed and classified by UL as suitable for the purpose specified and indicated.
4. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

D. Function: Lock and latch function numbers and descriptions of manufactures series as listed in hardware schedule.

E. Finishes: Identified in schedule.

2.04 HINGES

A. Hinges: Provide hinges on every swinging door.
1. Provide five-knuckle full mortise butt hinges unless otherwise indicated.
2. Provide ball-bearing hinges at all doors.
3. Provide hinges in the quantities indicated.
4. Provide non-removable pins on exterior outswinging doors.
5. Where electrified hardware is mounted in door leaf, provide power transfer hinges.

B. Manufacturers - Hinges:
1. Assa Abloy McKinney: www.assaabloydss.com.
2. Bommer Industries, Inc: www.bommer.com.
3. C. R. Laurence Co., Inc: www.crlaurence.com.
4. Hager Companies: www.hagerco.com.
5. Stanley Black & Decker: www.stanleyblackanddecker.com.

2.05 PUSH/PULLS

A. Push/Pulls: Comply with BHMA A156.6.
1. Provide push and pull on doors not specified to have lockset, latchset, exit device, or auxiliary lock.
2. On solid doors, provide matching push plate and pull plate on opposite faces.

B. Manufacturers - Push/Pulls:
1. Assa Abloy McKinney: www.assaabloydss.com.
2. C. R. Laurence Co., Inc: www.crlaurence.com.
3. Hager Companies: www.hagerco.com.

2.06 LOCKS AND LATCHES

A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
1. Hardware Sets indicate locking functions required for each door.
2. If no hardware set is indicated for a swinging door provide an office lockset.
3. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
4. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.

B. Electrically Operated Locks: Fail secure unless otherwise indicated.

C. Lock Cylinders: Manufacturer’s standard tumbler type, six-pin standard core.
1. Provide cams and/or tailpieces as required for locking devices required.

D. Keying: Grand master keyed.
1. Include construction keying.

E. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

2.07 MORTISE LOCKSETS

A. Locking Functions: As defined in BHMA A156.13, and as follows:
   1. Passage: F01.
   2. Office: F04, key not required to lock, remains locked upon exit.
   3. Store Door: F14, deadbolt locked by key from both sides, not an emergency exit (must be unlocked during occupied hours).
   4. Exit Only: F07 or F31, may have outside trim, may not be left unlocked.

B. Manufacturers - Mortise Locksets:
   1. Assa Abloy Corbin Russwin, Sargent, or Yale: www.assaabloydss.com.
   2. Best Access Systems, division of Stanley Security Solutions: www.bestlock.com.
   3. Hager Companies: www.hagerco.com.
   4. Schlage: www.schlage.com.

2.08 FLUSHBOLTS

A. Flushbolts: Lever extension bolts in leading edge of door, one bolt into floor, one bolt into top of frame.
   1. Pairs of Swing Doors: At inactive leaves, provide flush bolts of type as required to comply with code.
   2. Floor Bolts: Provide dustproof strike except at metal thresholds.

B. Manual Flushbolts: Provide lever extensions for top bolt at over-size doors.

C. Manufacturers - Flushbolts:
   1. Assa Abloy McKinney: www.assaabloydss.com.
   2. Hager Companies: www.hagerco.com.
   3. Ives: www.ives.ingersollrand.com.

2.09 ELECTRIC STRIKES

A. Electric Strikes: Complying with BHMA A156.31 and UL listed as a Burglary-Resistant Electric Door Strike; style to suit locks.

B. Manufacturers:
   1. Assa Abloy Folger Adam EDC, HES, or Securitron: www.assaabloydss.com.
   2. Or approved equal.

2.10 EXIT DEVICES

A. Locking Functions: Functions as defined in BHMA A156.3, and as follows:
   1. Entry/Exit, Always-Latched: Key outside locks and unlocks lever, no latch holdback (dogging).
   2. Exit Only, Secure: No outside trim, no key entry, no latch holdback, deadlocking latchbolt.

B. Manufacturers:
   1. Assa Abloy Corbin Russwin, Sargent, or Yale: www.assaabloydss.com.
   2. C. R. Laurence Co., Inc: www.crlaurence.com.
   3. DORMA Group North America: www.dorma-usa.com/usa.
   4. Hager Companies: www.hagerco.com.
   5. Von Duprin: www.vonduprin.com.

2.11 CLOSERS

A. Closers: Complying with BHMA A156.4.
   1. Provide surface-mounted, door-mounted closers unless otherwise indicated.
   2. Provide a door closer on every exterior door.
   3. Provide a door closer on every fire- and smoke-rated door. Spring hinges are not an acceptable self-closing device unless specifically so indicated.

4. On pairs of swinging doors, if an overlapping astragal is present, provide coordinator to ensure the leaves close in proper order.
5. At corridors, locate door-mounted closer on room side of door.

B. Manufacturers - Closers:
1. Assa Abloy Corbin Russwin, Norton, Rixson, Sargent, or Yale: www.assaabloydss.com.
2. C. R. Laurence Co., Inc: www.crlaurence.com.
3. DORMA Group North America: www.dorma-usa.com/usa.
4. Hager Companies: www.hagerco.com.
5. LCN: www.lcnclosers.com.

2.12 STOPS AND HOLDERS

A. Stops: Complying with BHMA A156.8; provide a stop for every swinging door, unless otherwise indicated.
1. Provide wall stops, unless otherwise indicated.
2. If wall stops are not practical, due to configuration of room or furnishings, provide overhead stop.
3. Stop is not required if positive stop feature is specified for door closer; positive stop feature of door closer is not an acceptable substitute for a stop unless specifically so stated.

B. Wall Stops:

C. Floor Stops:

D. Overhead Holders/Stops:

E. Manufacturers - Overhead Holders/Stops:
1. Assa Abloy Rixson or Sargent: www.assaabloydss.com.
2. C. R. Laurence Co., Inc: www.crlaurence.com.
3. DORMA Group North America: www.dorma-usa.com/usa.
4. Glynn-Johnson: www.glynn-johnson.com.

F. Manufacturers - Wall and Floor Stops/Holders:
1. Assa Abloy McKinney: www.assaabloydss.com.
2. C. R. Laurence Co., Inc: www.crlaurence.com.
3. Hager Companies: www.hagerco.com.

2.13 GASKETING AND THRESHOLDS

A. Gaskets: Complying with BHMA A156.22.
1. On each exterior door, provide weatherstripping gaskets, unless otherwise indicated; top, sides, and meeting stiles of pairs.
a. Where exterior door is also required to have fire or smoke rating, provide gaskets functioning as both smoke and weather seals.
2. On each exterior door, provide door bottom sweep, unless otherwise indicated.

B. Thresholds:
1. At each exterior door, provide a threshold unless otherwise indicated.

C. Manufacturers - Gasketing and Thresholds:
1. Assa Abloy McKinney: www.assaabloydss.com.
2. National Guard Products, Inc: www.ngpinc.com.
3. Pemko Manufacturing Co: www.pemko.com.
4. Zero International, Inc: www.zerointernational.com.

2.14 PROTECTION PLATES AND ARCHITECTURAL TRIM

A. Protection Plates:

1. Kickplate: Provide on push side of every door with closer, except storefront and all-glass doors.

B. Drip Guard: Provide projecting drip guard over all exterior doors unless they are under a projecting roof or canopy.

C. Manufacturers - Protection Plates and Architectural Trim:
1. Assa Abloy McKinney: www.assaabloydss.com.
2. C. R. Laurence Co., Inc: www.crlaurence.com.
3. Hager Companies: www.hagerco.com.

2.15 KEY CONTROLS

A. Key Management System: For each keyed lock on project, provide one set of consecutively numbered duplicate key tags with hanging hole and snap catch.

B. Facility Manager's Key Cabinet: Sheet steel construction, piano hinged door with key lock.
1. Mounting: Wall-mounted.
2. Capacity: Actual quantity of keys, plus 25 percent additional capacity.
3. Size key hooks to hold 6 keys each.
4. Finish: Baked enamel, manufacturer's standard color.
5. Key cabinet lock to building keying system.

C. Fire Department Lock Box: Heavy-duty, surface mounted, solid stainless-steel box with hinged door and interior gasket seal; single drill resistant lock with dust covers and tamper alarm.
1. Capacity: Holds 10 keys.
2. Finish: Manufacturer's standard dark bronze.
3. Products:
a. Knox Company; Knox-Box Rapid Entry System: www.knoxbox.com.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that doors and frames are ready to receive work; labeled, fire-rated doors and frames are present and properly installed, and dimensions are as indicated on shop drawings.

B. Verify that electric power is available to power operated devices and of the correct characteristics.

3.02 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and applicable codes.

B. Use templates provided by hardware item manufacturer.

C. Install hardware on fire-rated doors and frames in accordance with code and NFPA 80.

D. Mounting heights for hardware from finished floor to center line of hardware item: As listed in Schedule, unless otherwise noted:

3.03 ADJUSTING

A. Adjust hardware for smooth operation.

3.04 CLEANING

A. Clean adjacent surfaces soiled by hardware installation. Clean finished hardware per manufacturer's instructions after final adjustments has been made. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.05 PROTECTION

A. Do not permit adjacent work to damage hardware or finish.

3.06 SCHEDULE - Attached.

END OF SECTION

WMATA Building B

HW Set 1 001 Exterior Main Entry

Reuse Existing Hardware

HW Set 2 001A, 034 Main Entry Vestibule / Corridor

6	Hinges	CB199 4.5 x 4.5 NRP	630	STA
1	Exit Device	FL2208 LBR x 4908A	630	PRE
1	Exit Device	FL2201 LBR	630	PRE
1	Rim Cylinder	Type required	626	COR
2	Closer	D-4550 CS	689	STA
1	Kickplate	K1050	630	ROC
1	Seal	5050C	Cha	NAT
1	Astragal Set	115NA	628	NAT

HW Set 3 010, 019 Exterior Corridor

3	Hinges	CB199 4.5 x 4.5 NRP	630	STA
1	Exit Device	2103 x 1703A	630	PRE
1	Rim Cylinder	Type required	626	COR
1	Closer	D-4550 CS	689	STA
1	Kickplate	K1050	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT

HW Set 4 035A Exterior Vehicle

3	Hinges	CB199 4.5 x 4.5 NRP	630	STA
1	Exit Device	CD 2108 x 4908A	630	PRE
1	Rim Cylinder	Type required	626	COR
1	Mortise Cylinder	Type Required	626	COR
1	Closer	D-4550 HCS	689	STA
1	Kickplate	K1050	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT

HW Set 5 038A Exterior Electrical

3	Hinges	CB199 4.5 x 4.5 NRP	630	STA
1	Exit Device	2103 x 1703A	630	PRE
1	Rim Cylinder	Type required	626	COR
1	Closer	D-4551 CS	689	STA
1	Kickplate	K1050	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT

HW Set 6 036 Comm1

6	Hinges	CB199 4.5 x 4.5 NRP	630	STA
2	Flush Bolts	555	626	ROC
1	Dust proof Strike	570	626	COR
1	Lockset - storeroom	ML2057 NSA	630	COR

1	Closer	D-4550 CS	689	STA
1	OH Stop	9000	630	ABH
2	Kickplates	K1050	630	ROC

Note: requires Hollow Metal astragal on active door

HW Set 7 038 Exterior Electrical

6	Hinges	CB199 4.5 x 4.5 NRP	630	STA
2	Auto Flush Bolts	1845	626	ROC
1	Dust Proof Strike	570	626	BES
1	Exit Device – mortise	2303 x 1703A	630	PRE
1	Mortise Cylinder	Type required	626	COR
2	Closer	D-4550 HCS	689	STA
1	Coordinator	1600 x filler x brackets	BLK	ROC
2	Kickplates	K1050	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
2	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT

Note: requires Hollow Metal astragal on active door

HW Set 8 002, 012, 018, 027, 028, 029, 030 Break / Toilets

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Push Plate	70C	630	ROC
1	Pull Plate	110 x 70C	630	ROC
1	Closer	D-4551 Reg Arm	630	STA
	Note: EDA closer arm @ 029			
1	Kickplate	K1050	630	ROC
1	Mop Plate	K1050	630	ROC
1	Wall Stop	411	626	ROC
3	Silencers	608	Gray	ROC

HW Set 9 003, 006, 007, 008, 011, 013, 015, 017, 024, Offices

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - office	ML2051 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 10 032, 037 Mech

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4551 CS	689	STA
1	Kickplate	K1050 8" x 2" LDW	630	ROC
3	Silencers	608	Gray	ROC

HW Set 11 016 Electric

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4551 Reg Arm	689	STA
1	Kickplate	K1050 8" x 2" LDW	630	ROC
3	Silencers	608	Gray	ROC

HW Set 12 014, 031 Janitor

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4551 HCS	689	STA
1	Kickplate	K1050 8" x 2" LDW	630	ROC
1	Silencers	608	Gray	ROC

HW Set 13 025, 026, 037A Storage

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 14 023 Storage

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	OH Stop	4400	626	ABH
3	Silencers	608	Gray	ROC

HW Set 15 004, 004A, 009 Copy / Conference

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Latchset - passage	ML2010 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 16 022 Computer

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - classroom	ML2055 NSA	630	COR
1	Closer	D-4551 Reg Arm	689	STA
3	Silencers	608	Gray	ROC

HW Set 17 035 Vehicle

3	Hinge	CB199 4.5 x 4.5 NRP	630	STA
1	Lockset - office	ML2051 NSA	630	COR
1	Closer	D-4550 Reg Arm	689	STA
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	200N	628	NAT

HW Set 18 021, 021A Role Call

3	Hinges	CB168 4.5 x 4.5	652	STA
1	Exit Device	CD2114 x 4114A	630	PRE
1	Mortise Cylinder	Type Required	626	COR
1	Closer	D-4551 HCS	689	STA
1	Kickplate	K1050	630	ROC
1	Wall Stop	409	630	ROC
3	Silencers	608	Gray	ROC

HW Set 19 033 Unassigned

6	Hinges	CB168 4.5 x 4.5 NRP	652	STA
2	Flush Bolts	555	626	ROC

1	Dust Proof Strike	570	626	ROC
1	Lockset - office	ML2051 NSA	630	COR
1	Closer	D-4551	689	STA
2	Kickplate	K1050	630	ROC
1	Wall Stop	409	626	ROC
2	Silencers	608	Gray	ROC

HW Set 20 005 Secure Storage

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset – storeroom	ML2057 NSA	630	COR
1	Closer	D-4551 Reg Arm	689	STA
3	Silencers	608	Gray	ROC

HW Set 21 034A Exterior Entry Corridor

6	Hinges	CB199 4.5 x 4.5 NRP	630	STA
1	Key Rem Mullion	KR822	600	PRE
1	Exit Device	2103 x 1703A	630	PRE
1	Exit Device	2101	630	PRE
2	Rim Cylinder	Type required	626	COR
1	Closer	D-4551 CS	689	STA
1	Kickplate	K1050	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT
1	Electric Strike	9600 x Smart Pac 12VDC	630	HES
1	Power Supply	602RF		SDC
1	Card Reader	By Security Vendor		
1	Door Position Switch	By Security Vendor		
1	Request to exit	By Security Vendor		

Operation: Door is normally closed and locked. Entry at active door is by key in cylinder or authorized card validation which releases electric strike gate for entry by pull. Door remains locked upon closing. Strike is fail secure and remains locked upon loss of power. Request to exit momentarily shunts alarm allowing egress at all times by depressing panic bars.

Note: Electric Strike and Power Supply furnished only. Wiring and installation by Electrical Contractor

HW Set 22 035B, 035C, 035D, 035E Overhead

No Hardware required

END

WMATA Building B SOCC

HW Set 1 044A Exterior Entry

3	Hinge	CB199 4.5 x 4.5 NRP	630	STA
1	Exit Device	2103 x 1703	630	PRE
1	Cylinder	Type required	626	COR
1	Closer	D-4550 CS x SN	689	STA
1	Kickplate	K1050	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	C627A	628	NAT
1	Electric Strike	9600 x Smart Pac 12VDC	630	HES
1	Power Supply	602RF		SDC
1	Card reader	By Security Vendor		
1	Door Position Switch	By Security Vendor		
1	Request to Exit	By Security Vendor		

Operation: Door is normally closed and locked. Entry is by key in cylinder or authorized card validation which releases electric strike gate for entry by pull. Door remains locked upon closing. Strike is fail secure and remains locked upon loss of power. Request to exit momentarily shunts alarm allowing egress at all times by depressing panic bar.

Note: Electric Strike and Power Supply furnished only. Wiring and installation by Electrical Contractor

HW Set 2 044 Vestibule

3	Hinge	CB199 4.5 x 4.5 NRP	630	STA
1	Exit Device - passage	CD2114 x 4114A	630	PRE
1	Cylinder for dogging	Type required	626	COR
1	Closer	D-4551 CS x SN	689	STA
1	Kickplate	K1050	630	ROC
1	Threshold	424	719	NAT
1	Seal	5050C	CHA	NAT

HW Set 3 046 Exterior FP

3	Hinge	CB199 4.5 x 4.5 NRP	630	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4550 CS x SN	689	STA
1	Latch Protector	320	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT

HW Set 4 048 Break

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Push Plate	70C	630	ROC
1	Pull Plate	110 x 70C	630	ROC
1	Closer	D-4551 Reg Arm	630	STA
1	Kickplate	K1050	630	ROC
1	Mop Plate	K1050	630	ROC
1	Wall Stop	411	626	ROC
3	Silencers	608	Gray	ROC

HW Set 5 041 Office

4	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - office	ML2051 NSA	630	COR

1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 6 047 Comm2

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4551 Reg Arm	689	STA
1	Wall Stop	409	626	ROC
1	Seal	5050C	Cha	NAT

HW Set 7 040, 040A Dispatch

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset -storeroom	ML2057 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 8 045 Copy / Work

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Latchset - passage	ML2010 NSA	630	BES
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 9 039 Camera Monitoring

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Lockset - classroom	ML2055 NSA	630	COR
1	Closer	D-4551 EDA	689	STA
1	Wall Stop	409	626	ROC
1	Seal	5050C	Cha	NAT

HW Set 10 043 Break Room

4	Hinges	CB168 4.5 x 4.5	626	STA
1	Push Plate	70C	630	ROC
1	Pull Plate	110 x 70C	630	ROC
1	Closer	D-4551 Reg Arm	630	STA
1	Kickplate	K1050	630	ROC
1	Mop Plate	K1050	630	ROC
1	Wall Stop	411	626	ROC
3	Silencers	608	Gray	ROC

HW Set 11 043A Record Storage

4	Hinges	CB168 4.5 x 4.5	626	STA
1	Lockset -storeroom	ML2057 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 12 042, 042A Conference

4	Hinges	CB168 4.5 x 4.5	626	STA
1	Latchset - passage	ML2010 NSA	630	BES
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 13 049, 050 Toilets

3	Hinges	CB191 4.5 x 4.5	626	STA
1	Privacy Set	ML2020 NSA x indicator	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

END

WMATA Building C

HW Set 1 101 Exterior Entry

2	Hinges	CB199 4.5 x 4.5 NRP	630	STA
1	Hinge – electric	CECB199 4.5 x 4.5 – 18	630	STA
1	Exit Device - concealed	ELR2603 x TS	630	PRE
1	Power Supply	ELR151x battery back up		PRE
1	Rim Cylinder	Type required	626	COR
1	Pull Offset	BF157		
1	Closer	D-4551 CS	689	STA
1	Threshold	By Door Manufacturer		
1	Weatherstrip	By Door Manufacturer		
1	Sweep	By Door Manufacturer		
1	Card Reader	By Security Vendor		
1	Door Position Switch	By Security Vendor		

Operation: Door is normally closed and locked. Entry is by key in cylinder or valid card swipe which retracts latches for entry by pull. Request to exit in touchbar (TS) momentarily shunts alarm for egress at all times. Latch is fail secure and remains locked upon loss of power.

HW Set 2 101A Entry Vestibule

3	Hinges	CB199 4.5 x 4.5 NRP	630	STA
1	Push Bar Set	BF15747	630	ROC
1	Closer	D-4551 CS	689	STA

HW Set 3 111A, 111B, 117 Exterior Corridor / DT

3	Hinges	CB199 4.5 x 4.5 NRP	630	STA
1	Exit Device	CD2103 x 1703A	630	PRE
1	Rim Cylinder	Type required	626	COR
1	Mortise Cylinder	Type required	626	COR
1	Closer	D-4551 CS	689	STA
1	Kickplate	K1050	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT

HW Set 4 113B Exterior Fitness

3	Hinge	CB199 4.5 x 4.5 NRP	630	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4550 CS	689	STA
1	Kickplate	K1050	630	ROC
1	Latch Protector	320	630	ROC
1	Threshold	424	719	NAT
1	Weatherstrip	700ES	628	NAT
1	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT

HW Set 5 113A Exterior Fitness

6	Hinge	CB199 4.5 x 4.5 NRP	630	STA
2	Flush Bolts	555	626	ROC
1	Dust proof Strike	570	626	BES
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4550 CS	689	STA
2	Kickplates	K1050	630	ROC
1	Threshold	424	719	NAT

1	Weatherstrip	700ES	628	NAT
2	Sweep	200N	628	NAT
1	Rain Drip	16SS x 4" ODW	630	NAT

Note: Requires Hollow Metal astragal on active door

HW Set 6 118, 119, 123, 125, 126 Break / Toilets

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Push Plate	70C	630	ROC
1	Pull Plate	110 x 70C	630	ROC
1	Closer	D-4551 Reg Arm	630	STA
	Note: EDA closer arm @ 029			
1	Kickplate	K1050	630	ROC
1	Mop Plate	K1050	630	ROC
1	Wall Stop	411	626	ROC
3	Silencers	608	Gray	ROC

HW Set 7 103, 104, 105, 110 Offices

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - office	ML2051 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 8 111, 113 DT, Fitness

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - classroom	ML2055 NSA	630	COR
1	Closer	D-4551 Reg Arm	689	STA
1	Wall Stop @ 111	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 9 107, 109 Classroom

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - classroom	ML2055 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 10 112, 112A, 114 Storage Closet

6	Hinges	CB168 4 ½ x 4 1/2	652	STA
2	Flush Bolts	555	626	ROC
1	Dust proof Strike	570	626	BES
1	Lockset - storeroom	ML2057 NSA	630	COR
2	OH Stops	9000 series	626	ABH
2	Silencers	608	Gray	ROC

HW Set 11 121, 122 Janitor / Electrical

3	Hinges	CB168 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4551 Reg Arm	689	STA
1	Kickplate	K1050 8" x 2" LDW	630	ROC
1	Wall Stop	409	630	ROC
3	Silencers	608	Gray	ROC

HW Set 12 106, 124 Storage, Sprinkler

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

HW Set 13 120 Communications

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Lockset - storeroom	ML2057 NSA	630	COR
1	Closer	D-4551 Reg Arm	689	STA
1	Wall Stop	409	626	ROC
1	Seal	5050C	Cha	NAT

HW Set 14 116 Conference

3	Hinges	CB179 4.5 x 4.5	626	STA
1	Latchset - passage	ML2010 NSA	630	COR
1	Wall Stop	409	626	ROC
3	Silencers	608	Gray	ROC

END

SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass.

B. Glazing compounds and accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 90 05 - Joint Sealers: Sealant and back-up material.

B. Section 08 11 13 - Hollow Metal Doors and Frames: Glazed doors and borrowed lites.

C. Section 08 14 16 - Flush Wood Doors: Glazed doors.

D. Section 08 43 13 - Aluminum-Framed Storefronts.

E. Section 08 51 13 - Aluminum Windows: Glazed windows.

F. Section 10 28 00 - Toilet, Bath, and Laundry Accessories: Mirrors.

1.03 REFERENCE STANDARDS

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

B. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; current edition.

C. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings, Safety Performance Specifications and Methods of Test; 2010.

D. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2011.

E. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005.

F. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2011.

G. ASTM C1036 - Standard Specification for Flat Glass; 2006.

H. ASTM C1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass; 2004.

I. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2010.

J. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2009a.

K. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2010.

L. GANA (GM) - GANA Glazing Manual; Glass Association of North America; 2009.

M. GANA (SM) - FGMA Sealant Manual; Glass Association of North America; 2008.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

B. Certifications:

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

C. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

D. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.

E. Samples: Submit two samples 12 x 12 inch in size of glass units.

F. Certificates: Certify that products meet or exceed specified requirements.

G. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Insulating Glass Units: One of each glass size and each glass type.

1.05 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. Perform Work in accordance with GANA Glazing Manual and FGMA Sealant Manual for glazing installation methods.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

1.06 MOCK-UP

A. Provide mockup of 1 exterior window including glass.

B. Locate where directed.

C. Mockup may remain as part of the Work.

1.07 FIELD CONDITIONS

A. Do not install glazing when ambient temperature is less than 50 degrees F.

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.08 WARRANTY

A. Sealed Insulating Glass Units: Provide a five (5) year warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.

PART 2 PRODUCTS

2.01 GLAZING TYPES

A. Sealed Insulating Glass Units: Vision glazing, low-E.
   1. Application(s): All exterior glazing unless otherwise indicated.
   2. Between-lite space filled with argon.
   3. Basis of Design: Guardian Industries Corp: www.sunguardglass.com.
   4. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
      a. Tint and Coating: Clear with SunGuard SN 68 on #2 surface.
   5. Inboard Lite: Annealed float glass, 1/4 inch thick.
      a. Tint: None (clear).

6. Total Thickness: 1 inch.

B. Single Exterior Vision Glazing:
   1. Applications: Exterior door vision panels.
   2. Type: Fully tempered float glass.
   3. Tint: Clear.
   4. Thickness: 1/4 inch.
   5. Glazing Method: Gasket glazing.

C. Single Vision Glazing:
   1. Applications: All interior glazing unless otherwise indicated.
   2. Type: Fully tempered float glass.
   3. Tint: Clear.
   4. Thickness: 1/4 inch.

D. Fire-Rated Safety Glazing:
   1. Applications: Provide this type of glazing in the following locations:
      a. Glazed lites in fire doors.
      b. Sidelights, borrow lites, and other glazed openings in partitions indicated as having an hourly fire rating.
      c. Other locations indicated on the drawings.
   2. Fire Rating: As indicated on the drawings.
   3. Type: Glass-ceramic safety glazing.
   4. Thickness: 1/4 inch.

2.02 EXTERIOR GLAZING ASSEMBLIES

A. Structural Design Criteria: Select type and thickness to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with IBC code.
   1. Use the procedure specified in ASTM E1300 to determine glass type and thickness.
   2. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.
   3. Thicknesses listed are minimum.

2.03 GLASS MATERIALS

A. Float Glass Manufacturers:
   1. AGC Flat Glass North America, Inc: www.afgglass.com.
   2. Guardian Industries Corp: www.sunguardglass.com.
   3. PPG Industries, Inc: www.ppgideascapes.com.

B. Float Glass: All glazing is to be float glass unless otherwise indicated.
   1. Annealed Type: ASTM C1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select).
   2. Heat-Strengthened and Fully Tempered Types: ASTM C1048.
   3. Tinted Types: Color and performance characteristics as indicated.
   4. Thicknesses: As indicated; for exterior glazing comply with specified requirements for wind load design regardless of specified thickness.

C. Glass-Ceramic Safety Glazing: UL- or WH-listed as fire-protection-rated glazing and complying with 16 CFR 1201 test requirements for Category II with or without the use of a surface-applied film.

2.04 SEALED INSULATING GLASS UNITS

A. Manufacturers:
   1. Any of the manufacturers specified for float glass.

B. Sealed Insulating Glass Units: Types as indicated.

1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
2. Edge Spacers: Aluminum, bent and soldered corners.
3. Edge Seal: Glass to elastomer with supplementary silicone sealant.
4. Purge interpane space with dry hermetic air.

2.05 GLAZING COMPOUNDS

A. Manufacturers:
   1. Bostik Inc: www.bostik-us.com.
   2. Pecora Corporation: www.pecora.com.
   3. BASF Construction Chemicals-Building Systems: www.buildingsystems.basf.com.

B. Butyl Sealant: Single component; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; Shore A hardness of 10 to 20; black color; non-skinning.

2.06 GLAZING ACCESSORIES

A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness, ASTM C864 Option I. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness, ASTM C 864 Option I. Minimum 3 inch long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.

C. Glazing Tape: Preformed butyl compound with integral resilient tube spacing device; 10 to 15 Shore A durometer hardness; coiled on release paper; black color.
   1. Manufacturers:
      a. Pecora Corporation: www.pecora.com.
      b. Tremco Global Sealants: www.tremcosealants.com.

D. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option I;.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant.

D. Install sealants in accordance with ASTM C1193 and FGMA Sealant Manual.

E. Install sealant in accordance with manufacturer's instructions.

3.03 INSTALLATION - EXTERIOR/INTERIOR DRY METHOD (GASKET GLAZING)

A. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.

B. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.

C. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.04 INSTALLATION - EXTERIOR WET/DRY METHOD (PREFORMED TAPE AND SEALANT)

A. Cut glazing tape to length and set against permanent stops, 3/16 inch below sight line. Seal corners by butting tape and dabbing with butyl sealant.

B. Apply heel bead of butyl sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete the continuity of the air and vapor seal.

C. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.

D. Rest glazing on setting blocks and push against tape and heel bead of sealant with sufficient pressure to attain full contact at perimeter of pane or glass unit.

E. Install removable stops, with spacer strips inserted between glazing and applied stops, 1/4 inch below sight line. Place glazing tape on glazing pane or unit with tape flush with sight line.

F. Fill gap between glazing and stop with butyl type sealant to depth equal to bite of frame on glazing, but not more than 3/8 inch below sight line.

G. Apply cap bead of butyl type sealant along void between the stop and the glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.05 MANUFACTURER'SFIELD SERVICES

A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.

B. Monitor and report installation procedures and unacceptable conditions.

3.06 CLEANING

A. Remove glazing materials from finish surfaces.

B. Remove labels after Work is complete.

C. Clean glass and adjacent surfaces.

3.07 PROTECTION

A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

END OF SECTION

SECTION 08 91 00

LOUVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Louvers, frames, and accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 62 00 - Sheet Metal Flashing and Trim.

B. Section 07 90 05 - Joint Sealers.

C. Section 09 90 00 - Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS

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

B. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2005.

C. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2007.

D. AMCA 511 - Certified Ratings Program for Air Control Devices; Air Movement and Control Association International, Inc.; 2010.

E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.

F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2008.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.

D. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blankout areas required, and frames.

E. Samples: Submit two samples 2 by 2 inches in size illustrating finish and color of exterior and interior surfaces.

F. Test Reports: Independent agency reports showing compliance with specified performance criteria.

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

H. Maintenance Data: Include lubrication schedules, adjustment requirements.

1.05 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. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.

1.06 WARRANTY

A. Provide twenty year manufacturer warranty against distortion, metal degradation, and failure of connections.
   1. Finish: Include coverage against degradation of exterior finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Wall Louvers:
   1. Airolite Company, LLC: www.airolite.com.
   2. American Warming and Ventilating: www.awv.com.
   3. Construction Specialties, Inc: www.c-sgroup.com.

2.02 LOUVERS

A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified under AMCA 511.
   1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf without damage or permanent deformation.
   2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
   3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
   4. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers.

B. Stationary Louvers: Horizontal blade, extruded aluminum construction, with intermediate mullions matching frame.
   1. Free Area: 50 percent, minimum.
   2. Blades: Straight.
   3. Frame: 4 inches deep, channel profile; corner joints mitered and mechanically fastened, with continuous recessed caulking channel each side.
   4. Metal Thickness: Frame 0.081 inch; blades 0.081 inch.
   5. Finish: Fluoropolymer coating, finished after fabrication.
   6. Color: As selected from manufacturer's standard colors.

C. Operable Louvers: Operable horizontal blades, extruded aluminum construction.
   1. Free Area: 50 percent, minimum.
   2. Movable Blades: Straight, pivoted at center, with vinyl, rubber, or polyethylene blade edge and jamb seals; rattle-free linkage.
   3. Frame: 4 inches deep, channel profile; corner joints mitered and mechanically fastened, with continuous recessed caulking channel each side.
   4. Metal Thickness: Frame 0.081 inch; blades 0.081 inch.
   5. Finish: Fluoropolymer coating, finished after fabrication.
   6. Color: As selected from manufacturer's standard colors.

2.03 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M),.

B. Bird Screen: Interwoven wire mesh of steel, 0.063 inch diameter wire, 1/2 inch open weave, diagonal design.

C. Insect Screen: 18 x 16 size aluminum mesh.

D. Polyvinylidene Fluoride Coating: Minimum 70 percent Kynar 500/Hylar 500 resin, two coat finish, complying with AAMA 2604.

2.04 ACCESSORIES

A. Blank-Off Panels: Same material as louver, painted black on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.

B. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.

3.02 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions.

B. Install louvers level and plumb.

C. Align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.

D. Secure louver frames in openings with concealed fasteners.

3.03 ADJUSTING

A. Adjust operable louvers for freedom of movement of control mechanism. Lubricate operating joints.

3.04 CLEANING

A. Strip protective finish coverings.

B. Clean surfaces and components.

END OF SECTION

SECTION 09 21 16

GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal stud wall framing.

C. Metal channel ceiling framing.

D. Acoustic insulation.

E. Gypsum sheathing.

F. Cementitious backing board.

G. Gypsum wallboard.

H. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

A. Section 05 40 00 - Cold-Formed Metal Framing: Exterior wind-load-bearing metal stud framing.

B. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

C. Section 07 21 00 - Thermal Insulation: Acoustic insulation.

D. Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire rated walls.

E. Section 07 90 05 - Joint Sealers: Acoustic sealant.

F. Section 09 30 00 - Tiling: Tile backing board.

1.03 REFERENCE STANDARDS

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

B. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. (replaced SG-971)

C. ANSI A108.11 - American National Standard for Interior Installation of Cementitious Backer Units; 2010.

D. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 1999 (R2010).

E. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2002 (Reapproved 2007).

F. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2009a.

G. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2006.

H. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2009a.

I. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2008.

J. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2010.

K. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2007.

L. ASTM C1325 - Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cement Substrate Sheets; 2008b.

M. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2009a.

N. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.

O. ASTM E413 - Classification for Rating Sound Insulation; 2010.

P. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association; 2010.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.

1.05 QUALITY ASSURANCE

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.

B. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 3 years of documented experience.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.
   1. See PART 3 for finishing requirements.

B. Interior Partitions Indicated as Acoustic: Provide completed assemblies with the following characteristics:
   1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.02 METAL FRAMING MATERIALS

A. Manufacturers - Metal Framing, Connectors, and Accessories:
   1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com.
   2. Marino\Ware: www.marinoware.com.
   3. Phillips Manufacturing Company: www.phillipsmfg.com.

B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
   1. Studs: "C" shaped with flat or formed webs with knurled faces.
   2. Runners: U shaped, sized to match studs.
   3. Ceiling Channels: C shaped.
   4. Furring: Hat-shaped sections, minimum depth of 7/8 inch.

C. Exterior Non-Loadbearing Studs and Furring for Application of Gypsum Board: As specified in Section 09 22 16.

D. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

E. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.

2.03 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
   1. CertainTeed Corporation: www.certainteed.com.
   2. National Gypsum Company: www.nationalgypsum.com.
   3. USG Corporation: www.usg.com.

B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
   2. Thickness:
      a. Vertical Surfaces: 5/8 inch.
      b. Ceilings: 1/2 inch.
   3. Paper-Faced Products:
      a. Georgia-Pacific Gypsum LLC; ToughRock Gypsum Wallboard.
      b. National Gypsum Company; Gold Bond Brand Gypsum Wallboard.
      c. USG Corporation; Sheetrock Brand Gypsum Panels.

C. Backing Board For Wet Areas: One of the following products:
   1. Application: Surfaces behind tile in wet areas including shower ceilings and shower walls.
   2. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
      a. Thickness: 1/2 inch.
      b. Products:
         1) Custom Building Products; Wonderboard.
         2) National Gypsum Company; PermaBase Brand Cement Board.
         3) USG Corporation; Durock Brand Cement Board.

D. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
   1. Application: Vertical surfaces behind thinset tile, except in wet areas.
   2. Regular Board Thickness: 5/8 inch.
   3. Edges: Tapered.
   4. Products:
      a. Georgia-Pacific Gypsum LLC; ToughRock Moisture-Guard Gypsum Board ("Greenboard").
      b. National Gypsum Company; Gold Bond Brand XP Gypsum Board.
      c. USG Corporation; Sheetrock Brand Mold Tough Gypsum Panels.

E. Ceiling Board: Special sag-resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
   1. Application: Ceilings, unless otherwise indicated.
   2. Thickness: 1/2 inch.
   3. Edges: Tapered.
   4. Products:
      a. Georgia-Pacific Gypsum LLC; ToughRock CD Ceiling Board.
      b. National Gypsum Company; High Strength Brand Ceiling Board.
      c. USG Corporation; Sheetrock Brand Sag-Resistant Interior Gypsum Ceiling Board.

2.04 ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced.

B. Acoustic Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board.

C. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
   1. Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
   2. Ready-mixed vinyl-based joint compound.

D. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.

E. Screws for Attachment to Steel Members From 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
   1. Level ceiling system to a tolerance of 1/1200.
   2. Laterally brace entire suspension system.
   3. Install bracing as required at exterior locations to resist wind uplift.

C. Studs: Space studs as permitted by standard.
   1. Extend partition framing to structure where indicated and to ceiling in other locations.
   2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
   3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.

D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

E. Blocking: Install wood blocking for support of:
   1. Framed openings.
   2. Wall mounted cabinets.
   3. Plumbing fixtures.
   4. Toilet partitions.

5. Toilet accessories.
6. Wall mounted door hardware.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.04 BOARD INSTALLATION

A. Comply with ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

C. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

D. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board with sealant.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.06 JOINT TREATMENT

A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, bedded and finished with chemical hardening type joint compound.

B. Paper Faced Gypsum Board: Use paper joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.

C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 4: Walls and ceilings to receive paint finish, unless otherwise indicated.
   2. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.

D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch.

3.07 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 09 30 00

TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tile for floor applications.

B. Tile for wall applications.

C. Cementitious backer board as tile substrate.

D. Stone thresholds.

E. Ceramic accessories.

F. Ceramic trim.

1.02 RELATED REQUIREMENTS

A. Section 07 90 05 - Joint Sealers.

B. Section 09 21 16 - Gypsum Board Assemblies: Installation of tile backer board.

1.03 REFERENCE STANDARDS

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

B. ANSI A108 Series/A118 Series/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2009.

C. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2010.

D. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar; 1999 (R2010).

E. ANSI A108.1c - Specifications for Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Bed with Dry-Set or Latex Portland Cement Mortar; 1999 (R2010).

F. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive; 2009.

G. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar; 1999 (R2010).

H. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy; 1999 (R2010).

I. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (R2010).

J. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 1999 (R2010).

K. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 1999 (R2010).

L. ANSI A108.11 - American National Standard for Interior Installation of Cementitious Backer Units; 2010.

M. ANSI A118.4 - American National Standard Specifications for Latex-Portland Cement Mortar; 2010.

N. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation; 2010.

O. ANSI A118.7 - American National Standard Specifications for Polymer Modified Cement Grouts for Tile Installation; 2010.

P. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 1999 (R2005).

Q. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2008.

R. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2008.

S. TCNA (HB) - Handbook for Ceramic Tile Installation; 2011.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

D. Shop Drawings: Indicate perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.

E. Samples: Mount tile and apply grout on two plywood panels, minimum 18 x 18 inches in size illustrating pattern, color variations, and grout joint size variations.

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

G. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.

H. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Tile: 10 square feet of each size, color, and surface finish combination.

1.05 QUALITY ASSURANCE

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.

B. Maintain one copy of The Tile Council of North America Handbook and ANSI A108 Series/A118 Series on site.

C. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum 5 years of documented experience.

D. Installer Qualifications: Company specializing in performing tile installation, with minimum of 5 years of documented experience.

1.06 MOCK-UP

A. Construct tile mock-up where indicated on the drawings, incorporating all components specified for the location.
   1. Minimum size of mock-up is 4'x4'.
   2. Approved mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install adhesives in an unventilated environment.

B. Maintain ambient and substrate temperature of 50 degrees F during installation of mortar materials.

PART 2 PRODUCTS

2.01 TILE

A. Manufacturers: All products by the same manufacturer.

B. American Olean: www.americanolean.com.

C. Dal-Tile Corporation: www.daltile.com.

D. Metropolitan Ceramics, Inc. Basis of Design.

E. Ceramic Mosaic Tile: ANSI A137.1, and as follows:
   1. Moisture Absorption: 0 to 0.5 percent.
   2. Size and Shape: 8" x 8".
   3. Edges: Cushioned.
   4. Surface Finish: Unglazed.
   5. Colors: To be selected by Engineer from manufacturer's standard range.

F. Wall Tile: ANSI A137.1, and as follows:
   1. Moisture Absorption: 3.0 to 7.0 percent.
   2. Size and Shape: 8" x 12".
   3. Edges: Cushioned.
   4. Surface Finish: Matte glaze.
   5. Colors: To be selected by Engineer from manufacturer's standard range.

2.02 TRIM AND ACCESSORIES

A. Ceramic Accessories: Glazed finish, same color and finish as adjacent field tile; same manufacturer as tile.

B. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
   1. Applications: Use in the following locations:
      a. Open Edges: Bullnose.
      b. Inside Corners: Jointed.
      c. Floor to Wall Joints: Cove base.
   2. Manufacturer: Same as for tile.

C. Thresholds: Marble, white or gray, honed finish; 2 inches wide by full width of wall or frame opening; 1/2 inch thick; beveled one long edge with radiused corners on top side; without holes, cracks, or open seams.
   1. Applications: Provide at the following locations:

a. At doorways where tile terminates.
b. At open edges of floor tile where adjacent finish is a different height.

2.03 SETTING MATERIALS

A. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
1. Application(s): Use this type of bond coat where indicated.
2. Products:
a. Ardex Engineered Cements; : www.ardex.com
b. LATICRETE International, Inc; LATICRETE 254 Platinum: www.laticrete.com.
c. ProSpec, an Oldcastle brand; Permalastic System: www.prospec.com.

2.04 GROUTS

A. Manufacturers:
1. ProSpec, an Oldcastle brand: www.prospec.com.
2. Custom Building Products: www.custombuildingproducts.com.
3. LATICRETE International, Inc: www.laticrete.com.

B. Standard Grout: Any type specified in ANSI A118.6 or A118.7.
1. Colors: To be selected by Engineer from manufacturer's standard range.

2.05 THIN-SET ACCESSORY MATERIALS

A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12.
1. Thickness: 20 mils, maximum.
2. Crack Resistance: No failure at 1/16 inch gap, minimum.

B. Waterproofing Membrane at showers: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
1. Material: PVC sheet membrane, 40 mils, thick, minimum.
2. Products:
a. Compotite Corporation; Composeal Blue Shower Pan: www.compotite.com.
b. Custom Building Products; RedGard Waterproofing & Crack Prevention Membrane, with fiberglass mesh reinforcement at changes of plane and gaps: www.custombuildingproducts.com.

C. Underlayment at Floors: Specifically designed for bonding to thin-set setting mortar; having the following characteristics:
1. Crack Isolation: Comply with ANSI A118.12.
2. Water Resistance: Comply with ANSI A118.10, bonded waterproofing.
3. Products:
a. Custom Building Products; SpiderWeb Uncoupling Mat: www.custombuildingproducts.com.
b. Or approved equal.

D. Cementitious Backer Board: ANSI A118.9; High density, cementitious, glass fiber reinforced, 1/2 inch thick; 2 inch wide coated glass fiber tape for joints and corners.

E. Coated Glass Mat Backer Board: ASTM C1178/C1178M, with coated inorganic fiberglass mat on both surfaces and integral acrylic coating vapor retarder.
1. Standard Type: Thickness 1/2 inch.

F. Mesh Tape: 2-inch wide self-adhesive fiberglass mesh tape.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.

C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.

D. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by tile manufacturer and setting materials manufacturer.

E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Protect surrounding work from damage.

B. Vacuum clean surfaces and damp clean.

C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

D. Install cementitious backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of dry-set mortar to a feather edge.

E. Install tile backer board in strict accordance with manufacturer's instructions, using galvanized roofing nails or corrosion-resistant bugle head drywall screws. Bed fiberglass self-adhesive tape at all joints and corners with material used to set tiles.

3.03 INSTALLATION - GENERAL

A. Install tile and thresholds and grout in accordance with applicable requirements of ANSI A108.1 through A108.13, manufacturer's instructions, and The Tile Council of North America Handbook recommendations.

B. Request tile pattern. Do not interrupt tile pattern through openings.

C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.

D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.

E. Form internal angles square and external angles bullnosed.

F. Install ceramic accessories rigidly in prepared openings.

G. Sound tile after setting. Replace hollow sounding units.

H. Keep expansion joints free of adhesive or grout. Apply sealant to joints.

I. Allow tile to set for a minimum of 48 hours prior to grouting.

J. Grout tile joints. Use standard grout unless otherwise indicated.

K. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

A. Over interior concrete substrates, install in accordance with The Tile Council of North America Handbook Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.

3.05 INSTALLATION - SHOWERS

A. At tiled shower receptors install in accordance with The Tile Council of North America Handbook Method B415, mortar bed floor, and W244, thin-set over cementitious backer unit walls.

B. Grout with standard grout as specified above.

3.06 INSTALLATION - WALL TILE

A. On exterior walls install in accordance with The Tile Council of North America Handbook Method W244, thin-set over cementitious backer units, with waterproofing membrane.

B. Over cementitious backer units on studs, install in accordance with The Tile Council of North America Handbook Method W244, using membrane at toilet rooms.

C. Over coated glass mat backer board on studs, install in accordance with The Tile Council of North America Handbook Method W245.

3.07 CLEANING

A. Clean tile and grout surfaces.

3.08 PROTECTION

A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

SECTION 09 51 00

ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

1.02 RELATED REQUIREMENTS

A. Section 07 21 00 - Thermal Insulation: Acoustical insulation.

B. Section 07 90 05 - Joint Sealers: Acoustical sealant.

C. Section 08 31 00 - Access Doors and Panels: Access panels.

1.03 REFERENCE STANDARDS

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

B. ASTM C635 - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2007.

C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 2008.

D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2008e1.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Do not install acoustical units until after interior wet work is dry.

1.05 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Shop Drawings: Indicate grid layout and related dimensioning.

D. Product Data: Provide data on suspension system components.

E. Samples: Submit two samples 6x6 inch in size illustrating material and finish of acoustical units.

F. Samples: Submit two samples each, 6 inches long, of suspension system main runner.

G. Manufacturer's Installation Instructions: Indicate special procedures.

H. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.06 QUALITY ASSURANCE

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.

B. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

A. Manufacturers:
   1. Armstrong World Industries, Inc: www.armstrong.com.
   2. CertainTeed Corporation: www.certainteed.com.
   3. USG: www.usg.com.

B. Acoustical Units - General: ASTM E1264, Class A.

C. Acoustical Panels: Painted mineral fiber, ASTM E1264 Type III, with the following characteristics:
   1. Size: 24 x 24 inches.
   2. Thickness: 3/4 inches.
   3. Composition: Wet felted.
   4. Edge: Tegular.
   5. Surface Color: White. Color: Black where indicated.
   6. Surface Pattern: Non-directional fissured.
   7. Suspension System: Exposed grid.

D. Acoustical Panels: Cleanable.
   1. Size: 24 x 24 inches.
   2. Panel Edge: Tegular.
   3. Surface Pattern: Perforated.
   4. Surface Color: White.
   5. Product: Ceramaguard by Armstrong.
   6. Suspension System: Exposed grid Type 1.

2.02 SUSPENSION SYSTEM(S)

A. Manufacturers:
   1. Same as for acoustical units.

B. Suspension Systems - General: ASTM C635; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.

C. Exposed Steel Suspension System: Formed steel, commercial quality cold rolled; intermediate-duty.
   1. Profile: Tee; 15/16 inch wide face.
   2. Construction: Double web.
   3. Finish: White painted. Color: Black where indicated.

2.03 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.

B. Perimeter Moldings: Same material and finish as grid.
   1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.

C. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

B. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.

C. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

D. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

G. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

H. Do not eccentrically load system or induce rotation of runners.

I. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.
   2. Overlap and rivet corners.

3.03 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Lay directional patterned units with pattern parallel to longest room axis.

D. Fit border trim neatly against abutting surfaces.

E. Install units after above-ceiling work is complete.

F. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

G. Cutting Acoustical Units:

1. Cut to fit irregular grid and perimeter edge trim.
2. Make field cut edges of same profile as factory edges.
3. Double cut and field paint exposed reveal edges.

H. Where round obstructions occur, provide preformed closures to match perimeter molding.

I. Install hold-down clips on panels within 20 ft of an exterior door.

3.04 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.05 SCHEDULE

A. Office Areas: 24 x 24 inch acoustical units with interlocking suspension grid.

B. Locker Room, Toilet Room Areas: 24 x 24 inch cleanable acoustical units, interlocking exposed T suspension grid.

END OF SECTION

SECTION 09 65 00

RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Resilient tile flooring.

B. Resilient base.

C. Installation accessories.

1.02 REFERENCE STANDARDS

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

B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2010e1.

C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2008.

D. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile; 2004 (Reapproved 2010)e1.

E. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile; 2004 (reapproved 2010).

F. ASTM F1861 - Standard Specification for Resilient Wall Base; 2008.

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

D. Selection Samples: Submit manufacturer's complete set of color samples for Engineer's initial selection.

E. Verification Samples: Submit two samples, 6x6 inch in size illustrating color and pattern for each resilient flooring product specified.

F. Concrete Testing Standard: Submit a copy of ASTM F710.

G. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.

H. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

I. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Flooring Material: 10 SF of each type and color.
   2. Extra Wall Base: 10 linear feet of each type and color.

1.04 QUALITY ASSURANCE

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.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect roll materials from damage by storing on end.

1.06 FIELD CONDITIONS

A. Maintain temperature in storage area between 55 degrees F and 90 degrees F.

B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 TILE FLOORING

A. Vinyl Composition Tile: Homogeneous, with color extending throughout thickness, and:
   1. Minimum Requirements: Comply with ASTM F1066, of Class corresponding to type specified.
   2. Size: 12 x 12 inch.
   3. Thickness: 0.125 inch.
   4. Pattern: Solid color.
   5. Manufacturers:
      a. Armstrong World Industries, Inc: www.armstrong.com.
      b. Mannington Mills, Inc: www.mannington.com.
      c. Tarkett Inc: www.tarkett.com.

2.02 RESILIENT BASE

A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove, and as follows:
   1. Height: 4 inch.
   2. Thickness: 0.125 inch thick.
   3. Finish: Satin.
   4. Length: Roll.
   5. Color: Color as selected from manufacturer's standards.
   6. Accessories: Premolded external corners and end stops.
   7. Manufacturers:
      a. Burke Flooring: www.burkemercer.com.
      b. Johnsonite, Inc: www.johnsonite.com.
      c. Roppe Corp: www.roppe.com.

2.03 ACCESSORIES

A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.

B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.

C. Moldings, Transition and Edge Strips: Same material as flooring.

D. Filler for Coved Base: Plastic.

E. Sealer and Wax: Types recommended by flooring manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
   1. Test in accordance with ASTM F710.
   2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.

C. Prohibit traffic until filler is cured.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of sub-floor conditions.

B. Install in accordance with manufacturer's instructions.

C. Spread only enough adhesive to permit installation of materials before initial set.

D. Fit joints tightly.

E. Set flooring in place, press with heavy roller to attain full adhesion.

F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.

H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

I. Install flooring in recessed floor access covers, maintaining floor pattern.

3.04 TILE FLOORING

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless manufacturer's instructions say otherwise.

3.05 RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.

B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.

C. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.06 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's instructions.

3.07 PROTECTION

A. Prohibit traffic on resilient flooring for 48 hours after installation.

3.08 SCHEDULE

A. See Finish Schedule

END OF SECTION

SECTION 09 65 66

RESILIENT ATHLETIC FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Adhered rubber tile.

B. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 08 11 13 - Hollow Metal Doors and Frames.

B. Section 08 71 00 - Door Hardware.

C. Section 09 65 00 - Resilient Flooring.

1.03 REFERENCE STANDARDS

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

B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2006a.

C. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2005 (Reapproved 2010).

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Manufacturer's printed data sheets for products specified.

D. Shop Drawings: Fabrication and installation details, and layout, and colors.

E. Selection Samples: Manufacturer's color charts for flooring materials specified, indicating full range of colors and textures available.

F. Verification Samples: Actual flooring material specified, not less than 12 in square, mounted on solid backing.

1.05 QUALITY ASSURANCE

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.

B. Installer Qualifications: An experienced installer certified in writing by the flooring manufacturer to be qualified for installation of specified flooring system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in unopened containers clearly labeled with manufacturer's name and identification of contents.

B. Store materials in dry and clean location until needed for installation. During installation, handle in a manner that will prevent marring and soiling of finished surfaces.

1.07 FIELD CONDITIONS

A. Maintain temperature in spaces to receive adhesively installed resilient flooring within range of 70-95 degrees F for not less than 48 hours before the beginning of installation and for not less than 48 hours after installation has been completed. Subsequently, do not allow temperature in installed spaces to drop below 50 degrees F or to go above 100 degrees F.

PART 2 PRODUCTS

2.01 PREFORMED ATHLETIC FLOORING

A. Manufacturers: All products by the same manufacturer.
   1. Basis of Design: Everlast Sports Surfacing; Ultra Tile: www.everlastsportssurfacing.com.
   2. Or approved equal.

B. Rubber Tile Flooring: Recycled rubber material formed into square tiles, invisible installed with adhesive.
   1. Thickness: Minimum 1 in.
   2. Size: Nominal 36 in square.
   3. Tensile Strength: Minimum 150 psi, per ASTM D412.
   4. Hardness: Minimum 55, when tested in accordance with ASTM D2240 using Type A durometer.
   5. Surface Texture: Lightly textured.
   6. Color: As selected from manufacturer's standards.

2.02 ACCESSORIES

A. Leveling Compound: Latex-modified cement formulation as recommended by flooring manufacturer for substrate conditions.

B. Adhesive: Water-resistant type recommended by flooring manufacturer for project conditions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates for conditions detrimental to installation of athletic flooring. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of athletic flooring to substrate.

C. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
   1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Concrete: Use leveling compound as necessary to achieve substrate flatness of plus or minus 1/8 inch within 10 ft radius.

C. Remove coatings that are incompatible with flooring adhesives, using methods recommended by flooring manufacturer.

D. Broom clean areas to receive athletic flooring immediately before beginning installation.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of sub-floor conditions.

B. Comply with manufacturer's recommendations.

C. Rubber Tile Flooring:
   1. Lay out center lines in spaces to receive tile flooring, based on location of principal walls. Start tile installation from center, and adjust as necessary to avoid tiles less than one-half width at perimeter.
   2. Lay tiles square with room axis, matching for color and pattern by selecting from cartons and mixing as recommended by manufacturer.

3.04 CLEANING

A. Clean flooring using methods recommended by manufacturer.

3.05 PROTECTION

A. Protect finished athletic flooring from construction traffic to insure that it is without damage upon completion of the work.

END OF SECTION

SECTION 09 68 13

TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Carpet tile, fully adhered.

B. Carpet tile for areas including access flooring.

1.02 REFERENCE STANDARDS

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.

B. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2006.

C. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2010e1.

D. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2008.

E. CRI (CIS) - Carpet Installation Standard; Carpet and Rug Institute; 2009.

F. CRI (GLA) - Green Label Testing Program - Approved Adhesive Products; Carpet and Rug Institute; Current Edition.

G. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; National Fire Protection Association; 2011.

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.

D. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.

E. Submit two, 6 inch long samples of edge strip.

F. Manufacturer's Installation Instructions: Indicate special procedures.

G. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

H. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Carpet Tiles: Quantity equal to 10 percent of total installed of each color and pattern installed.

1.04 QUALITY ASSURANCE

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.

B. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.

C. Installer Qualifications: Company specializing in installing carpet with minimum ____ years experience.

1.05 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Mohawk; Product Wear-Dated Nylon.

B. Other Acceptable Manufacturers: Approved equal.
   1. Lees Carpets: www.leescarpets.com.
   2. Milliken & Company: www.milliken.com.

2.02 MATERIALS

A. Carpet Tile: 100% Nylon, manufactured in one color dye lot.
   1. Basis of Design Product: Aladdin Energized Tile manufactured by Mohawk.
   2. Tile Size: 24x24 inch, nominal.
   3. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
   4. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
   5. Stitches: 11.3 per inch.
   6. Density Factor: 5669 kilotex.
   7. Underlayment: Rebond Padding.
   8. Total Weight: 53 oz/sq yd.

2.03 ACCESSORIES

A. Sub-Floor Filler: White premix latex; type recommended by flooring material manufacturer.

B. Edge Strips: Vinyl, color as selected.

C. Adhesives: Acceptable to carpet tile manufacturer, compatible with materials being adhered; maximum VOC of 50 g/L; CRI Green Label certified; in lieu of labeled product, independent test report showing compliance is acceptable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.

C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.

D. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for flooring installation by testing for moisture and pH.
   1. Test in accordance with ASTM F710.
   2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.

C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.

D. Vacuum clean substrate.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of sub-floor conditions.

B. Install carpet tile in accordance with manufacturer's instructions and CRI Carpet Installation Standard.

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.

F. Locate change of color or pattern between rooms under door centerline.

G. Fully adhere carpet tile to substrate.

H. Trim carpet tile neatly at walls and around interruptions.

I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

END OF SECTION

SECTION 09 69 00

ACCESS FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Structural floor supported pedestal framing system.

B. Removable floor panels.

C. Accessories, including facia panels, plenum dividers, grilles, ramps, stairs, and railings.

D. System electrostatic grounding.

1.02 RELATED REQUIREMENTS

A. Section 07 90 05 - Joint Sealers.

B. Section 09 65 00 - Resilient Flooring: Finish for access flooring panels.

C. Section 09 68 13 - Tile Carpeting: Finish for access flooring panels.

D. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Grounding and bonding of access floor system to building grounding system.

1.03 REFERENCE STANDARDS

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

B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2003.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

D. CISCA (AF) - Recommended Test Procedures for Access Floors; Ceilings & Interior Systems Construction Association; 2004.

E. NFPA 75 - Standard for the Protection of Information Technology Equipment; National Fire Protection Association; 2009.

F. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data for grid system, panels, and accessories; electrical resistance characteristics and ground connection requirements.

D. Shop Drawings: Indicate floor layout, interruptions to grid, panels requiring drilling or cut-out for services, appurtenances or interruptions, edge details, elevation differences, stairs, and ramps.

E. Samples: Submit two samples of floor grid and panel, 12x12 inch in size illustrating finishes and color.

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

G. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

H. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.

I. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Floor Panels: Four of each size.
   2. Extra Pedestals and Stringers: Four each.
   3. Panel Lifting Devices: One, of manufacturer's standard type.

1.05 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. Designer Qualifications: Design floor system structure layout for this project under direct supervision of a Professional Structural Engineer experienced in design of floors of the type required and licensed in Maryland.

C. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.

D. Installer Qualifications: Company specializing in performing the type of work required in this section, with minimum 5 years of experience.

1.06 MOCK-UP

A. Construct 2 mock-up, 4 feet long by 4 feet wide, with all specified accessories installed including stair and ramp.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Access Flooring:
   1. Free Axez USA: www.freeaxez.com.
   2. Haworth: www.haworth.com.
   3. Basis of Design: Tate Access Floors, Inc; Product ConCore CC 2000: www.tateaccessfloors.com.

2.02 ACCESS FLOORING

A. Access Flooring: Factory-fabricated system consisting of removable floor panels and supporting structure that allows access to each space below floor without requiring removal of panels other than the one directly above the space to which access is needed; provide all components and accessories required for complete installation and as indicated.
   1. Comply with requirements of NFPA 75.
   2. Comply with applicable codes for access for the handicapped.

3. Configuration: Clamped stringer system.
4. Finished Floor Elevation: Top of access floor 6", 18", and 30" inches nominal height above building structural floor.
5. Floor Panel Size: 24 x 24 inches.
6. Electrical Grounding Connection: Listed and classified by Underwriters Laboratories as suitable for the purpose specified and indicated.

B. Performance Requirements:
1. Pedestals:
a. Maximum Axial Load: 5,000 lb without permanent deformation.
b. Ultimate Strength: Not less than twice design load.
2. Floor Panels: Conform to the following:
a. Live Load: 250 lb/sq ft.
b. Maximum Deflection: 0.04 inch.
c. Concentrated Load: 1,000 lb on 1 sq in at any location with maximum deflection of 0.08 inch.
d. Permanent Deformation: 0.02 inch maximum at design load.
e. Ultimate Strength: Not less than twice design load.
f. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
3. Lateral Stability: Design system for lateral stability in all directions, with or without panels in place.
4. Surface Electrical Resistance: Maximum 1 ohm per panel.

2.03 COMPONENTS

A. Pedestals: Steel with flat bottom base plate, threaded supporting rod, vibration proof lock nut to permit 1-1/2 inch adjustment, galvanized finish.

B. Frame Grid Stringers: Continuous type, consisting of steel channels, box, or tee sections.

C. Floor Panels:
1. Sheet steel plates, composite lightweight concrete core.
2. Panel Edge: Vinyl trim, mechanically locked to panels.
3. Floor Panel Finish Adhesive: Moisture resistant type recommended by floor finish manufacturer.

2.04 ACCESSORIES

A. Facia Panels: Laminated construction as follows:
1. Front and Back Face Sheets: Aluminum sheet.
2. Core: 3/4 inch thick plywood.
3. Accessories: Include corner pieces, trim, reinforcing, and clip angles.

B. Ramps and Stairs: Same materials, structural strength, and construction as floor panels; flush extruded aluminum cover plates at junction with floor system.

C. Ramp and Stair Hand Railings: Wall Mounted, Satin Finish Aluminum.

D. Electrostatic Grounding Connectors: Solid copper.

E. Cable Cutout Protection: Extruded polyvinyl chloride edging, self-extinguishing.

F. Gaskets: Closed cell sponge rubber, preformed to suit.

G. Wall Base: Extruded plastic angles.

H. Sealant: type as specified in Section 07 90 05.

2.05 FINISHES

A. Floor Panel Finish:
   1. Vinyl tile, static conductive type 1/8 inch thick, as specified in Section 09 65 00; color as selected.
   2. Carpet tile, as specified in Section 09 68 13; color as selected.

B. Exposed Metal Surfaces: Baked enamel finish; color as selected.

C. Facia Panel: Baked enamel finish; color as selected.

D. Ramp Surface: Sheet rubber; color as selected.

2.06 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
   1. Floor Panel Flatness: Plus or minus 0.02 inch in any direction.
   2. Floor Panel Width or Length From Specified Size: Plus or minus 0.02 inch.
   3. Floor Panel Squareness: Plus or minus 0.03 inch difference between opposite diagonal dimensions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field measurements are as shown on shop drawings.

3.02 PREPARATION

A. Vacuum clean substrate surfaces.

3.03 INSTALLATION

A. Install components in accordance with manufacturer's instructions.

B. Secure pedestal base plate to subfloor with adhesive.

C. Install additional pedestals where grid pattern is interrupted by room appurtenances or at cut-outs.

D. Install stringers and floor panels on pedestals with full bearing.

E. Close field cut floor panels with edge trim.

F. Provide floor with edge trim and end closures. Provide lateral braces at stair edges and other locations where pedestals are not braced.

G. Provide positive electrical earth grounding of entire floor assembly in accordance with NFPA 75.

H. Facia Panels:
   1. Install facia panels at exposed sides.
   2. Secure panels to clip angles attached to structural floor and edge of floor panels.
   3. Install metal trim at intersection of facia panels and access floor and at abutting walls and columns.

I. Railings Where required:
   1. Extend railing posts through floor panels to structural floor; secure to flange fittings anchored to structural floor.
   2. Brace posts in position at floor panels with floor collar retainers.
   3. Secure railings at walls with flanged fittings anchored to walls.
   4. Electrically ground railings to floor system.

3.04 TOLERANCES

A. Maximum Out of Level Floor Panel Tolerance: 1/16 inch in 10 ft, non-cumulative.

3.05 ADJUSTING

A. Adjust pedestals to achieve a level floor and to assure adjacent floor panel surfaces are flush.

3.06 PROTECTION

A. Do not permit traffic over unprotected floor surface.

3.07 SCHEDULES

A. All panels: 24 x 24 inch floor panel, See Finish Schedule for specific room finishes.

END OF SECTION

SECTION 09 72 00

WALL COVERINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation and prime painting.

B. Wall covering.

1.02 REFERENCE STANDARDS

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

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

C. ASTM F793 - Standard Classification of Wallcovering by Use Characteristics; 2010a.

D. FS L-P-1040 - Plastic Sheets and Strips (Polyvinyl Fluoride); Federal Specifications and Standards; Revision B, 1977.

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on wall covering and adhesive.

D. Samples: Submit two samples of wall covering, 6x6 inch in size illustrating color, finish, and texture.

E. Test Reports: Indicate verification of flame and smoke ratings, when tested by UL.

F. Manufacturer's Installation Instructions: Indicate special procedures.

G. Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.

1.04 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. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.

C. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.05 MOCK-UP

A. Locate where directed.

B. Mock-up may remain as part of the Work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Inspect roll materials at arrival on site, to verify acceptability.

B. Protect packaged adhesive from temperature cycling and cold temperatures.

C. Do not store roll goods on end.

1.07 FIELD CONDITIONS

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

B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.

C. Provide lighting level of 80 ft candles measured mid-height at substrate surfaces.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Construction Specialties Inc.; Product 4000- High Impact Wall CoveringAcrovyn 4000- High Impact Wall Covering].

B. Other Acceptable Manufacturers:
1. Omnova Solutions Inc: www.omnova.com.
2. Koroseal/RJF International: www.koroseal.com.
3. Or approved equal.

2.02 MATERIALS

A. Requirements for All Wall Coverings:
1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.

B. Wall Covering: PVC, conforming to the following:
1. Total Thickness: .060".
2. Color: As selected from manufacturer's standard colors.
3. Surface Texture: As selected from manufacturer's standard textures.

C. Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.

D. Termination Trim: PVC, clear.

E. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.

F. Substrate Primer and Sealer: Alkyd enamel type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are prime painted and ready to receive work, and conform to requirements of the wall covering manufacturer.

B. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet nor vary at a rate greater than 1/16 inch/ft.

3.02 PREPARATION

A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.

B. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.

C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

D. Apply one coat of primer sealer to substrate surfaces. Allow to dry. Lightly sand smooth.

E. Vacuum clean surfaces free of loose particles.

3.03 INSTALLATION

A. Apply adhesive and wall covering in accordance with manufacturer's instructions.

B. Install termination trim.

C. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.04 CLEANING

A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.

B. Reinstall wall plates and accessories removed prior to work of this section.

3.05 PROTECTION

A. Do not permit construction activities at or near finished wall covering areas.

3.06 SCHEDULES

A. Break Rooms B 002, B 048, BS 043 Role Call, C 118, A 004.

END OF SECTION

SECTION 09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints, stains, and other coatings.

C. Scope: Finish all interior and exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
   1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
   2. Exposed surfaces of steel lintels and ledge angles.
   3. Mechanical and Electrical:
      a. In finished areas, paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
      b. In finished areas, paint shop-primed items.
      c. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
      d. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.

D. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
   5. Floors, unless specifically so indicated.
   6. Glass.
   7. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications: Shop-primed items.

1.03 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

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

B. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

C. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2011.

D. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 2007.

E. GreenSeal GS-11 - Paints; 1993.

1.05 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on all finishing products, including VOC content.

D. Samples: Submit two paper chip samples, 2x2 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.

E. Certification: By manufacturer that all paints and coatings do not contain any of the prohibited chemicals specified; GreenSeal GS-11 certification is not required but if provided shall constitute acceptable certification.

F. Manufacturer's Instructions: Indicate special surface preparation procedures.

G. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

H. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.
   1. Extra Paint and Coatings: 1 gallon of each color; store where directed.
   2. Label each container with color in addition to the manufacturer's label.

1.06 QUALITY ASSURANCE

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.

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

C. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 3 years experience.

1.07 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 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.08 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: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

B. Provide all paint and coating products from the same manufacturer to the greatest extent possible.

C. Paints, transparent finishes, stains, primers, sealers, and block fillers:
1. Base Manufacturer: Sherwin Williams Company.www.sherwin-williams.com.
2. Duron, Inc: www.duron.com.
3. Glidden Professional: www.gliddenprofessional.com.
4. Benjamin Moore & Co: www.benjaminmoore.com.
5. PPG Architectural Finishes, Inc: www.ppgaf.com.
6. Pratt & Lambert Paints: www.prattandlambert.com.

2.02 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:
a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.

D. Colors: As indicated on drawings
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 The Authority.
3. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling they are mounted on/under.

2.03 PAINT SYSTEMS - EXTERIOR

A. Paint CE-OP-3A - Concrete/Masonry, Opaque, Alkyd, 3 Coat:
1. One coat of block filler.
2. Semi-gloss: Two coats of alkyd enamel.

B. Paint ME-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:
1. One coat of alkyd primer.

2. Semi-gloss: Two coats of alkyd enamel.

C. Paint MgE-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
1. One coat galvanize primer.
2. Semi-gloss: Two coats of alkyd enamel.

2.04 PAINT SYSTEMS - INTERIOR

A. Paint WI-TR-V - Wood, Transparent, Varnish, No Stain:
1. One coat sealer.
2. Satin: One coat of varnish.

B. Paint CI-OP-3A - Concrete/Masonry, Opaque, Alkyd, 3 Coat:
1. One coat of block filler.
2. Semi-gloss: Two coats of alkyd enamel.

C. Paint MI-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:
1. One coat of alkyd primer.
2. Semi-gloss: Two coats of alkyd enamel.

D. Paint MI-OP-2A - Ferrous Metals, Primed, Alkyd, 2 Coat:
1. Touch-up with alkyd primer.
2. Semi-gloss: Two coats of alkyd enamel.

E. Paint MgI-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
1. One coat galvanize primer.
2. Semi-gloss: Two coats of alkyd enamel.

F. Paint CI-OP-3Af - Concrete/Masonry, Alkyd Floor Enamel, 3 Coat:
1. One coat of alkali resistant primer.
2. Gloss: Two coats of alkyd floor enamel.

G. Paint CI-OP-3E - Concrete/Masonry, Epoxy Enamel, 3 Coat:
1. One coat of catalyzed epoxy primer.
2. Gloss: Two coats of catalyzed epoxy enamel.

H. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:
1. One coat of alkyd primer sealer.
2. Eggshell: Two coats of latex enamel.

I. Paint FI-OP-3A - Fabrics/Insulation Jackets, Alkyd, 3 Coat:
1. One coat of alkyd primer sealer.
2. Semi-gloss: Two coats of alkyd enamel.

2.05 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

3.01 EXAMINATION

A. Do not begin application of coatings until substrates have been properly prepared.

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

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

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

E. 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. Gypsum Wallboard: 12 percent.
   2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
   3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
   4. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 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 and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

G. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

H. 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.

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

J. 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).

K. Uncorroded Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand or power tool wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

L. 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.

M. Interior Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.

3.03 APPLICATION

A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

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

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

D. Apply each coat to uniform appearance.

E. Sand wood and metal surfaces lightly between coats to achieve required finish.

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

G. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

H. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

A. The Authority will provide field inspection.

3.05 CLEANING

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

3.06 PROTECTION

A. Protect finished coatings until completion of project.

B. Touch-up damaged coatings after Substantial Completion.

END OF SECTION

SECTION 10 11 01

VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Blocking and supports.

B. Section 09 21 16 - Gypsum Board Assemblies: Concealed supports in metal stud walls.

1.03 REFERENCE STANDARDS

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

B. ANSI A135.4 - American National Standard for Basic Hardboard; 2004.

C. ANSI A208.1 - American National Standard for Particleboard; 2009.

D. ASTM A424 - Standard Specification for Steel, Sheet, for Porcelain Enameling; 2009a.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide manufacturer's data on markerboard, trim, and accessories.

D. Shop Drawings: Indicate wall elevations, dimensions, joint locations, special anchor details.

E. Manufacturer's printed installation instructions.

F. Maintenance Data: Include data on regular cleaning, stain removal.

1.05 QUALITY ASSURANCE

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.

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

1.06 WARRANTY

A. Provide five year warranty for markerboard to include warranty against discoloration due to cleaning, and staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Visual Display Boards:
   1. MooreCo, Inc\Best-Rite: www.moorecoinc.com.
   2. Claridge Products and Equipment, Inc: www.claridgeproducts.com.
   3. Polyvision Corporation (Nelson Adams): www.polyvision.com.

2.02 VISUAL DISPLAY BOARDS

A. Markerboards: Porcelain enamel on steel, laminated to core.
   1. Color: White.
   2. Metal Face Sheet Thickness: 0.024 inch (24 gage).
   3. Core: Particleboard, manufacturer's standard thickness, laminated to face sheet.
   4. Backing: Aluminum foil, laminated to core.
   5. Size: As indicated on drawings.
   6. Frame: Extruded aluminum, with concealed fasteners.
   7. Frame Finish: Anodized, natural.
   8. Accessories: Provide chalk tray and map rail.

2.03 MATERIALS

A. Porcelain Enameled Steel Sheet: ASTM A424, Type I, Commercial Steel, with fired-on vitreous finish.

B. Particleboard: ANSI A208.1; wood chips, set with waterproof resin binder, sanded faces.

C. Foil Backing: Aluminum foil sheet, 0.005 inch thick.

2.04 ACCESSORIES

A. Map Rail: Extruded aluminum, manufacturer's standard profile, with cork insert and runners for accessories; 1 inch wide overall, full width of frame.

B. Chalk Tray: Aluminum, manufacturer's standard profile one piece full length of chalkboard, molded ends; concealed fasteners, same finish as frame.

C. Mounting Brackets: Concealed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.02 INSTALLATION

A. Install boards in accordance with manufacturer's instructions.

B. Install with top of chalk tray at 30 inches above finished floor.

C. Secure units level and plumb.

3.03 CLEANING

A. Clean board surfaces in accordance with manufacturer's instructions.

3.04 SCHEDULE

A. See drawings for sizes and locations

END OF SECTION

SECTION 10 14 00

SIGNAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Room and door signs.

1.02 REFERENCE STANDARDS

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

B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2003.

C. ATBCB ADAAG - Americans with Disabilities Act Accessibility Guidelines; 2002.

1.03 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.

D. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
   1. When content of signs is indicated to be determined later, request such information from The Authority through Engineer at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
   2. Submit for approval by The Authority through Engineer prior to fabrication.

E. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.

F. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.

G. Verification Samples: Submit samples showing colors specified.

H. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

I. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.

1.04 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. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package signs as required to prevent damage before installation.

B. Package room and door signs in sequential order of installation, labeled by floor or building.

C. Store tape adhesive at normal room temperature.

1.06 FIELD CONDITIONS

A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.

B. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flat Signs:
1. Best Sign Systems, Inc: www.bestsigns.com.
2. Mohawk Sign Systems, Inc: www.mohawksign.com.
3. Seton Identification Products: www.seton.com/aec.

2.02 SIGNAGE APPLICATIONS

A. Accessibility Compliance: All signs are required to comply with ADAAG and ANSI/ICC A 117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.

B. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
1. Sign Type: Flat signs with engraved panel media as specified.
2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Grade II braille.
3. Character Height: 1 inch.
4. Sign Height: 4 inches, X length required.
5. Office Doors: Identify with room numbers to be determined later, not the numbers shown on the drawings; in addition, provide "window" section for replaceable occupant name.
6. Conference and Meeting Rooms: Identify with room numbers to be determined later, not the numbers shown on the drawings; in addition, provide "window" section with sliding "In Use/Vacant" indicator.
7. Service Rooms: Identify with room names and numbers to be determined later, not those shown on the drawings.
8. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", room numbers to be determined later, and braille.

2.03 SIGN TYPES

A. Flat Signs: Signage media without frame.
1. Edges: Square.
2. Corners: Radiused.
3. Wall Mounting of One-Sided Signs: Concealed or exposed screws.

B. Color and Font: Unless otherwise indicated:
1. Character Font: Helvetica, Arial, or other sans serif font.
2. Character Case: Upper case only.
3. Background Color: To be selected from manufacturers standard colors.
4. Character Color: Contrasting color.

2.04 TACTILE SIGNAGE MEDIA

A. Engraved Panels: Laminated colored plastic; engraved through face to expose core as background color:
   1. Total Thickness: 1/8 inch.

2.05 ACCESSORIES

A. Exposed Screws: Chrome plated.

B. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install neatly, with horizontal edges level.

C. Locate signs where indicated:
   1. Room and Door Signs: Locate on wall at latch side of door with centerline of sign at 60 inches above finished floor.
   2. If no location is indicated obtain The Authority's instructions.

D. Protect from damage until Substantial Completion; repair or replace damage items.

END OF SECTION

SECTION 10 21 13.19

PLASTIC TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Solid plastic toilet compartments.

B. Urinal screens.

1.02 RELATED REQUIREMENTS

A. Section 05 50 00 - Metal Fabrications: Concealed steel support members.

B. Section 06 10 00 - Rough Carpentry: Blocking and supports.

C. Section 10 28 00 - Toilet, Bath, and Laundry Accessories.

1.03 REFERENCE STANDARDS

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

B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.05 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.

1.06 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall and floor supports, door swings.

D. Product Data: Provide data on panel construction, hardware, and accessories.

E. Samples: Submit two samples of partition panels, 6x6 inch in size illustrating panel finish, color, and sheen.

F. Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Plastic Toilet Compartments:
   1. Ampco Products, Inc: www.ampco.com.
   2. Metpar Corp: www.metpar.com.
   3. Basis of Design: Scranton Products (Santana/Comtec/Capital): www.scrantonproducts.com.

2.02 COMPONENTS

A. Toilet Compartments: Solid molded phenolic plastic panels, doors, and pilasters, floor-mounted headrail-braced.
   1. Color: As selected from Manufacturer's complete standard colors..

B. Urinal Screens: Wall mounted with continuous panel bracket, and floor-to-ceiling vertical upright consisting of pilaster anchored to floor and ceiling.

2.03 ACCESSORIES

A. Pilaster Shoes: Formed ASTM A666, Type 304 stainless steel with No. 4 finish, 3 in high, concealing floor fastenings.
   1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.

B. Head Rails: Hollow stainless steel tube, 1 x 1-5/8 inch size, with anti-grip strips and cast socket wall brackets.

C. Wall and Pilaster Brackets: Polished stainless steel.

D. Attachments, Screws, and Bolts: Stainless steel, tamper proof type.
   1. For attaching panels and pilasters to brackets: Through-bolts and nuts; tamper proof.

E. Hardware: Polished stainless steel:
   1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
   2. Door Latch: Slide type with exterior emergency access feature.
   3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
   4. Coat hook with rubber bumper; one per compartment, mounted on door.
   5. Provide door pull for outswinging doors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.

B. Verify correct spacing of and between plumbing fixtures.

C. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.

B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.

C. Attach panel brackets securely to walls using anchor devices.

D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

E. Field touch-up of scratches or damaged finish will not be permitted. Replace damaged or scratched materials with new materials.

3.03 TOLERANCES

A. Maximum Variation From True Position: 1/4 inch.

B. Maximum Variation From Plumb: 1/8 inch.

3.04 ADJUSTING

A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.

B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.

3.05 SCHEDULES

A. See drawings for locations

END OF SECTION

SECTION 10 22 26.33

FOLDING PANEL PARTITIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Acoustic operable panel partition.

B. Ceiling track, ceiling guards, and operating hardware.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood blocking and track support shimming.

B. Section 07 90 05 - Joint Sealers: Acoustical sealant.

C. Acoustic barrier placed between top of partition track and roof deck above.

D. Section 08 71 00 - Door Hardware: Lock cylinders for panels.

1.03 REFERENCE STANDARDS

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

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

C. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.

D. ASTM E413 - Classification for Rating Sound Insulation; 2010.

E. ASTM E557 - Standard Guide for The Installation of Operable Partitions; 2000 (Reapproved 2006)e1.

F. ASTM E596 - Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures; 1996 (Reapproved 2009).

G. ASTM F793 - Standard Classification of Wallcovering by Use Characteristics; 2010a.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on partition materials.

D. Shop Drawings: Indicate opening sizes, track layout, details of track and required supports, and stacking depth.

E. Samples for Selection: Submit two samples of full manufacturer's color range for selection of colors.

F. Samples for Review: Submit two samples of surface finish, 12 x 12 inches size, illustrating quality, colors selected, texture, and weight.

G. Manufacturer's Instructions: Indicate special procedures and installation sequence.

H. Certificates: Certify that partition system meets or exceeds specified acoustic requirements.

I. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods. Describe cleaning materials detrimental to finish surfaces and hardware finish.

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

C. Installer Qualifications: Company specializing in performing work of this section with minimum 3 years of experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Design is based on Modernfold; Product AcoustiSeal 942.

B. Other Acceptable Manufacturers:
   1. Hufcor, Inc: www.hufcor.com.
   2. Panelfold, Inc: www.panelfold.com.
   3. Or approved Equal.

2.02 COMPONENTS

A. Operable Panel Partition: Side opening; paired panels; side stacking; manually operated.
   1. Panel Finish: Vinyl coated fabric.
   2. Noise Reduction Coefficient (NRC): ASTM E596, NRC of 0.80 minimum.
   3. Sound Transmission Class (STC): 48-52 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90, on panel size of 100 sq ft.
   4. Surface Burning Characteristics of Panel Finish: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
   5. Installed partition system track capable of supporting imposed loads, with maximum deflection of 1/360 of span.

B. Panel Construction:
   1. Panel Substrate Facing: Steel sheet.

C. Core: 16 gage formed sheet steel frame top, bottom, jambs, and intermediates; welded construction, internally reinforced at suspension points, with acoustical insulation fill.
   1. Thickness with Finish: 3 inches.
   2. Factory applied surface finish.
   3. Hinges: Continuous piano type, 18 gage stainless steel.
   4. Panel to Panel Seals: Grooved and gasketed astragals; continuous flexible ribbed vinyl seal fitted to panel edge construction; color to match panel finish.

D. Track: Formed steel; 1-1/4 x 1-1/4 inches size; thickness and profile designed to support loads, steel sub-channel and track connectors. The manufacturer shall provide structure to carry the weight of the panels in the form of a steel beam and steel columns.The design shall be signed and sealed by a structural engineer in the State of Maryland.

E. Carriers: Nylon wheels on trolley carrier at top of every panel, sized to carry imposed loads, with threaded pendant bolt for vertical adjustment.

F. Hardware: Latching door handles of cast steel, satin chrome finish; lock cylinder keyed to building keying system; pull bars.

G. Acoustic Seals: Flexible acoustic seals at jambs, meeting mullions, ceilings, retractable floor and ceiling seals, and above track to structure acoustic seal.

H. Vinyl Coated Fabric: ASTM F793 Category VI, polyvinyl fluoride finish for washability and improved flame retardance color as selected from manufacturer's standard range.

I. Pocket Enclosures: Door, frame, and trim to match adjacent walls.

J. Pass Door: Single door, 36 inch wide x 80 inch high opening; same design and construction as panel; fit door with perimeter acoustic gaskets.

K. Acoustic Sealant: Specified in Section 07 90 05.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify track supports are laterally braced and will permit track to be level within 1/4 inch of required position and parallel to the floor surface.

C. Verify floor flatness of 1/8 inch in 10 feet, non-cumulative.

D. Verify wall plumbness of 1/8 inch in 10 feet, non-cumulative.

3.02 INSTALLATION

A. Install partition in accordance with manufacturer's instructions and ASTM E557.

B. Fit and align partition assembly and pocket doors level and plumb.

C. Lubricate moving components.

D. Apply acoustic sealant to achieve required acoustic performance.

3.03 ADJUSTING

A. Adjust partition assembly to provide smooth operation from stacked to full open position. Do not over-compress acoustic seals.

B. Visually inspect partition in full extended position for light leaks to identify a potential acoustical leak.

C. Adjust partition assembly to achieve lightproof seal.

3.04 CLEANING

A. Clean finish surfaces and partition accessories.

3.05 CLOSEOUT ACTIVITIES

A. Demonstrate operation of partition and identify potential operational problems.

END OF SECTION

SECTION 10 26 01

WALL AND CORNER GUARDS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Blocking for wall and corner guard anchors.

1.02 REFERENCE STANDARDS

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

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.

1.03 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.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.

D. Samples: Submit two sections of bumper rail, 24 inch long, illustrating component design, configuration, color and finish.

E. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Wall and Corner Guards:
   1. Arden Architectural Specialties, Inc: www.ardenarch.com.
   2. Construction Specialties, Inc: www.c-sgroup.com.
   3. InPro Corporation: www.inprocorp.com.

2.02 COMPONENTS

A. Bumper Rails: Factory- or shop-fabricated, with preformed end caps and internal and external corners:
   1. Performance of Installed Assembly:
      a. Support vertical live load of 100 lb/lineal ft with deflection not to exceed 1/50 of span between supports.

b. Resist lateral force of 250 lbs at any point without damage or permanent set.

2. Material: Polyvinyl chloride, color as selected from manufacturer's standard colors.
3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
4. Mounting: Surface.

B. Corner Guards - Surface Mounted: High impact vinyl with extruded aluminum full height retainer and integral impact absorbing device.

1. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.
2. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
3. Size: 2 inches.
4. Corner: Square.
5. Color: As selected from manufacturer's standard colors.
6. Length: One piece.
7. Preformed end caps.

2.03 FABRICATION

A. Fabricate components with tight joints, corners and seams.

B. Pre-drill holes for attachment.

C. Form end trim closure by capping and finishing smooth.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.

3.02 INSTALLATION

A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.

B. Position top of bumper rail 32 inches from finished floor.

C. Position corner guard inches above finished floor to 60 inches high.

D. Terminate rails 6 inches short of door opening.

E. Coordinate installation of vinyl fabric wall covering with corner guard frame and cover.

3.03 TOLERANCES

A. Maximum Variation From Required Height: 1/4 inch.

B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

3.04 SCHEDULE

A. Install bumper rails in break rooms as noted on drawings. Install corner guards on all outside corners in corridors and public spaces.

END OF SECTION

SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Accessories for toilet rooms, showers, and utility rooms.

B. Grab bars.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00- Rough Carpentry: Concealed supports for accessories, including in wall framing and plates.

B. Section 09 30 00 - Tiling: Ceramic washroom accessories.

C. Section 10 21 13.19 - Plastic Toilet Compartments.

1.03 REFERENCE STANDARDS

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

B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2009.

C. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip; 1999 (Reapproved 2009).

D. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2010.

E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

F. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.

G. ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium; 2003 (Reapproved 2009).

H. ASTM C1036 - Standard Specification for Flat Glass; 2006.

I. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2008.

1.04 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.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with the placement of internal wall reinforcement and reinforcement of toilet partitions to receive anchor attachments.

1.06 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on accessories describing size, finish, details of function, attachment methods.

D. Samples: Submit two samples of each accessory, illustrating color and finish.

E. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products listed are made by Bobrick.

B. Other Acceptable Manufacturers:
   1. A & J Washroom Accessories Inc: www.ajwashroom.com.
   2. American Specialties, Inc: www.americanspecialties.com.
   3. Bradley Corporation: www.bradleycorp.com.

2.02 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
   1. Grind welded joints smooth.
   2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.

B. Keys: Provide 5 keys for each accessory to The Authority; master key all lockable accessories.

C. Stainless Steel Sheet: ASTM A666, Type 304.

D. Stainless Steel Tubing: ASTM A269, Type 304 or 316.

E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating.

F. Mirror Glass: Float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

G. Adhesive: Two component epoxy type, waterproof.

H. Fasteners, Screws, and Bolts: Hot dip galvanized, tamper-proof, security type.

I. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.03 FINISHES

A. Stainless Steel: No. 4 satin brushed finish, unless otherwise noted.

B. Chrome/Nickel Plating: ASTM B456, SC 2, satin finish, unless otherwise noted.

C. Galvanizing for Items Other than Sheet: Comply with ASTM A123/A123M; galvanize ferrous metal and fastening devices.

2.04 TOILET ROOM ACCESSORIES

A. Toilet Paper Dispenser: Double roll, surface mounted bracket type, stainless steel, spindleless type for tension spring delivery designed to prevent theft of tissue roll.
   1. Attached Purse Shelf: 0.03 inch satin finished stainless steel, with rolled or formed edge at front.

B. Paper Towel Dispenser: Folded paper type, stainless steel, semi-recessed, with viewing slots on sides as refill indicator and tumbler lock.
   1. Capacity: 300 C-fold minimum.

C. Electric Hair and Hand Dryer:
   1. Basis of Design: Excel Dryer Corp, Xlerator Model XL-W:
   2. Operation: Push button.
   3. Voltage: 110 - 120 volts.
   4. Total Energy Usage: 1725 watts or less.
   5. Style: Horizontal, traditional, Surface mounted.
   6. Drying Time: Sensor Auto on/off (max 80 seconds).
   7. Air Flow: 160 cfm (274 cu m/h).
   8. Air Velocity: 5500 lfm (27.94 m/sec).
   9. Warranty: 10 years.
   10. Vandal-Resistant: Tamper-resistant screw attachment.
   11. Cover Material: Stainless steel.
   12. Mounting Height:
      a. Handicap: 45 inches (1143 mm).
   13. Manufacturers:
      a. American Dryer, Inc; DR Series: www.americandryer.com.
      b. World Dryer Corporation: www.worlddryer.com.

D. Waste Receptacle:[vinyl],
   1. Product: 3546 manufactured by Rubbermaid.

E. Soap Dispenser: Liquid soap dispenser, wall-mounted, surface, with stainless steel cover and horizontal stainless steel tank and working parts; push type soap valve, check valve, and window gage refill indicator, tumbler lock.
   1. Minimum Capacity: 46 ounces.
   2. Product: Model 9346 manufactured by Impact Products.

F. Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.
   1. Minimum capacity: 250 seat covers, each side.

G. Grab Bars: Stainless steel, 1-1/4 inches outside diameter, minimum 0.05 inch wall thickness, nonslip grasping surface finish, concealed flange mounting; 1-1/2 inches clearance between wall and inside of grab bar.
   1. Length and configuration: As indicated on drawings.

2.05 SHOWER AND TUB ACCESSORIES

A. Shower Curtain Rod: Stainless steel tube, 1 inch outside diameter, 0.04 inch wall thickness, satin-finished, with 3 inch outside diameter, minimum 0.04 inch thick satin-finished stainless steel flanges, for installation with exposed fasteners.

B. Shower Curtain:
   1. Material: Opaque vinyl, 0.008 inch thick, matte finish, with antibacterial treatment, flameproof and stain-resistant.
   2. Material: Cotton, machine washable, and mildew-resistant.

3. Size: 36 by 72 inches, hemmed edges.
4. Grommets: Stainless steel; pierced through top hem on 6 inch centers.
5. Color: White.
6. Shower curtain hooks: Chrome-plated or stainless steel spring wire designed for snap closure.

C. Folding Shower Seat: Wall-mounted recessed; welded tubular seat frame, structural support members, hinges and mechanical fasteners of Type 304 stainless steel, L-shaped, right-hand seat.
1. Seat: One-piece, pan-type, 0.05 inch stainless steel sheet, Type 304. Weld seams and grind smooth.
2. Size: ADA compliant.

D. Wall-Mounted Soap Dish: Heavy duty, seamless stainless steel, surface-mounted with drain holes, without grab bar, satin finish; with concealed mechanical fastening suitable for substrate and backplate.

E. Towel Bar: Stainless steel Type 304, 3/4 inch square tubular bar; rectangular brackets, concealed attachment, satin finish.

2.06 UTILITY ROOM ACCESSORIES

A. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, with 1/2 inch returned edges, 0.06 inch steel wall brackets.
1. Drying rod: Stainless steel, 1/4 inch diameter.
2. Hooks: 2, 0.06 inch stainless steel rag hooks at shelf front.
3. Mop/broom holders: 3 spring-loaded rubber cam holders at shelf front.
4. Length: 36 inches.
5. Length: Manufacturer's standard length for number of holders/hooks.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify exact location of accessories for installation.

C. Verify that field measurements are as indicated on drawings.

3.02 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.

B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions.

B. Install plumb and level, securely and rigidly anchored to substrate.

C. Mounting Heights and Locations: As required by accessibility regulations, as indicated on drawings, and as follows:

3.04 SCHEDULE

A. See Toilet Rooms on drawings for toilet room accessories.

B. Provide shelf/ mop broom holders in each Janitor Closet on the drawings.

END OF SECTION

SECTION 10 44 00

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire extinguishers.

B. Fire extinguisher cabinets.

C. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

B. Section 09 90 00 - Painting and Coating: Field paint finish.

1.03 REFERENCE STANDARDS

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

B. NFPA 10 - Standard for Portable Fire Extinguishers; 2010.

C. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Procurement Documents for submittal procedures.

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

C. Shop Drawings: Indicate cabinet physical dimensions.

D. Product Data: Provide extinguisher operational features.

E. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

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

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

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguishers:
1. Ansul, Inc: www.ansul.com.
2. Pyro-Chem: www.pyrochem.com.
3. Larsens Manufacturing Co: www.larsensmfg.com

B. Fire Extinguisher Cabinets and Accessories:
1. Ansul, Inc.: www.ansul.com.
2. JL Industries, Inc: www.jlindustries.com.
3. Larsen's Manufacturing Co: www.larsensmfg.com.

2.02 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.
1. Cartridge Operated: Spun shell.
2. Class: A:B:C.
3. Size: 30 pound.

2.03 FIRE EXTINGUISHER CABINETS

A. Metal: Formed primed steel sheet; 0.036 inch thick base metal.

B. Cabinet Configuration: Semi-recessed type.
1. Sized to accommodate accessories.
2. Trimless type.

C. Door: 0.036 inch thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with two butt hinge. Provide nylon catch.

D. Door Glazing: Glass, clear, 1/8 inch thick float. Set in resilient channel gasket glazing.

E. Weld, fill, and grind components smooth.

F. Finish of Cabinet Exterior Trim and Door: Red baked enamel.

G. Finish of Cabinet Interior: White enamel.

2.04 ACCESSORIES

A. Extinguisher Brackets: Formed steel, chrome-plated.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Place extinguishers and accessories in cabinets.

3.03 SCHEDULES

A. Provide cabinets in office areas and corridors.

B. Provide brackets in storage, mechanical, and electrical areas.

END OF SECTION

SECTION 10 51 00

LOCKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Locker units with hinged doors.

B. Metal tops and filler panels.

C. Locker benches.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood base construction.

B. Section 06 10 00 - Rough Carpentry: Wood blocking and nailers.

1.03 REFERENCE STANDARDS

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

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

1.04 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.

1.05 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data on locker types, sizes and accessories.

D. Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code.

E. Samples: Submit two samples 3 x 6 inches in size, of each color scheduled; applied to specified base metal.

F. Manufacturer's Installation Instructions: Indicate component installation assembly.

1.06 MOCK-UP

A. Provide mock-up of one full size locker, single tier with sloped top, in selected colors.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lockers:
   1. Basis of Design: ASI Solutions, Inc.:
   2. Penco Products, Inc: www.pencoproducts.com.
   3. Republic Storage Systems Co: www.republicstorage.com.

2.02 MATERIALS

A. Sheet Steel: ASTM A653/A653M SS Grade 33/230, with G60/Z180 coating, stretcher leveled; to the following minimum thicknesses:
   1. Body and Shelf: 24 gage, 0.024 inch.
   2. Door Outer Face: 18 gage, 0.048 inch.
   3. Door Inner Face: 20 gage, 0.036 inch.
   4. Door Frame: 16 gage, 0.060 inch.
   5. Hinges: 14 gage, 0.075 inch.
   6. Sloping Top: 20 gage, 0.036 inch.
   7. Trim: 20 gage, 0.036 inch.

B. Accessories For Each Locker: Two single prong wall hooks, coat hanger bar.

C. Locker Benches: Stationary type; bench top of laminated birch species wood, stained, sealed and varnished; pedestals of chrome steel, 16 inches high.

2.03 LOCKER UNITS

A. Width: 15 and 12 inches.

B. Depth: 15 and 12 inches.

C. Height: 72 inches.

D. Configuration: single and double tier.

E. Mounting: Surface mounted.

F. Base: Fabricate for wood base.
   1. Base Height: 4 inch.

G. Top: Sloped metal with closures.

H. Locking: Equipped for combination locks.

I. Ventilation Method: Door louvers.

J. Class: Conventional.

K. Locker Body: Formed and flanged; with steel stiffener ribs; electric spot welded.

L. Frames: Formed channel shape, welded and ground flush, welded to body, resilient gaskets and latching for quiet operation.

M. Doors: Hollow double pan, sandwich construction with acoustic insulation fill, 1-3/16 inch thick; welded construction, channel reinforced top and bottom with intermediate stiffener ribs, grind and finish edges smooth.

N. Hinges: Two for doors under 42 inches high; three for doors over 42 inches high; weld securely to locker body and door.

O. Integral Cylinder Lock: combination type, master keyed; provide four master keys.

P. Number Plates: Provide oval shaped brass plates. Form numbers 1 inch high of block font style with ADA designation, in contrasting color.

Q. Provide ventilation openings at top and bottom of each locker.

R. Form recess for operating handle and locking device.

S. Finish edges smooth without burrs.

T. Fabricate sloped metal tops, ends and closure pieces.

U. Provide perforated end panels and filler strips.

2.04 FINISHING

A. Clean, degrease, and neutralize metal; prime and finish with one coat of baked enamel.

B. Paint locker bodies and doors in contrasting colors.

C. Paint locker units 1 color, as selected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared bases are in correct position and configuration.

B. Verify bases and embedded anchors are properly sized.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install lockers plumb and square.

C. Place and secure on prepared base.

D. Secure lockers with anchor devices to suit substrate materials. Minimum Pullout Force: 100 lb.

E. Bolt adjoining locker units together to provide rigid installation.

F. Install end panels, filler panels, and sloped tops.

G. Install accessories.

H. Replace components that do not operate smoothly.

3.03 CLEANING

A. Clean locker interiors and exterior surfaces.

3.04 SCHEDULES

A. Locker Rooms: 15 inches wide, 15 inches deep, 72 inches high, single tier.

B. SOCC: 12 inches wide, 12 inches deep, 72 inches high, double tier.

END OF SECTION

SECTION 12 21 13

HORIZONTAL LOUVER BLINDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Horizontal slat louver blinds.

B. Operating hardware.

1.02 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Concealed wood blocking for attachment of headrail brackets.

1.03 REFERENCE STANDARDS

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

B. WCMA A100.1 - Safety of Corded Window Covering Products; Window Covering Manufacturers Association; 2010. (ANSI/WCMA A101.1)

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

C. Product Data: Provide data indicating physical and dimensional characteristics.

D. Samples: Submit two samples, 6 inch long illustrating slat materials and finish, color, cord type and color.

E. Manufacturer's Installation Instructions: Indicate special procedures.

F. Maintenance Materials: Furnish the following for The Authority's use in maintenance of project.

1.05 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. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Horizontal Louver Blinds:
   1. Hunter Douglas: www.hunterdouglas.com.
   2. Levolor Contract: www.levolorcontract.com.
   3. Graber, division of Springs Window Fashions: www.graberblinds.com.

2.02 BLINDS AND BLIND COMPONENTS

A. Blinds: Horizontal slat louvers hung from full-width headrail with full-width bottom rail; manual control of raising and lowering by cord with full range locking; blade angle adjustable by control wand; complying with WCMA A100.1.

B. Metal Slats: Spring tempered pre-finished aluminum; radiused slat corners, with manufacturing burrs removed.
   1. Width: 1 inch.
   2. Color: As selected.

C. Slat Support: Woven polypropylene cord, ladder configuration.

D. Head Rail: Pre-finished, formed aluminum box, with end caps; internally fitted with hardware, pulleys, and bearings for operation; same depth as width of slats

E. Bottom Rail: Pre-finished, formed PVC with top side shaped to match slat curvature; with end caps. Color: Same as headrail.

F. Lift Cord: Braided nylon; continuous loop. Provide lift cords long enough to be operated from the ground if windows are high.

G. Control Wand: Extruded hollow plastic; hexagonal shape.
   1. Removable type. Provide wands long enough to be operated from the ground if windows are high.

H. Headrail Attachment: Wall brackets.

I. Accessory Hardware: Type recommended by blind manufacturer.

2.03 FABRICATION

A. Determine sizes by field measurement.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings are ready to receive the work.

3.02 INSTALLATION

A. Install blinds in accordance with manufacturer's instructions.

B. Secure in place with flush countersunk fasteners.

3.03 INSTALLATION TOLERANCES

A. Maximum Variation of Gap at Window Opening Perimeter: 1/4 inch.

B. Maximum Offset From Level: 1/8 inch.

3.04 ADJUSTING

A. Adjust blinds for smooth operation.

3.05 CLEANING

A. Clean blind surfaces just prior to occupancy.

3.06 SCHEDULE

A. All Windows, interior and exterior..

END OF SECTION

SECTION 12 59 00

SYSTEMS FURNITURE

PART 1- GENERAL:

1.01 SUMMARY

A. Section Includes:
1. 10' x 12' Workstation
2. 13' x 16' Workstation
3. Miscellaneous cabinets and work surfaces

1.02 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

B. Product Data: For each furniture item specified, including details of construction relative to materials, dimensions, and finishes.

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

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver items in manufacturer's original unopened packaging.

B. Store materials in original protective packaging to prevent soiling, physical damage, or wetting.

C. Handle so as to prevent damage to finished material.

D. Maintain protective covers on all items until installation is complete.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Products, General: To establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other manufacturers, a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation. Subject to compliance with requirements, provide either the named products or equal products.

2.02 BASIS-OF-DESIGN PRODUCT:

A. Knoll Furniture, Inc, Reff Series: Provide modular work stations, in nominal sizes, as indicated on drawings. Provide panels with raceway bases to allow for routing of computer, telephone, and electrical systems. Provide wire management ports on all work surfaces with multi-outlet, pop-up receptacles. Provide one adjustable pull-out computer keyboard drawer at each corner work surface. General work station components are as follows:

2.03 COMPONENTS:

A. Panels:
The modular panel will be composed of de-mountable panels, which fasten together with a continuous connector. Every fabric panel surface shall be tackable and acoustical.

The panel system must be able to accept stacking modules. Panels to be constructed of a hollow, aluminum frame.

1. Frame to be bolted together at each corner and painted black.
2. Panel bases will consist of leveler hardware with 1 1/2'' of adjustment.
3. Base side plates to be at least 22-gauge steel.
4. Panel widths including the fabric outer surface shall be no greater than 2 1/2'' thick. Panels are 64'' high. Widths shall be provided in 6'' increments from 18'' wide to 48'' wide.
5. The standard tackable acoustical panel must meet a minimum NRC rating of .65 and a STC rating of 13. Standard high acoustical ratings shall be available with a NRC rating of 0.80 and an STC rating of 22.
6. The panel skins must be replaceable in the field.
7. All panels require side plate covers with replaceable knock out cover plates for data and electrical.
8. Panel raceway covers should be available with painted or plated finishes.
9. All panel raceway covers require connection with a spring tab to prevent covers from easily coming off.
10. All panel seams shall contain a cover reveal strip to cover the connection hardware and/or slotted channel.
11. All posts should have an appearance relative to the adjoining panel.
12. Posts will have a wood finish.
13. The underside of the top trim shall contain a continuous PVC extrusion that is friction fit.
14. Panel top trim will be constructed of medium density fiberboard with a veneered surface. Panel reconfigurations will occur without removing panel skins.

B. Work surfaces:

1. Work surfaces to be 24'' deep
2. Work surfaces to be available in 13 widths from 24'' to 96''
3. The underside of the work surface to be pre-drilled with threaded, metal inserts for metal-to-metal connection for cantilevers and under work surface storage units.
4. Work surfaces to be pre-drilled for panel mount hardware and /or freestanding hardware
5. Two work surface thickness' to be available-1 1/4'' and 1 3/4.''
6. Grommets will be a standard work surface option in painted or plated finishes.
7. Work surfaces will be finished in laminates with a wood edge. Laminate work surfaces with a wood edge will have wood finished on all four sides.
8. Work surfaces must be finished and sealed on all six sides.
9. 5 Ply, 1 3/4'' thick work surface construction is particle board perimeter frame surrounding a vertical honeycomb core (capable of withstanding 70lbs. per square inch) covered by particle board substrates with laminate or veneer surface and gator ply laminate backer sheet applied to the underside.

C. Work surface Hardware

1. All exposed work surface support hardware requires paint finish options to match the work surface laminates.
2. Cantilever supports require an access hole for wire management.

D. End Panels

1. All end panels require a black leveler glides with 1 1/2'' of height adjustment.
2. Particle board construction 45 lbs./CF construction covered on veneer or laminate on all six sides.
3. Veneer parts will be stained with a polyurethane finish on all six sides.
4. All end panels will come with support hardware to attach to work surfaces in a freestanding application.
5. End panels shall be non-handed.

E. Pedestals and Cabinets

1. Cabinets must be finished with veneer on all sides available in three heights - 49'', 64'' and 72'' high, three widths- 16'', 30'' and 36'' wide and three depths-20'', 24'' and 30'' wide. Styles available for wardrobe cabinets, hinged doors open shelves file drawers and audiovisual types available. Veneer cabinets must be stained and a polyur shall be applied on all six sides.
2. Pedestal depth must be 23'' deep.
3. All drawers must have an option of wood dovetailed, five sided drawers or optional metal interior drawers on pedestals and cabinets.
4. Wood drawer interior construction is no less than a 4-sided 5 ply wood box, oak veneered and finished inside and out. All corners are dovetailed for superior fit.
5. All file drawers will be equipped for letter or legal filing.
6. Box drawers have 3/4 suspension and ball bearing slides.
7. Full extension steel, ball bearing slides are provided which will accept a filing load more than 125lbs.
8. Metal drawer interior will include one pencil tray.
9. Metal drawer interior constructed should be no less than 22-gauge CRCQ steel painted black.
10. The metal drawer interior of lateral file construction should be no less than 20-gauge CRCQ steel painted black.
11. Freestanding pedestals must be equipped with four leveler glides constructed of galvanized steel. To allow up to 1 1/2'' of height adjustment. Levelers are accessible from the inside of the pedestal.
12. All pedestals are available with finished backs.
13. All pedestals may replace end panels in a freestanding application.
14. Pedestals to be non handed
15. Shelves in pedestals are 1 1/16'' thick and are to be finished on all six sides.
16. Drawer and drawer fronts are no less than 15/16'' thick.
17. 16'' wide box and file drawers have an interior drawer width of no less than12.''

F. Overhead Storage

1. Panel mounted overhead storage should be available in eight widths from 30'' wide to 96'' wide.
2. Panel mount overhead storage to be constructed of no less than 45 lb. density particleboard with laminate or veneer surface substrates.
3. Storage options to include-flipper doors, hinged doors, shelves without side gables, shelves with side gables.
4. Support structure should be at least 14-gauge steel construction.
5. Metal-to-metal fasteners will be used to connect support hardware to panel brackets.
6. Panel brackets to have a spring lock to prevent disengagement from the panel.
7. Flipper door mechanism must contain ball bearing slides and rubber wheels.
8. Overheads over 48'' wide must contain a center support.
9. Metal-to-metal fasteners must be used to connect support hardware to panel brackets.
10. All sides of overheads must be finished in veneer or laminate.
11. All overhead storage will have the option of mounting a tasklight.
12. The tasklight will be recessed under the overhead.
13. Tasklights will have the ability to be retrofitted in the field.
14. Tasklights will be available as standard and high efficiency models.
15. Dividers will be available as an option to retrofit on the inside of overheads.
16. Overheads must be able to be panel mounted on 1'' increments, panel-up-mounted and freestanding desk mounted.
17. Overheads will be capable of spanning more than one panel.

G. Electrical

1. Power is distributed through the base raceway and beltway of Reff panels. The raceway will accommodate data and communications cables either simultaneously or separately.

The raceway is self-shielded and provides separation of data cables from electrical wiring.

2. Two electrical systems will be available:
   a. 2 + 2, four circuit, 8-wire
   b. 3 + 3, six circuit, 10-wire
3. All electrical systems consist of modular components which are field installed and non-directional. The base raceway is a 22-gauge steel “box” design which allows power and communications to be accessed on either or both sides of the panel.
4. Base raceways will be 6" (6-1/8") in height.
5. All panels will provide pass-through electrical and communications. Panels 24" and wider will accept receptacles and in-feeds. Depending upon width, panels can accept one to four outlets per panel side. In 6" raceway covers, outer knockouts are for data modules. 18" and 20" wide panels have knockouts for data modules only.
6. The hardwire connector for power entry into the panel system must be performed by a certified electrician.
7. Power connectors and jumpers carry power from power rail to power rail. Connectors are used to connect power rails in adjacent panels while jumpers pass the power through the raceways of panels that do not require power access to the next available power rail. Power Connectors and Jumpers will be provided in 8-wire and 10-wire configurations. All power connectors and jumpers are enclosed in steel flexible conduit in compliance with local electrical codes.

H. Communications

1. Data and communications cables are routed through the base and beltway raceways of panels. Cable Capacity shall be as follows:
   a. 6" high raceway: 40 (25-pair) 3/8" cables or 120 Category 5 cables.
2. When panels are electrified, communications cables are routed in the raceway cable tray. Access is provided by communications modules which install in the data position in 6" raceways. Modules can also be installed in the outlet positions in panels that are non-electrified or with pass-through cables.
3. Data and communications will enter raceways from the floor level. Power poles are not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Verify that materials are those specified before installing.

B. Install furniture after other finishing operations, including painting, have been completed.

C. Install furniture in scheduled locations.

D. Install furniture coordinated with the electrical utility requirements.

E. Clean and polish exposed surfaces, using materials and methods recommended by the manufacturer.

3.02 PROTECTION

A. Protect furniture against damage during remainder of construction period, complying with manufacturer's directions.

END OF SECTION

SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 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.

1.02 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):
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
3. ASME B16.25 - Buttwelding Ends.
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.
7. ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
8. ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

C. ASTM International (ASTM):
1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
3. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
4. ASTM A795 - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

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

E. American Water Works Association (AWWA):
   1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
   2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

F. National Fire Protection Association: (NFPA)
   1. NFPA 13 - Installation of Sprinkler Systems.
   2. NFPA 14 - Standard for the Installation of Standpipe, Private Hydrants and Hose Systems.
   3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.

1.03 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.

1.04 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.

1.05 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.

F. Maintain one copy of each document on site.

1.06 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.

1.07 PRE-INSTALLATION MEETINGS

A. Pre Installation Meetings: Refer to Contract Documents.

1.08 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

1.09 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

2.01 VALVES

A. Manufacturers:
   1. Conbraco Industries
   2. Nibco.
   3. Stockham
   4. Substitutions: Refer to Contract Documents.

B. Gate Valves:
   1. Over 2 inches: Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, hand wheel, OS&Y, solid, rubber covered bronze or cast iron wedge, flanged or grooved ends.
   2. Over 4 inches: Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, iron body indicator post assembly.

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

D. Butterfly Valves:
   1. Cast or Ductile Iron Body: Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends. With extended neck, hand wheel and gear drive and integral indicating device, and external tamper switch rated 10 amp at 115 volt AC.

E. Check Valves:
   1. Over 2 inches: Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends with automatic ball check.
   2. 4 inches and over: Iron body, bronze disc with stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

F. 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.

2.02 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.
   1. Steel Fittings: ASME B16.9, wrought steel, butt welded; ASME B16.25, butt weld ends; ASME B16.5, steel flanges and fittings; ASME B16.11, forged steel socket welded and threaded.
   2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings; ASME B16.4, threaded fittings.
   3. Malleable Iron Fittings: ASME B16.3, threaded fittings ASTM 47.
   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.

2.03 PIPE HANGERS AND SUPPORTS

A. Conform to NFPA 13.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

E. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

F. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.

G. Vertical Support: Steel riser clamp.

H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

PART 3 EXECUTION

3.01 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.

3.02 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 91 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. Refer to Section 09 91 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 gate, ball, or butterfly 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.

3.03 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.

3.04 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.

3.05 TESTING

A. Perform all testing in accordance with NFPA 13

END OF SECTION

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes wet-pipe sprinkler system, system design, installation, and certification.

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.
3. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
4. Section 26 05 00 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.02 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. NFPA 13 - Installation of Sprinkler Systems.

1.03 SYSTEM DESCRIPTION

A. System to provide coverage for the entire building.

B. Provide hydraulically designed system to NFPA 13 ordinary hazard, Group 2 occupancy requirements.

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

D. Interface system with building control system.

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

1.04 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.

1.05 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.

1.06 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.

1.07 QUALIFICATIONS

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

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

C. Design system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Maryland.

1.08 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting: Refer to Contract Documents.

1.09 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.

1.10 WARRANTY

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

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.

1.12 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

2.01 SPRINKLERS

A. Manufacturers:
   1. Tyco Fire Systems.
   2. Grinnell Corp.

B. Suspended Ceiling Type:
   1. Type: Recessed pendant type with matching escutcheon plate.
   2. Finish: Chrome plated.
   3. Escutcheon Plate Finish: Chrome plated
   4. Fusible Link: Fusible solder link type or Glass bulb type temperature rated for specific area hazard.

C. 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.

D. Side wall Type:
   1. Type: Recessed horizontal side wall type with matching escutcheon plate.
   2. Finish: Chrome plated.
   3. Escutcheon Plate Finish: Chrome plated.
   4. Fusible Link: Fusible-solder link type or Glass bulb type temperature rated for specific area hazard.

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

F. Reserve Sprinkler Cabinet: Cabinet construction shall conform to NFPA requirements and shall have storage capacity in accordance with NFPA No. 13 for storing spare sprinkler heads of each type installed plus a sprinkler head wrench.

G. 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

2.02 ALARM VALVE STATION

A. Acceptable Manufacturers
   1. Tyco Fire Systems
   2. ITT Grinnell

3. Viking Corporation

B. An assembly of equipment and devices incorporating a main clapper type check valve and trim with accessories. Valve designed for operation on a variable pressure operation water supply and for horizontal or vertical installation with flanged or groove inlet and outlet; Model J-1.

C. Alarm Check Valve: Designed for 250 psi. water working pressure. Ductile iron body with bolted hand-hole, Teflon coated hot rolled steel clapper with stainless steel accessories and EPDM rubber face. Valve housing tapped for inlet and outlet pressure gauges, alarm devices and main system drain.

D. Alarm Check Valve Trim: All trim components listed for 250 psi working pressure. All piping ¾-inch or less not provided shall be galvanized steel. Provide manufacturers standard trim package including the following:
1. Inlet and outlet pressure gauges with drain ports
2. Alarm shut-off valve
3. Alarm test valve
4. Drain valve
5. All necessary piping, pipe nipples and fittings

E. Retard Chamber: Ductile iron body, cast iron bushings, painted red. Designed to compensate for variable water pressure surges or water hammer; Model C-1

F. Water Motor Gong (Alarm Portion of Alarm Valve Assembly): UL listed, FM approved, rated to 175 psi water working pressure. System shall include water motor alarm with inlet and outlet tapping, drive shaft, inlet strainer, closure plate and red painted exterior gong; Model F-1

G. Alarm Pressure Switch (Provide at the Alarm Valve Retard Chamber): UL listed, FM approved, adjustable between 4 and 20 psi, NEMA-4 rated, die-cast cover with red finish. Switch shall provide a signal to the fire alarm panel when the sprinkler system activates. Dual (SPDT) snap action switches, maximum system minimum service pressure rating of 250 psi, tamper resistant, ½-inch NPT male pressure connection; Model Alarm Pressure Switch

2.03 PIPING SPECIALTIES

A. Acceptable Manufacturers (Water Flow Switch):
1. Potter Electric Signal Co.
2. ITT Grinnell Corporation
3. Guardian Fire Equipment, Inc

B. Water Flow Switch: UL Listed, FM Approved; Tamper proof cover and collar, vane type switch for mounting horizontal or vertical, two single pole, double throw micro-switches; rated 10 amp at 120 volt AC and 2.5 amp at 24 volt DC.

C. Acceptable Manufacturers (Tamper Switches):
1. Potter Electric Signal Co.; Figure 6220
2. ITT Grinnell Corporation

3. Guardian Fire Equipment, Inc

D. Tamper Switches: UL listed, FM approved, red baked enamel cover, j-bolt mounting, two single-pole double-throw micro-switches, 120 volts. Coordinate Electrical Contractor. Use with OS&Y valves.

E. Acceptable Manufacturers (Swing Check Valve):
1. Viking Corporation; Model D-1
2. ITT Grinnell Corporation.
3. Stockham

F. Swing Check Valve (At Siamese Fitting): Ductile iron with EPDM rubber faced, Teflon coated steel clapper; UL Listed and FM Approved, 250 pound cold water working pressure designed for vertical or horizontal installation, grounded or flanged inlet and outlet.

G. Acceptable Manufacturers (Ball Drip)
1. Guardian Fire Equipment, Inc; Model 6432
2. American Fire Protection, Inc
3. Viking

H. Ball Drip: Cast brass body, brass ball, threaded connections, 3/4” x 3/4",

2.04 BACKFLOW PREVENTER

A. Acceptable Manufacturers:
1. Conbraco Industries; Model RP4A
2. Watts Regulator Company
3. Zurn-Wilkins
4. Substitutions: Refer to Contract Documents.

B. Backflow Preventer (Fire Protection): ASSE Standard 1015; Double check valve, 304 Stainless steel housing with grooved end connections, independent tri-link check modules with common housing, reversible elastomer discs, UL/FM grooved gear operated butterfly valves with tamper switch, suitable for continuous operating pressure of 175 psi and operating temperatures between 33° F. and 140° F. and inlet strainer.

2.05 FIRE DEPARTMENT CONNECTIONS:

A. Acceptable Manufacturers:
1. Guardian Fire Equipment, Inc.; Series 6000
2. Elkhart Brass Manufacturing Co., Inc.
3. Potter Roemer.

B. Flush Design: UL/FM; Wall type with brass finish, 250 gpm flow rate per each 2 1/2” inlet, two-way with fire department thread size, threaded dust-cap and chain of matching material and finish, drain: 3/4 inch automatic drip, connected to drain.

C. Identification: "Sprinkler - Fire Department Connection"; brass construction with brass finish

PART 3 EXECUTION

3.01 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.

3.02 INTERFACE WITH OTHER PRODUCTS

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

3.03 CLEANING

A. Cleaning Requirements: Refer to Contract Documents.

B. Flush entire piping system of foreign matter, in accordance with NFPA 13.

3.04 TESTING

A. Test entire system in accordance with NFPA.

3.05 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.

END OF SECTION

SECTION 21 13 16

DRY-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes dry-pipe sprinkler system, system design, installation, and certification.

B. Related Sections:
   1. Section 21 05 13 - Common Motor Requirements for Fire-Suppression Equipment: Product requirements for motors for placement by this section.
   2. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product requirements for vibration isolators for placement by this section.
   3. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.2 REFERENCES

A. National Fire Protection Association:
   1. NFPA 13 - Installation of Sprinkler Systems.

1.3 SYSTEM DESCRIPTION

A. System to provide coverage building areas noted.

B. Provide hydraulically designed system to NFPA 13 light hazard occupancy requirements.

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

D. Interface system with building fire control system. Provide fire department connections as indicated on Drawings.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. 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.

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

D. Design Data: Submit design calculations.

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

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

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.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 13 and the requirements of jurisdiction having authority.

B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

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

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

C. Design system under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Store products in shipping containers until installation.

C. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

1.11 EXTRA MATERIALS

A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

B. Furnish extra sprinklers under provisions of NFPA 13.

C. Furnish suitable wrenches for each sprinkler type.

D. Furnish metal storage cabinet adjacent to alarm valve.

PART 2 PRODUCTS

2.1 SPRINKLERS

A. Manufacturers:
   1. Tyco Fire Systems
   2. Grinnell Corp
   3. Substitutions: Section 01 60 00 - Product Requirements.

B. Suspended Ceiling Type:
   1. Type: Recessed pendant type with matching escutcheon plate.
   2. Finish: Chrome plated.
   3. Escutcheon Plate Finish: Chrome plated.
   4. Fusible Link: Fusible-solder link type or Glass bulb type temperature rated for specific area hazard.

C. 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.

2.2 PIPING SPECIALTIES

A. Dry Pipe Sprinkler Alarm Valve: UL Listed, FM Approved; Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, accelerator, and test and drain.

B. Water Motor Alarm: UL Listed, FM Approved; Hydraulically operated impeller type alarm with aluminum alloy red enameled gong and motor housing, nylon bearings, and inlet strainer.

C. Water Flow Switch: UL Listed, FM Approved; Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

2.3 AIR COMPRESSOR

A. Manufacturers:
   1. Tyco Fire Systems
   2. Grinnell Corp
   3. Substitutions: Section 01 60 00 - Product Requirements

B. Compressor: Single unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloading valve.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 13

B. Install outside alarm-gong on building wall.

C. Install piping to minimize obstruction with other work.

D. Install piping in concealed spaces above finished ceilings.

E. Center sprinklers in two directions in ceiling tile and install piping offsets.] [one direction only in ceiling tile with location in other direction variable, dependent upon spacing and coordination with ceiling elements.

F. Install air compressor on vibration isolators. Refer to Section 21 05 48.

G. Hydrostatically test entire system.

H. Require test be witnessed by Fire Marshall, Authority having jurisdiction and Owner's insurance underwriter.

3.2 INTERFACE WITH OTHER PRODUCTS

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

3.3 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements : Final cleaning.

B. Flush entire piping system of foreign matter.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

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

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. Related Documents
   1. Drawings and general provisions of the Contract, including special provisions, apply to this Section.

B. Section includes materials and methods common to other Sections of this Division:
   1. Formed steel channel.
   2. Dielectric Fittings
   3. Flexible Connectors
   4. Sleeves and Seals
   5. Cutting and Patching
   6. Welding Procedures
   7. Firestopping
   8. Access Doors
   9. Joint Sealants
   10. Field Painting
   11. Motors

C. Related Sections:
   1. Section 03 30 00 – Cast In Place Concrete.
   2. Section 05 50 00 – Metal Fabrications
   3. Division 06 – Wood and Plastics
   4. Section 07 84 00 – Firestopping
   5. Section 08 31 00 – Access Doors and Panels
   6. Section 09 91 00 - Painting
   7. Division 22 – Plumbing Sections As Included
   8. Division 26 – Electrical Sections As Included

1.02 REFERENCES

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

B. 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. Use latest edition of publication.

C. American National Standards Institute (ANSI):
   1. ANSI/ASME B31; Code for Pressure Piping.

2. A 13.1 Scheme for the Identification of Piping Systems.
3. B 31; Code for Pressure Piping.

D. American Society of Mechanical Engineers (ASME):
1. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

E. American Welding Society (AWS):
1. Soldering Manual. 2nd ed. 1977.
2. Brazing Manual. 4th ed. 1991.
3. A 5.8 Specifications for Filler Metals for Brazing.
4. D 1.1 Structural Welding Code for Steel.

F. National Electric Manufacturer's Association (NEMA) Standards as apply to specified products.
1. NEMA MG1; Motors and Generators.

G. Steel Structures Painting Council (SSPC):

1.03 SUBMITTALS

A. Submittals Procedures: Refer to Contract Documents.

B. Certificates: Buy America Act Certification

C. General: Submit the following according to the General Provisions and Contract Documents. Submit in sufficient detail to show full compliance with Contract Documents.

D. 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. Include material and equipment specifications, sizes, types, dimensions, weights, rated capacities, and performance tables or performance curves.
5. Include utility requirements for wiring, piping, and service connection data, motor sizes complete with electrical characteristics.

E. Shop Drawings: Submit shop drawings where required under other individual Sections of this Division
1. Include dimensional data for rough in and installation instructions.
2. Indicate typical layout including dimensions and utility connections.
3. Submit Fabrication Drawings for construction and connections to equipment.
4. Submit drawings showing field measured conditions.
5. Shop drawings detailing fabrication and installation for equipment pads, metal and wood supports and anchorage for materials and equipment.
6. Coordination drawings for access panel and door locations.

7. Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

F. Samples:
   1. Submit samples where required under other individual Sections of this Division.

1.04 CLOSEOUT SUBMITTALS:

A. Close-out Procedures: Refer to Contract Documents.

B. Record Documents
   1. Record installed locations and position of systems, components, and accessories.
   2. Maintain and update documents on a daily basis.
   3. Provide electronic files of Record Documents in addition to Printed copies.

C. Operation and Maintenance Manuals: Submit operation and maintenance manuals for each of the following items of equipment or systems.
   1. Water Heaters
   2. Pumps, Accessories, and Specialties
   3. Valves
   4. Backflow Preventer
   5. Floor Drains
   6. Plumbing Fixtures
   7. Faucets
   8. Flush Valves

D. Include the following elements in each O & M manual:
   1. Erection or installation instructions.
   2. Start-up procedures.
   3. Recommended and alternative operating procedures.
   4. Schedule of preventive maintenance requirements.
   5. Schedule of recommended spare parts to be stocked, complete with part number, inventory quantity, and ordering information.
   6. Detailed maintenance procedures.
   7. Schedule of lubrication requirements.
   8. Corrected and approved control and wiring diagrams.
   9. Data sheet listing pertinent equipment or system information, as well as the addresses and telephone numbers of the nearest sales and service representatives.

E. Submit Operation and Maintenance Manuals by complete system.

1.05 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. Requirements of Regulatory Agencies: Comply with construction requirements of State, County, and such other local political subdivision's specifications as may exceed the requirements of the codes, standards, and approving bodies referenced herein.

1. Perform Work in accordance with State of Maryland standard.
2. Perform Work in accordance with International Building Code.
3. Perform Work in accordance with International Plumbing Code.

D. Qualify welding processes and operators for structural steel according to AWS D1.1.

E. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX.

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.
3. Provide certified pipe welder(s) capable of welding in accordance with ASME B31. Submit proof of certification when requested.

F. All equipment or apparatus of any one system must be the product of one manufacturer or equivalent products of a number of manufacturers which are suitable for use in a unified or assembled system.

G. Comply with requirements of the National Fire Protection Association (NFPA) Standards referenced in the various Specifications Sections, and as directly appropriate to the work and workmanship.

H. Comply with requirements for both the Underwriters' Laboratories, Inc. (UL) Listings, Labels, and Approvals and the National Electrical Manufacturers' Associations (NEMA) Stamps or Seals as applicable to electrical equipment or apparatus forming parts of the Mechanical Equipment.

I. Certificates and Permits: Upon completion of work, and prior to final payment, furnish to the A/E formal certification of final inspections from authorities having jurisdiction and secure required permits, if any, from such authorities. Additionally, prepare detailed diagrams and drawings, which may be required by those authorities having jurisdiction.

1. Source Quality Control: Products used throughout these specifications, and as indicated on the Drawings, are those of companies having established reputations in the manufacture of the particular materials, equipment, or apparatus specified. Such products may be of their own

make, or products of others for which they assume full responsibility when used in said assemblies (which are not manufactured completely by them), and with replacement parts available.

1.06 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. Provide: Furnish and install.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and equipment to the project site in a clean condition with openings plugged or capped (or otherwise sealed by packaging) both during shipping and during temporary storage.

B. Delivered equipment crating and/or packaging shall clearly identify pick-points or lift-points. In the absence of crating or packaging, pick-points or lift-points must be identified on the equipment.

C. When unloading materials and equipment provide special lifting harness or apparatus as may be required by manufacturers. Handle materials and equipment in accordance with manufacturer's written instructions.

D. The Contractor shall determine the required equipment needed for unloading operations and have such equipment on site to perform unloading work on the date of equipment delivery.

E. Store materials and equipment, both on and off site, in accordance with manufacturer's written instructions.

1.08 DRAWING INTERPRETATION AND COORDINATION

A. Mechanical Drawings are diagrammatic and indicate the general arrangement of systems and equipment, unless indicated otherwise by dimensions or Detail Drawings.

B. Plans are intended to show size, capacity, approximate location, direction, and general relationship of one work phase to another, but not the exact detail or arrangement.

C. For locations of building elements, refer to dimensioned Architectural and Structural Drawings and perform field measurements to verify exact locations.

D. Equipment outlines shown on Detail Drawings, or dimensions indicated anywhere on the Drawings, are limiting dimensions. Equipment exceeding approximate dimensions indicated by equipment outlines on Detail Drawings and any equipment or arrangements that reduce indicated clearances or exceed specific equipment dimensions may not be used.

E. Electrical Service Devices:
   1. Provide starters, fused disconnect switches or combination starter fusible disconnect switch types as required for motors and equipment and of this Division of the Specifications. Correct sizing of starters and disconnect switches shall be the joint responsibility of the Contractor and the equipment or apparatus manufacturer.
   2. Motor starters shall be minimum NEMA Size 1. Electrical enclosures to be NEMA 12 for indoor units and NEMA 4 for outdoor units unless otherwise indicated on the Drawings.
   3. Starters shall be complete with two sets of auxiliary contacts; one set normally open; one set normally closed.
   4. For motors 25 HP or greater, provide autotransformer type reduced voltage starters.
   5. Motor starters and disconnect switches shall be located as indicated on the Drawings.

1.09 MATERIALS, EQUIPMENT AND WORKMANSHIP

A. Install equipment in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment. Obtain these instructions from the manufacturer and such instructions shall be considered a part of these Specifications. Type, capacity, and application of equipment shall be suitable and capable of satisfactory operation.

B. All equipment or apparatus of any one system must be the product of one manufacturer or equivalent products of a number of manufacturers which are suitable for use in a unified or assembled system.

1.10 WARRANTY

A. Extended Warranties: See individual Sections for extended Warranties.

B. Submit manufacturer's warranty and verify that forms are completed in Owner's name and registered with manufacturer.

C. Date warranties to date of Substantial Completion for Project.

D. Correct defective Work within a one year period after Date of Substantial Completion.

1.11 MAINTENANCE

A. Maintenance Service:
   1. Provide service and maintenance for one year from date of Substantial Completion, except where longer service is indicated in individual sections.

PART 2 PRODUCTS

2.01 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.

2.02 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: 18 gage thick galvanized steel.

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

C. Sealant: Acrylic; refer to Section 07 92 00.

2.03 MECHANICAL SLEEVE SEALS

A. Manufacturers:
   1. Thunderline Link-Seal, Inc.
   2. NMP Corporation
   3. Substitutions: Refer to Contract Documents.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.04 FORMED STEEL CHANNEL

A. Manufacturers:
   1. Unistrut Corp.
   2. B-Line Systems.
   3. Allied Tube & Conduit Corp.

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

2.05 CONCRETE

A. Refer to Section 03 30 00 – Cast In Place Concrete.

B. Concrete work for plumbing installations is specified in Section 03 30 00. Provide dimensional drawings, templates, anchor bolts and accessories required for mounting and anchoring equipment.

2.06 GROUT:

A. Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B.
   1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory-packaged.

2.07 ACCESS DOORS

A. Refer to Section 08 31 00.

B. Provide access doors for maintenance or adjustments purposes for all plumbing system components including valves, clean outs and traps, and controls.

C. Unless indicated otherwise, access doors to match surrounding surface, provided with recess to accept matching finish. Provide UL rated doors in fire rated construction.

D. Provide flush type steel framed panel with concealed hinges, size minimum 12 x 12 inch for inspection and hand access, and minimum 18 x 18 inch for man access.

E. Provide cam type locking device with hand or key lock when located in public corridors and washrooms complete with master keys.

2.08 PIPE AND PIPE FITTINGS:

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

2.09 JOINING MATERIALS:

A. Refer to individual piping system specification Sections in Division 22 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, except where thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
   2. ASME B16.20 for grooved, ring-joint, steel flanges.
   3. AWWA C110, rubber, flat face, 1/8 inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Solder Filler Metal: ASTM B 32.
   1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.
   2. Alloy HB: Tin-antimony-silver-copper-nickel, having 0.10 percent maximum lead content.
   3. Alloy Sb5: Tin (95 percent) and antimony (5 percent), having 0.20 percent maximum lead content.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end pressure pipes.
   1. Sleeve: ASTM A 126, Class B, gray iron.
   2. Followers: ASTM A 47, Grade 32510 or ASTM A 536 ductile iron.
   3. Gaskets: Rubber.
   4. Bolts and Nuts: AWWA C111.

5. Finish: Enamel paint.

2.10 PIPING SPECIALTIES:

A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.
   1. Inside Diameter: Closely fit around pipe, tube, and insulation.
   2. Outside Diameter: Completely cover opening.
   3. Cast Brass: Split casting, with concealed hinge and set-screw.
   4. Finish: Polished chrome plate.
   5. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.

2.11 FIRESTOPPING

A. Refer to Section 07 84 00 – Firestopping.

B. Provide firestopping against the spread of fire, smoke and gases where penetrations occur for piping and ductwork.

2.12 FLASHING

A. Flash and counter flash where mechanical equipment passes through exterior or waterproofed walls, floors, and roofs.

B. Flash pipes projecting 12 inch minimum above finished roof surface with flashing worked 1 inch minimum into hub, 8 inch minimum clear on sides with minimum 24 x 24 inch sheet size. For pipes through outside walls turn flange back into wall and caulk.

C. Provide curbs for mechanical roof installations 12 inch minimum high. Flash and counter flash with galvanized steel, soldered and made waterproof.

2.13 PAINTING

A. Shop Paint: For primer coats provide only those primers that are compatible with field coats specified in Section 09 91 00.

2.14 MOTORS

A. Provide energy efficient motors of sufficient capacity to operate the equipment under all conditions of operations without loading beyond the nameplate current or power.

B. In no case are the motors offered to be less than the horsepower specified except when it can be demonstrated that because the efficiency of the driven equipment is greater than that specified, a lesser horsepower will suffice.

C. Provide motors one-half horsepower and larger designed to operate on 460 volt, three phase, 60 Hertz current unless indicated otherwise or specified otherwise.

D. Provide motors smaller than one-half horsepower designed to operate on 120 volt, single phase, 60-Hertz current unless otherwise specified.

E. Motors of drip proof, ball bearing type unless otherwise specified.

F. Provide motors designed to operate in an ambient temperature of 40 degrees C. in continuous operation with a service factor of 1.15.

G. Explosion proof motors shall comply with requirements of Class I, Division I, Group D, Hazardous Locations, as defined by the National Electrical Code.

H. Provide totally enclosed fan cooled motors where motors are located outdoors.

I. When integral horsepower, poly-phase squirrel-cage induction type motors are provided, their design shall incorporate high efficiency, high power factor features and be certified by the manufacturer as having been tested in accordance with the latest edition or revision of NEMA standard MG1-12.53b (IEEE Standard 112, Test Method B).

J. Motor Connections:
   1. Use lugged connections on motors 10 HP and larger. Wire nuts are not acceptable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Refer to equipment specifications in other Sections for roughing-in requirements.

3.02 INSTALLATION

A. General Requirements: Install equipment, components, and materials at locations indicated on the Drawings and in accordance with manufacturer's instructions. Refer to Contract Documents.

3.03 EQUIPMENT INSTALLATION--COMMON REQUIREMENTS:

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the CM.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Perform required interconnection of plumbing systems to other mechanical and electrical equipment, devices, or apparatus, regardless of where such Products are specified, in order to ensure the completeness of such mechanical systems.

E. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

F. Install equipment giving right-of-way to piping systems installed at a required slope.

G. All equipment shall operate without objectionable noise or vibration as determined by the A/E. If such objectionable noise or vibration should be produced by apparatus, piping, ducts, or other parts of this work, make necessary changes, as determined by the A/E without additional compensation.

3.04 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 22 piping Sections specify unique piping installation requirements.

B. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

C. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.

D. Un-insulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.

E. Un-insulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.

F. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.

G. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.

3.05 INSTALLATION - SLEEVES

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

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

C. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

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

E. Extend sleeves through floors 4 inches above finished floor level. Caulk sleeves full depth and provide floor plate.

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

G. Install chrome plated steel escutcheons at finished surfaces.

H. Size large enough to allow for movement due to expansion and to provide for continuous insulation.

I. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

3.06 CONCRETE BASES

A. Refer to Section 03 30 00

B. Where indicated, mount equipment on reinforced concrete housekeeping bases poured directly on prepared structural floor slab.

C. Provide dimensional drawings, templates, anchor bolts, and accessories required for mounting and anchoring equipment.

D. Construct concrete bases of dimensions indicated, but not less than 6 inches thickness and 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations.

E. Concrete Mix: 4000-psig, 28-day compressive-strength concrete and reinforcement.

3.07 DEMOLITION

A. Refer to Division 02 – Existing Conditions.

B. Disconnect, demolish, and remove Work indicated on the Drawings.

C. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

D. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

E. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

F. Removal: Remove indicated equipment from Project site.

G. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.08 CUTTING AND PATCHING

A. Cutting and Patching: Refer to Contract Documents.

B. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

C. Locate holes and provide sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

D. Repair cut surfaces to match adjacent surfaces.

E. Perform patching in finished construction of building under the sections of specifications covering these materials.

3.09 ERECTION OF METAL SUPPORTS AND ANCHORAGE:

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

3.10 GROUTING

A. Refer to Section 03 60 00 Grout

B. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

C. Cure placed grout according to manufacturer's written instructions.

3.11 FIRESTOPPING

A. Refer to Section 07 84 00

B. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material.

3.12 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

A. Refer to Section 22 05 53 – Identification for Plumbing and Equipment.

3.13 PAINTING AND FINISHING

A. Refer to Section 09 91 00 – Painting.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.14 FIELD QUALITY CONTROL

A. General: Perform cleaning, testing, startup, adjusting, balancing, and commissioning operations as specified in other Sections included under Division 22 - Plumbing.

3.15 PROTECTION

A. Protect equipment and materials in storage on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

B. Protect equipment with polyethylene covers and crates.

C. Protect installed work from subsequent construction activities.

D. Operate, drain, and flush bearings and refill with change of lubricant before final acceptance.

E. Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Provide extended nipples for lubrication.

F. Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not re-use existing materials and equipment unless specifically indicated.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

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

B. Related Sections:
1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for the placement of inserts or sleeves in concrete forms specified by this section.
2. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
3. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
4. Section 07 92 00 - Joint Protection: Product requirements for sealant materials for placement by this section.
5. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
6. Section 21 13 13 - Wet Pipe Sprinkler System
7. Section 21 13 16 – Dry-Pipe Systems
8. Section 22 11 00 - Facility Water Distribution: Execution requirements for placement of hangers and supports specified by this section.
9. Section 22 13 00 - Facility Sanitary Sewerage: Execution requirements for placement of hangers and supports specified by this section.
10. Section 23 11 23- Facility Natural Gas Piping

1.02 REFERENCES

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

B. American Society of Mechanical Engineers (ASME):
1. ASME B31.9 - Building Services Piping.

C. ASTM International (ASTM):

1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

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

E. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

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 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

H. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

1.03 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.

1.04 SYSTEM DESCRIPTION

A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.

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

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

1.05 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code FM/UL for fire resistance ratings and surface burning characteristics.

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

1.06 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Certificates: Buy America Act Certification

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

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

E. 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.

F. Design Data:
1. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
2. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

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

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

I. 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.

1.07 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. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage 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 and Roof 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.

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

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

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

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

H. Perform Work in accordance with applicable authority, AWS D1.1 for welding hanger and support attachments to building structure.

1.08 QUALIFICATIONS

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

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

1.09 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

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.

1.10 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.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 WARRANTY

A. Warranty Requirements: Refer to Contract Documents.

PART 2 PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
1. Anvil Inc.
2. Carpenter & Paterson Inc.
3. Flex-Weld, Inc.
4. Michigan Hanger Co.

B. Plumbing Piping - DWV:
1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.

6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

C. Plumbing Piping - Water:
1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
7. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
8. Vertical Support: Steel riser clamp.
9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
11. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.02 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.03 INSERTS

A. Manufacturers:
1. Anvil Inc.
2. Carpenter & Paterson Inc.
3. Michigan Hanger Co.

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.05 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: 18 gage thick galvanized steel.

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

C. Sealant: Acrylic; refer to Section 07 92 00.

2.06 MECHANICAL SLEEVE SEALS

A. Manufacturers:
1. Thunderline Link-Seal, Inc.
2. NMP Corporation
3. Substitutions: Refer to Contract Documents.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.07 FORMED STEEL CHANNEL

A. Manufacturers:
1. B-Line Systems.
2. Unistrut Corp.
3. Allied Tube & Conduit Corp.

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

2.08 FIRESTOPPING

A. Manufacturers:
1. Dow Corning Corp.
2. Hilti Corp.
3. 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: Multiple component silicone elastomeric compound and compatible silicone sealant.
2. Foam Firestopping Compounds: Multiple 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.

2.09 FIRESTOPPING ACCESSORIES

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

B. Dam Material: Permanent:
1. Mineral fiberboard.
2. Mineral fiber matting.
3. Sheet metal.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:
1. Furnish UL listed products or products tested by independent testing laboratory.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.01 EXAMINATION

A. Administrative Requirements: Verification of existing conditions before starting work. Refer to Contract Documents.

B. Verify openings are ready to receive sleeves.

C. Verify openings are ready to receive firestopping.

3.02 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 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.

F. Obtain permission from Structural Engineer before drilling or cutting structural members.

3.03 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.04 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1, ASTM F708, MSS SP 58, MSS SP 69, MSS SP 89.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

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

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

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

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

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

I. Support riser piping independently of connected horizontal piping.

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

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

L. 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.

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

3.05 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment, unless indicated otherwise. Refer to Section 03 30 00.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members, formed steel channel, steel pipe and fittings. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 21 05 48.

3.06 INSTALLATION - FLASHING

A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

D. Seal floor, shower, and mop sink drains watertight to adjacent materials.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.07 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 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.

3.08 INSTALLATION - FIRESTOPPING

A. Refer to Section 07 84 10

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

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

D. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.

E. Compress fibered material to maximum 40 percent of its uncompressed size.

F. Remove dam material after firestopping material has cured.

G. Fire Rated Surface:
   1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
      b. Size sleeve allowing a minimum of 1 inch void between the 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.

H. Non-Rated Surfaces:
   1. Seal opening through non-fire rated wall, partition, floor, ceiling, and roof opening as follows:
      a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
      b. Size sleeve allowing a minimum of 1 inch void between the sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Install escutcheons, floor plates or ceiling plates 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.

3.09 FIELD QUALITY CONTROL

A. Field Quality Requirements: Refer to Contract Documents.

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

3.10 CLEANING

A. Cleaning Requirements: Refer to Contract Documents.

B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Requirements for protecting finished Work: Refer to Contract Documents.

B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

A. In Accordance with this Section and the Contract Drawings.

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
Cast Iron (All Sizes)	5	5/8
Cast Iron (All Sizes) with 10 foot length of pipe	10	5/8
Copper Tube, 1-1/4 inches and smaller	6	1/2
Copper Tube, 1-1/2 inches and larger	10	1/2

PVC (All Sizes)	4	3/8
Steel, 3 inches and smaller	12	1/2
Steel, 4 inches and larger	12	5/8

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

B. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Pipe markers.
   4. Ceiling tacks.
   5. Lockout devices.

A. Related Sections:
   1. Section 21 13 13 - Wet Pipe Sprinkler System
   2. Section 21 13 16 – Dry-Pipe Systems
   3. Section 22 11 00 - Facility Water Distribution: Execution requirements for placement of hangers and supports specified by this section.
   4. Section 22 13 00 - Facility Sanitary Sewerage: Execution requirements for placement of hangers and supports specified by this section.
   5. Section 23 11 23- Facility Natural Gas Piping

1.2 REFERENCES

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

C. American Society of Mechanical Engineers:
   1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.02 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Certificates: Buy America Act Certification

C. Product Data: Submit manufacturers catalog literature for each product required.

D. 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.

E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

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

1.03 CLOSEOUT SUBMITTALS

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

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

1.04 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. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.05 QUALIFICATIONS

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

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

1.06 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.07 EXTRA MATERIALS

A. Execution and Closeout Requirements: Extra materials, spare parts and maintenance products. Refer to Contract Documents.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Brady Corp

B. Champion America, Inc.

C. Seton Identification Products

2.02 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.03 TAGS

A. Plastic Tags:
   1. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.

B. Metal Tags:
   1. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

2.04 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
   1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
   1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.05 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color-coded head.

B. Color code as follows:
   1. Plumbing valves: Green.

2.06 VALVE CHART

A. Valve Chart Frame: Aluminum frame, plastic window; sized to accommodate included chart, minimum size 8-1/2 by 11 inches.

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 plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Identify water heaters, pumps, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

I. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Related Documents
1. Drawings and general provisions of the Contract, including General and Special Provisions, apply to this Section.

B. Section Includes:
1. Piping system insulation.
2. Pipe insulation jackets.
3. Insulation accessories including vapor retarders and accessories.

C. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
3. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product and Execution requirements for inserts at hanger locations.
4. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for plumbing piping and equipment identification.

1.02 REFERENCES

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

B. American Society of Heating, Ventilating and Air Conditioning Engineers (ASHRAE):
1. ASHRAE Fundamentals Handbook (2001), Chapter 24, Thermal and Moisture Control in Insulated Assemblies – Applications.

C. American Society of Plumbing Engineers (ASPE):
1. ASPE Fundamentals of Plumbing Design Data Book, Volume 1, Chapter 12, Insulation

D. ASTM International:
1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

3. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
8. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
9. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
10. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
11. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
12. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
13. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
14. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
15. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
16. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
17. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
18. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
19. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

1.03 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Certificates: Buy America Act Certification

C. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

D. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

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

1.04 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. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

D. Furnish materials in accordance with State of Maryland standards.

1.05 QUALIFICATIONS

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

B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements: Refer to Contract Documents.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature during and after installation for minimum period of 24 hours.

1.08 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.09 WARRANTY

A. Warranty: Refer to Contract Documents.

B. Furnish five year manufacturer warranty for man made fiber.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. CertainTeed Corporation

B. Johns Manville Insulations

C. Knauf Insulation

D. Owens Corning

E. Rubatex Corp.

2.02 CELLULAR GLASS

A. Insulation: ASTM C552, Type II - pipe and tubing insulation, Class 2 - Jacketed.
   1. 'K' factor: ASTM C177 or ASTM C518, 0.29 at 75 degrees F.

2.03 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible.
   1. 'K' factor: ASTM C177 or ASTM C518, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 450 degrees F.
   3. Maximum Moisture Absorption: 0.1 percent by volume.
   4. Density: 2.0 lb/cu ft.

B. Vapor Retarder Jacket: ASTM C1136 Flexible, Low Permeance Vapor Retarders for Thermal Insulation, Type II.

C. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.

D. Vapor Retarder Lap Adhesive:
   1. Compatible with insulation.

E. Insulating Cement/Mastic:
   1. ASTM C195; hydraulic setting on mineral wool.

2.04 ELASTOMERIC CELLULAR FOAM

A. Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular form: ASTM C534; Type I, Tubular form.

B. Elastomeric Foam Adhesive:
   1. Air dried, contact adhesive, compatible with insulation.

2.05 PIPE INSULATION AND EQUIPMENT JACKETS

A. Manufacturers:
   1. Childers products Company Inc.
   2. Foster
   3. Johns Manville Insulation Zeston

B. PVC Plastic Pipe Jacket:
   1. Product Description: [ASTM D1784,] One piece molded type fitting covers and sheet material, off-white color.
   2. Thickness: 10 mil.
   3. Connections: Brush on welding adhesive. Covering Adhesive Mastic:
   4. Compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify piping and equipment has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Exposed Piping: Locate insulation seams in least visible location.

B. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

C. Inserts and Shields:

D. Application: Piping or Equipment 2 inches diameter or larger.
   1. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   2. Insert location: Between support shield and piping and under finish jacket.
   3. Insert configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
   4. Insert material: Compression resistant insulating material suitable for planned temperature range and service.

5. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 10 for penetrations of assemblies with fire resistance rating greater than one hour.
6. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
7. Factory Insulated Equipment: Do not insulate.
8. Exposed Equipment: Locate insulation seams in least visible locations.
9. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
10. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
11. Insulated equipment containing fluids below ambient temperature: Insulate entire system.
12. Mineral fiber insulated equipment containing fluids below ambient temperature: Provide vapor retarder jackets, factory-applied or field-applied. Finish with glass-cloth and vapor barrier adhesive.
13. Mineral fiber insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor retarder, factory-applied or field-applied. Finish with glass cloth and adhesive.
14. Finish insulation at supports, protrusions, and interruptions.
15. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
16. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

3.03 SCHEDULES

A. Plumbing Systems:

B. Domestic Hot Water Supply:
1. Cellular Glass Insulation:
2. Pipe Size Range: 1inch and Smaller.
3. Thickness: 1/2 inch.
4. Pipe Size Range: 1 1/4 inch and Larger.
5. Thickness: 1 inch.
6. Elastomeric Cellular Foam Insulation:
7. Pipe Size Range: 1inch and Smaller.
8. Thickness: 1/2 inch.
9. Pipe Size Range: 1 1/4 inch and Larger.
10. Thickness: 1 inch.

C. Domestic Hot Water Re-circulation:
1. Cellular Glass Insulation:
2. Pipe Size Range: Up to 3/4 inch.
3. Thickness: 1/2 inch.

D. Domestic Cold Water:
   1. Cellular Glass Insulation:
   2. Pipe Size Range: 1inch and Smaller.
   3. Thickness: 1/2 inch.
   4. Pipe Size Range: 1 1/4 inch and Larger.
   5. Thickness: 1 inch.
   6. Elastomeric Cellular Foam Insulation:
   7. Pipe Size Range: 1inch and Smaller.
   8. Thickness: 1/2 inch.
   9. Pipe Size Range: 1 1/4 inch and Larger.
   10. Thickness: 1 inch.

E. Plumbing Vents Within 10 feet of Exterior:
   1. Cellular Glass Insulation:
   2. Pipe Size Range: All Sizes.
   3. Thickness: 1/2 inch.

END OF SECTION

SECTION 22 10 00

FACILITY PLUMBING PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Hot water recirculation pumps.

B. Related Sections:
   1. Section 07 84 10 - Firestopping: Product requirements for firestopping for placement by this section.
   2. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
   3. Section 22 05 13 - Common Motor Requirements for Plumbing Equipment: Product requirements for motors for placement by this section.
   4. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product and Execution requirements for inserts at hanger locations.
   5. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification and valve tags for placement by this section.
   6. Division 26 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.02 REFERENCES

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

B. American National Standards Institute (ANSI):
   1. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.

C. ASTM International (ASTM):

D. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.03 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Certificates: Buy America Act Certification

C. Product Data:
   1. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

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

1.04 CLOSEOUT SUBMITTALS

A. Closeout Submittal Requirements: Refer to Contract Documents.

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

1.05 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 State of Maryland standards.

1.06 QUALIFICATIONS

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

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

1.07 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting. Refer to Contract Documents.

1.08 DELIVERY, STORAGE, AND HANDLING

B. Delivery, storage and handling: Refer to Contract Documents.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.09 ENVIRONMENTAL REQUIREMENTS

D. Environmental Requirements: Refer to Contract Documents.

1.10 FIELD MEASUREMENTS

E. Verify field measurements prior to fabrication.

1.11 WARRANTY

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

1.12 EXTRA MATERIALS

A. Spare parts and maintenance products Closeout Requirements. Refer to Contract Documents.

B. Furnish two pump seals for each pump model.

PART 2 PRODUCTS

2.01 IN-LINE CIRCULATOR PUMPS (HWRP-1)

A. Manufacturers:
   1. Bell & Gossett Model E3.
   2. Substitutions: Refer to Contract Documents.

B. Casing: In-line wet rotor design, lead-free brass body rated for 150 psig maximum working pressure, 40 degree F. minimum working temperature and 230 degrees F. maximum working temperature, sweat connections.

C. Wetted Parts: Stainless steel

D. Impeller: Nylon.

E. Motor Stator: High efficiency ECM, Isolated from circulating fluid by stainless steel can, rotor sheathed in stainless steel.

F. Motor: Non-overloading type with built-in impedance protection.

G. Drive: Flexible coupling.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examination: Coordination and project conditions. Refer to Contract Documents.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove all scale and dirt, on inside and outside, before assembly.

3.03 INSTALLATION - THERMOMETERS AND GAGES

A. Refer to Section 22 11 00.

3.04 INSTALLATION - HANGERS AND SUPPORTS

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

3.05 INSTALLATION - ABOVE GROUND PIPING

A. Install aboveground piping in accordance with Section 22 11 00.

3.06 INSTALLATION - PUMPS

A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings.

C. Install pumps on vibration isolators. Refer to Section 22 05 48.

D. Install flexible connectors at or near pumps where piping configuration does not absorb vibration. Refer to Section 22 05 48.

E. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve on pump discharge.

F. Provide air cock and drain connection on horizontal pump casings.

G. Check, align, and certify alignment of base mounted pumps prior to start-up.

H. Lubricate pumps before start-up.

END OF SECTION

SECTION 22 11 00

FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Domestic water piping, within 5 feet of building.
2. Domestic water piping, above grade.
3. Unions and flanges.
4. Valves.
5. Pipe hangers and supports.
6. Pressure gages.
7. Pressure gage taps.
8. Thermometers.
9. Flow control valves.
10. Water pressure reducing valves.
11. Relief valves.
12. Strainers.
13. Hydrants.
14. Backflow preventers.
15. Water hammer arrestors.
16. Thermostatic mixing valves.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 00 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
4. Section 22 05 00 – Common Work Results for Plumbing: product requirements for firestopping and access doors
5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
6. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification and valve tags for placement by this section.
7. Section 22 07 00 - Plumbing Insulation: Product and execution requirements for pipe insulation.
8. Division 31 - Soils for Earthwork: Soils for backfill in trenches.
9. Division 31 - Aggregates for Earthwork: Aggregate for backfill in trenches.
10. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this section.

11. Section 31 23 16.13 - Trenching: Execution requirements for trenching required by this section.
12. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.
13. Section 33 13 00 - Disinfecting of Water Utility Distribution: Product and execution requirements for disinfection of domestic water piping beyond 5 feet of building.

1.02 REFERENCES

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

B. American National Standards Institute (ANSI):
1. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.

C. American Society of Mechanical Engineers (ASME):
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 B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
6. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

D. American Society of Sanitary Engineering (ASSE):
1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
2. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
3. ASSE 1012 - Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.
4. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
5. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type.

E. ASTM International (ASTM):
1. ASTM B32 - Standard Specification for Solder Metal.
2. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

5. ASTM E1 - Standard Specification for ASTM Thermometers.
6. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
7. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
8. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

F. American Welding Society (AWS):
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

G. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
3. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

H. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

I. Plumbing and Drainage Institute (PDI):
1. PDI WH201 - Water Hammer Arrester Standard.

1.03 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Certificates: Buy America Act Certification

C. 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. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

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

1.04 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.

1.05 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 State of Maryland standard, International Plumbing Code and International Building Code.

D. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

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

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

1.07 PRE-INSTALLATION MEETINGS

A. Pre-installation meetings: Refer to Contract Documents.

1.08 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.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements: Refer to Contract Documents.

B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Warranty Requirements: Refer to Contract Documents.

1.12 EXTRA MATERIALS

A. Extra Materials: Refer to Contract Documents.

B. Furnish two packing kits for each size valve, two loose keys for outside hose bibs, hose end vacuum breakers for hose bibs.

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.

PART 2 PRODUCTS

2.01 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Pipe: ASTM B 88; Type K copper, annealed, flared joints, cast copper alloy flare-type fittings; ANSI B16.26

B. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2466, Schedule 40, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.02 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88 (ASTM B88M), Type L, hard drawn.
   1. Fittings: ASME B16.18; cast copper alloy or ASME B16.22; wrought copper and bronze.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F. Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.03 UNIONS AND FLANGES

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

B. Flanges for Pipe 2-1/2 inches and Larger:
   1. Copper Piping: Class 150, slip-on bronze flanges.
   2. PVC Piping: PVC flanges.
   3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.04 BALL VALVES

A. Manufacturers:
   1. Apollo Valve Co.; Series 70LF-100, 70LF-100-27, 70LF-200 and 70LF-200-27
   2. NIBCO, Inc.
   3. Stockham Valves & Fittings.

B. Ball Valves (4 in 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.

C. Lockable Ball Valves (2 in 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, stainless steel latch/lock lever handle and nut and vinyl grip.

2.05 CHECK VALVES

A. Manufacturers:
   1. Apollo Valve Co.; Model 161TLF or Model 161SLF
   2. NIBCO, Inc.
   3. Stockham Valves & Fittings.

B. Swing Check Valves (2 in and smaller): MSS SP-80, ASME B1.20.1; 200 PSI CWP at 100°F, solid bronze body and cap, horizontal swing, bronze seat, Y-Pattern, renewable seat disc, stainless steel Hinge Pin, Lead Free, solder or threaded ends.

C. Manufacturers:
1. Apollo Valve Co.; Model CVB61-LF or CVB61LF-800
2. NIBCO, Inc.
3. Stockham Valves & Fittings.

D. Check Valves (2 in and smaller): MSS SP-80, ASME B1.20.1; 400 PSI CWP, 350°F., maximum temperature, in-line design, solid bronze body, spring actuated, stainless steel spring, Lead-Free, solder or threaded ends.

2.06 STRAINERS

A. Manufacturers:
1. Apollo Valve Co.; Series 59LF000-20 or 59LF300-20
2. Sarco.
3. Substitutions: Refer to Contract Documents.

B. Strainers (4 in and smaller): AB 1952 Certified; 400 PSI CWP at 150°F., in-line design, solid bronze body and cap, Teflon O-ring, 20-mesh stainless steel screen, Lead-Free, solder or threaded ends.

2.07 THERMOMETERS

A. Manufacturers:
1. H. O. Trerice; Model No. BX9
2. Marsh Instrument
3. Taylor Instrument

B. Thermometers: Adjustable angle type, front blue appearing mercury tube type in 9 inch cast aluminum case with powder coating and one piece clear acrylic front window and separable brass thermowell.

C. Scale in black figures on white background. Scale graduated so as to show system design point temperature at midpoint of scale.

D. Where insulation thickness exceeds 2-inches a longer stem shall be used with an extension neck brass separable themowell. Extension neck must be a minimum of 2-inches long.

E. Blue colored organic fluid shall be used in lieu of mercury.

2.08 PRESSURE GAUGES

A. Manufacturers:

1. H. O. Trerice; Model No. 500X, with Type FFG-No. 735 and Model No. 872
2. Marsh Instrument
3. Taylor Instrument

B. Pressure Gauges: ASME B40.1, Grade2A; 4 ½-inch diameter dial with cast aluminum case, stainless steel friction type ring and glass window. 300 stainless steel rotary type movement with stainless steel bushing.

C. Scale in black figures on white background. Scale shall indicate zero to 1-1/2 times the working pressure in the system in which gauge is installed, micrometer adjustable type pointer, +/- 0.50 scale range accuracy.

D. Needle Valve: Brass body, seat and stem, Teflon packing and brass handle, 2000 PSI operating pressure and 300° F. maximum operating temperature.

E. Pressure Snubber: Install pressure snubber to prevent radical fluctuation of movement, bronze body and core ¼-inch NPT.

2.09 BALANCE VALVES

A. Manufacturers:
1. ITT Bell & Gossett; Circuit Setter Plus, CB
2. Nibco
3. Flow Design

B. Calibrated Balance Valve (Hot water return system) (1/2-inch through 2-inch): Provide valves that can perform flow metering, precision flow balancing and positive shut off with no drip seats, integrally valved run-out ports for metering purposes. Valves shall indicate balance position and include a balancing positioner (travel stop indicator) so valve can be opened or closed and returned to former balance setting, 200 psig design pressure and 250 degrees F. design temperature

C. Valve Construction: Bronze body/brass ball construction with glass and carbon filled TFE seat rings, drain fitting.

2.10 PRESSURE REDUCING VALVES

A. Manufacturers:
1. Apollo Valves; Model PRH-LF
2. Wilkins Regulators
3. Watts Regulators

B. Pressure Reducing Valve (1/2 – 2 inch): ASSE 1003; Lead Free, internal thermal expansion by-pass, stainless steel bolts and springs, spring range from 10 to 125 psig., in-line strainer, union end connection. ASTM grade Lead-Free bronze body, cap and bonnet, built-in by-pass, integral stainless steel strainer, FDA

approved EPDM diaphragm and seat disc, up to 400 psig maximum inlet supply pressure, 33°F to 180°F temperature range, up to 300 gpm flow rate.

2.11 THERMOSTATIC MIXING VALVES

A. Manufacturers:
   1. Apollo Valve Co.; Series 34HL-105-01
   2. Wilkins Regulators
   3. Watts Regulators

B. Dual Thermostatic Mixing Valve Assembly: ASSE 1069 and ASSE 1017; 0.5 gpm temperature flow, integral replaceable inlet strainers and check valves, union isolation bronze ball valves, bronze construction with rough bronze finish, Hi-Lo flow calibration valve, hot and cold water protection failure, independent low and high temperature control, (0-160 psi) pressure gauges, (0°F - 200°F) thermometer; 150 psi maximum pressure, 200°F maximum temperature, factory assembled and tested.

2.12 NON-FREEZE WALL HYDRANT

A. Manufacturers:
   1. Zurn Industries, Inc.; Model 1310
   2. Josam Manufacturers Co.
   3. Wade

B. Non-Freeze Wall Hydrant: ASSE; Exposed non-freeze design wall hydrant for standard 3/4 inch hose end outlet and of length suited to wall thickness, anti-siphon, anti-draining, integral backflow preventer, bronze casing, all bronze interior parts, non-turning operating rod with closure valve, replaceable bronze seat and seat washer 3/4-inch inlet, 3/4-inch hose end outlet, polished bronze face, loose operating keys.

2.13 PIPING SYSTEM SPECIALTIES

A. Manufacturers (Manual Air Vents):
   1. ITT Bell & Gossett; No. 4V
   2. Taco, Inc
   3. Or Approved Equal

B. Manual Air Vents: Chrome-plated brass, 75 psi maximum working pressure and 240 degrees F. maximum operating temperature, screwdriver operated, threaded type.

C. Manufacturers (Vacuum Breakers):
   1. Watts Regulator Co.; Model 8A
   2. Woodford Manufacturing Company
   3. Or Approved Equal

D. Vacuum Breakers: ANSI A112.1.1 and ASSE Standard 1011; Hose threaded, brass construction with standard 3/4 inch hose outlet.

E. Manufacturers (Water Hammer Arrestors):
   1. Sioux Chief, Inc. Hydra-Rester
   2. Or Approved Equal

F. Water Hammer Arrestors: P.D.I. Standard WH201; Piston type, Type L copper tube, poly piston with EPDM O-rings, lead-free threaded fittings.

2.14 FLEXIBLE PIPE CONNECTORS

A. Corrugated bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure 300 psig

2.15 BACKFLOW PREVENTERS –REDUCED PRESSURE

A. Manufacturers:
   1. Watts Regulator Co.
   2. Apollo Valves
   3. Zurn - Wilkins

B. Backflow Preventer (1/4 - 2-inch): ASSE 1013; Sweat type bronze inlets and outlets, bronze body construction, double check valve pressure design, union connections, and test cocks, lead-free construction, bronze supply strainer, 1/4 turn, full port ball valves before and after the device and device composed of a pressure differential relief valve between two positive seating check valves and an atmospheric vent, continuous pressure use of 175 psi and operating temperatures up to 140 degrees F., air gap; Model LF009-QT-S with ES-AG

C. Backflow Preventer (2 1/2 to 10-inch): ASSE 1013; fused epoxy coated cast iron body with plastic seats, independent torsion spring check modules, replaceable elastomer disc, differential pressure relief valve, stainless housing and sleeve; 1/4 turn, full port, lead-free bronze ball valve test cocks, OS&Y inlet and outlet valves, stainless steel hardware, continuous pressure use of 175 psi at temperature range of 33°F to 140° F., air gap; Model LF009-OSY-S with ES-AG.

PART 3 EXECUTION

3.01 EXAMINATION

A. Administrative Requirements: Refer to Contract Documents.

B. Verify excavations are to required grade, dry, and not over-excavated.

C. Verify trenches are ready to receive piping.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside 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.

3.03 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection to existing piping system size, location, and invert are as indicated on Drawings.

B. Establish elevations of buried piping with not less than 42 inches of cover.

C. Establish minimum separation of 12 inches from other services piping in accordance with International Plumbing Code.

D. Excavate pipe trench in accordance with Section 31 23 16.

E. Install pipe to elevation as indicated on Drawings.

F. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth.

G. Install pipe on prepared bedding.

H. Route pipe in straight line.

I. Install pipe to allow for expansion and contraction without stressing pipe or joints.

J. Pipe Cover and Backfilling:
   1. Backfill trench in accordance with Section 31 23 23.

3.04 INSTALLATION - ABOVE GROUND PIPING

A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 29.

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 05 29.

G. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 00.

H. Install non-conducting dielectric connections wherever jointing dissimilar metals.

I. Slope piping and arrange systems to drain at low points.

J. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

K. Provide dielectric unions at points of connection of copper tubing and piping to ferrous metal piping or equipment.

L. Provide reducing fittings where reduction in pipe sizes is necessary. Bushings will not be accepted.

M. Install ball valves at inlets and outlets to each piece of equipment.

N. Cross and Inter-Connections: Do not install piping in a manner which can create a direct cross connection or an inter-connection between potable water and polluted water, or in a manner whereby a backflow of polluted water system could occur.

O. Valve Installation: Install a valve where each branch leaves the main and at Plumbing Fixtures to facilitate repairs or replacements of such while the system is in operation. Unless indicated otherwise on the Drawings install gate valves in water lines. Install globe valves in water lines where throttling, control or bypass is required.

P. Piping Pitch: Unless otherwise indicted pitch potable water piping one-inch in fifty feet.

Q. Insulate piping. Refer to Section 22 07 00.

R. Install pipe identification in accordance with Section 22 05 53.

3.05 PIPE JOINING

A. General Provisions: Refer to Contract Documents. Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.
   1. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.
   2. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.

B. Copper Tubing and Pipe Joints: Cut tubing and piping ends square, deburr and ream to size of original bore.
   1. Solder: Prior to sweating, clean pipe ends and fitting surfaces involved in the joint, to bright metal without marring surfaces. Finished joints shall show no evidence of hard-temper due to over-heating, no evidence of improper solder draw, and excess solder must be removed.
   2. Flared: Cut tubing and piping ends square, deburr and ream to size of original bore. Finished joints shall show evenness of flaring and proper seating of joining parts.
   3. Brazing: Prior to brazing, clean the surfaces involved in the brazing to remove oxides and surface soil. Exercise care so as not to remove excess material to result in a loose fit of the joint. Perform brazing in accordance with recommendations of the Copper Development Association Inc. Copper, Brass, Bronze, Product Handbook.

C. Ductile Cast Iron Pipe Joints:
   1. Push-On Joints: Properly seat sealing gasket, evenly and sufficiently lubricate the spigot end of pipe, and fully enter joint until joint line is visible. Make deflection, if required, only after the joint has been assembled properly.
   2. Mechanical Joints: Properly position sealing gasket and gland for bolting and then enter the spigot into pipe bell end until joint line is visible. Tighten bolts evenly maintaining approximate distance between gland and face of flange at all points around the socket. Do not exceed pipe manufacturer's specifications for maximum torque applied to bolts.
   3. Flanged: Face accurately, install gaskets and draw up square and tight to ensure full gasket flow and seal.

3.06 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

A. Install domestic water piping system in accordance with ASME B31.9.

B. Thermometer and Gauge Installations:
   1. Thermometer in Piping: Provide thermometer with 3/4-inch NPT separable socket of noncorrosive material and with 2 3/4-inch extension neck and stem of a length to reach the pipe centerline.

2. Pressure Gauges in Piping: Provide pressure gauge with 1/4-inch NPT separable socket of noncorrosive material and with 1/4-inch brass nipple for installation of gauge cock.

C. Hose Bibb and Hydrant Installation:
1. Interior: 30 inches above finished floor.
2. Non-Freeze: Unless indicated otherwise, 30 inches above grade.

D. Water Hammer Installation: Install water hammer arrestors on each plumbing fixture supply branch to reduce water hammer in the piping system in accordance with P.D.I.-WH201.
1. Install water hammer arrestors in accessible locations. Provide access panels as required.
2. Water hammer arrestors shall conform to ASSE 1010.

E. Backflow Preventer Installation:
1. Prior to installation, thoroughly flush all pipes to remove any foreign matter.
2. Install backflow preventers in accessible indoor locations for servicing, testing and freeze protection.
3. Install a strainer ahead of each backflow preventer.
4. In dead-end service applications (boiler feed lines, cooling tower make-up or other equipment with periodic flow requirements), install a check valve ahead of each backflow preventer.
5. Install a drain line and air gap piped from the relief valve connection on each backflow preventer.
6. Installation of backflow preventers shall comply with all state and local codes.
7. Completed installation by a licensed journeyman, recognized by the authority having jurisdiction.
8. Provide clearances as recommended by manufacturer.

3.07 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(sq. root)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.

D. Testing (Aboveground inside structure): Hydrostatic at 50 percent over system operating pressure but not less than 100 psig.
   4. Locate test pressure source on upstream sides on lines containing check valves and set control valves in open position for test duration.
   5. Do not subject equipment, piping specialties or plumbing fixtures to test pressures.
   6. Isolate in-line items that may be damaged by test pressures.
   7. Maintain test pressure to within 3 psi of initial test pressure, without introduction of additional pressure, until an examination is made to determine each joint and connection leak free, but in no case less than four hours actual test time.

E. Cleaning: After testing flush entire system, through each outlet, until free of sediment and other foreign matter.

F. Disinfection: After system flushing perform system disinfection from valve at source of supply through each outlet and connected fixtures and equipment.
   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 at system outlets to ensure full system volume of treated water.
   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.

3.08 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.
   7. Notification: Give the Engineer a minimum of three days advance notice of the times when piping system acceptance testing will be conducted.

END OF SECTION

SECTION 22 13 00

FACILITY SANITARY SEWERAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Sanitary sewer piping buried within 5 feet of building.
2. Sanitary sewer and vent piping below grade and under slab
3. Sanitary sewer and vent piping above grade.
4. Floor drains.
5. Cleanouts.
6. Trap primer valves.

B. Related Sections:
1. Section 07 84 00 – Fire-stopping: Product requirements for fire-stopping for placement by this section.
2. Section 08 31 00 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
4. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and fire-stopping for placement by this section.
5. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
6. Division 31 - Earthwork: Soils for backfill in trenches.
7. Division 31 - Aggregates for Earthwork: Aggregate for backfill in trenches.
8. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this section.
9. Section 31 23 16.13 - Trenching: Execution requirements for trenching required by this section.
10. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.

1.02 REFERENCES

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

B. American Society of Mechanical Engineers (ASME):
1. ASME A112.21.1 - Floor Drains.
2. ASME B31.9 - Building Services Piping.

C. ASTM International (ASTM):

1. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
2. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
3. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
4. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
5. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
6. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
7. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
8. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
9. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
10. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
11. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
12. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
13. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

1.03 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Certificates: Buy America Act Certification

C. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers 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. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

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

1.04 CLOSEOUT SUBMITTALS

A. Closeout Submittal Requirements: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of equipment and clean-outs.

C. Operation and Maintenance Data: Submit frequency of treatment required for interceptors. Include, spare parts lists, exploded assembly views for pumps and equipment.

1.05 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 State of Maryland standards.

D. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

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

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

1.07 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting: Refer to Contract Documents.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Delivery Storage and Handling Product Requirements: Refer to Contract Documents.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements: Refer to Environmental Documents.

B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

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

1.12 EXTRA MATERIALS

A. Spare parts and maintenance products Execution and Closeout Requirements: Refer to Contract Documents.

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.

PART 2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
   1. Fittings: PVC, ASTM D2729.

2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

B. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.
   1. Fittings: ASTM D2466, Schedule 40, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

2.02 SANITARY SEWER AND VENT PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2729, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

B. PVC Pipe: ASTM D2665, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2665, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.03 FLOOR DRAINS

A. Manufacturers:
   1. Zurn Industries
   2. Josam Manufacturing
   3. J. R. Smith
   4. Substitutions: Refer to Contract Documents.

B. General - Floor Drain:
   1. Drain outlets suited to the joint style of piping to which they are connected; provide side outlet drains where required.
   2. Provide flashing clamp device on drains installed in floor areas having waterproof membrane.
   3. Where scheduled, provide nickel-bronze funnels to receive the discharge of equipment drains, wastes, etc, attached to top of floor drain grate.
   4. Provide square strainers in tile floors, round strainers in all other floor types.
   5. Double drainage flange and weep-holes.

C. Floor Drain (FD-1): ASME A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, and 6-inch round, adjustable stainless steel, medium duty strainer, trap primer tap; ZS-415SS-6B-P.

D. Floor Drain (FD-2): ASME A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, and 6-inch round, adjustable stainless steel, medium duty strainer, trap primer tap; ZS-415SS-6B-P .

E. Floor Drain (FD-3): ASME A112.21.1; lacquered cast iron body, weep holes, 9-inch round, heavy duty cast iron slotted grate, sediment bucket, seepage pan and adjustable extension frame, trap primer tap, cast iron funnel assembly; Z-520-P-Y with ZB-328-4 Funnel.

F. Floor Drain (FD-4): ASME A112.21.1; lacquered cast iron body, 9-inch round, medium duty cast iron slotted grate, sediment bucket, seepage pan and combination membrane flashing clamp, trap primer tap; Z-507-P-Y .

2.04 TRAP PRIMER VALVES

A. Acceptable Manufacturers:
   1. Precision Plumbing Products, Inc.
   2. Watts
   3. MiFab

B. Trap Primer Valve: Automatic operation via line pressure drop, corrosion resistant brass, ½-inch threaded male inlet and threaded female outlet, O-ring seals tested at temperature range of –40 degrees F to 450 degrees F, ASSE No.1018, capable of serving up to 4 drains, corrosion resistant brass fittings with copper reservoir and clear plastic inspection cover on reservoir; Model PR-500.

C. Trap Primer: Automatic operation via line pressure drop, adjustable line pressure, adjustable delivery amount, corrosion resistant brass, ½-inch threaded male inlet and threaded female outlet, O-ring seals tested at temperature range of –40 degrees F to 450 degrees F, ASSE No. 1018, capable of serving 1 to 2 drains; Model P-2

2.05 WATERLESS TRAP PRIMER

A. Acceptable Manufacturers:
   1. ProSet Systems; Model Trap Guard System
   2. Sure Seal
   3. Substitutions: Refer to Contract Documents.

B. Waterless system, up to 33 gpm flow rate, elastomeric material, designed to fit in floor drains.

2.06 CLEANOUTS

A. Manufacturers:
   1. Zurn Industries
   2. Josam Manufacturing
   3. J. R. Smith

B. Floor cleanout, heavy duty, adjustable, coated cast iron body with gas and watertight ABS tapered threaded plug, round scoriated cast iron secured top; Model Z-1400-HD.

C. Interior Finished Wall Areas: Wall cleanout with smooth stainless steel access cover with securing screw, coated cast iron body, bas and watertight ABS tapered threaded plug; Model Z-1441.

D. Interior Unfinished Accessible Areas: Horizontal cleanout tee, coated cast iron body with gas and watertight ABS tapered threaded plug; Model Z-1445.

E. Vertical cleanout tee, coated cast iron body with gas and watertight ABS tapered threaded plug, smooth round stainless steel wall access cover with securing screw; Model Z-1446.

F. Horizontal cleanout tee with access cover, coated cast iron body with gas and watertight ABS tapered threaded plug, round galvanized cast iron floor access cover and frame; Model ZN-1448-G

PART 3 EXECUTION

3.01 EXAMINATION

A. Administrative Requirements: Refer to Contract Documents.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, 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.

3.03 INSTALLATION - HANGERS AND SUPPORTS

A. Inserts:
1. Refer to Section 22 05 29.

B. Pipe Hangers and Supports:
1. Refer to Section 22 05 29.

3.04 INSTALLATION - BURIED PIPING SYSTEMS

A. Verify connection to existing piping system size, location, and inverts are as indicated on Drawings.

B. Establish elevations of buried piping with not less than 3.5 ft of cover.

C. Establish minimum separation of 12" from other services piping in accordance with International Plumbing Code.

D. Remove scale and dirt on inside of piping before assembly.

E. Excavate pipe trench in accordance with Section 31 23 16.

F. Install pipe to elevation as indicated on Plumbing and Civil Drawings.

G. Install pipe on prepared bedding.

H. Route pipe in straight line.

I. Pipe Cover and Backfilling:
   1. Backfill trench in accordance with Section 31 23 23.
   2. Maintain optimum moisture content of fill material to attain required compaction density.
   3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
   4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
   5. Do not use wheeled or tracked vehicles for tamping.

3.05 INSTALLATION - ABOVE GROUND PIPING

A. Establish invert elevations, slopes for drainage to 1/4 or 1/8 inch per foot minimum, as required by IPC. Maintain gradients.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearances at cleanout for snaking drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

G. Install piping to maintain headroom. Do not spread piping, conserve space.

H. Group piping whenever practical at common elevations.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 21 05 16.

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

K. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 00.

L. Install piping penetrating roofed areas to maintain integrity of roof assembly.

M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

N. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 90 00.

O. Install bell and spigot pipe with bell end upstream.

P. Sleeve pipes passing through partitions, walls and floors.

Q. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 07 84 00 or 22 05 29.

R. Support cast iron drainage piping at every joint and as recommended by IPC.

3.06 FIELD QUALITY CONTROL

A. Field inspecting, testing, adjusting, and balancing. Refer to Contract Documents.

B. Test sanitary waste and vent piping system in accordance with applicable code and local authority having jurisdiction.

END OF SECTION

SECTION 22 30 00

PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Expansion Tank
2. Water heater.

B. Related Sections:
1. Section 07 92 00 – Joint Sealants: Product requirements for calking between fixtures and building components for placement by this section.
2. Section 22 11 00 - Facility Water Distribution: Supply connections to plumbing fixtures.
3. Section 22 13 00 - Facility Sanitary Sewerage: Waste connections to plumbing fixtures.
4. Division 26 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.02 REFERENCES

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

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's literature for plumbing equipment.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit literature and parts list.

1.05 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. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested in accordance with DOE 10 CFR and ANSI Z21.10.3.

C. Meet the requirements of the American Gas Association (AGA)

1.06 WARRANTY

A. Furnish five year manufacturer warranties for water heaters.

1.07 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

2.01 POTABLE WATER EXPANSION TANK

A. Acceptable Manufacturers
   1. Amtrol; Model ST, Therm –X – Trol
   2. A. O. Smith
   3. Wood

B. ASME construction, NSF/ANSI 61 Certified, welded steel outer shell with welds meeting ASME Section IX, rigid polypropylene liner mechanically bonded with heavy duty rubber diaphragm, and pre-charged air chamber, brass system connection, drain fitting and air charging fitting.

2.02 COMMERCIAL GAS WATER HEATERS

A. Manufacturers:
   1. A.O. Smith Model BTH-150.
   2. State Industries.
   3. Substitutions: Refer to Contract Documents.

B. Automatic, natural gas fired, vertical storage type, AGA Certified, maximum working pressure: 150 psi.

C. Tanks: Welded steel ASME labeled pressure vessel; ceramic coating, with ASME rated temperature and pressure relief valve, inlet and outlet fittings, drain fitting and valve. Steel jacket with enamel finish foam insulation with thickness meeting ASHRAE 90

D. Controls: Automatic immersion water thermostat with adjustable temperature range, manual reset high limit thermostat, gas pressure regulator, burner with 100 percent safety shut-off pilot and thermocouple, intermittent electronic ignition, low water cut-off.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install Work in accordance with State of Maryland standards, International Plumbing Code and International Building Code.

B. Install water heaters in accordance to AGA, NSF, NFPA, UL requirements. Coordinate with plumbing piping and related fuel piping, gas vent, and electrical work to achieve operating system.

C. Install water heater on 4” high concrete pad. Pad shall be 6” larger than the foot print of the heater.

D. Clean and flush tanks after installation. Keep openings sealed until pipe connections are made.

E. On tanks, install drain at water inlet and outlet, thermometer with range of 40 to 200 degrees F, and ASME pressure relief valve suitable for maximum working pressure.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Mop Service Basins
6. Electric water coolers.
7. Showers.
8. Washer/Dryer Box

B. Related Sections:
1. Section 07 92 00 – Joint Sealants: Product requirements for calking between fixtures and building components for placement by this section.
2. Section 22 11 00 - Facility Water Distribution: Supply connections to plumbing fixtures.
3. Section 22 13 00 - Facility Sanitary Sewerage: Waste connections to plumbing fixtures.
4. Division 26 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.02 REFERENCES

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

B. American National Standards Institute (ANSI):
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

C. Air-Conditioning and Refrigeration Institute:
1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.

D. American Society of Mechanical Engineers (ASME):
1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
2. ASME A112.18.1 - Plumbing Fixture Fittings.
3. ASME A112.19.2 - Vitreous China Plumbing Fixtures.

4. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
5. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.

1.03 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. Manufacturer's Installation Instructions: Submit installation methods and procedures.

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

1.04 CLOSEOUT SUBMITTALS

A. Closeout Submittals: Refer to Contract Documents.

B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.05 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. Perform Work in accordance with State of Maryland standard.

C. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc., as suitable for purpose specified and indicated.

D. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

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

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

1.07 PRE-INSTALLATION MEETINGS

A. Pre-installation Meeting.: Refer to Contract Documents.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Product Delivery, Storage, and Handling Requirements: Refer to Contract Documents.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.09 WARRANTY

A. Warranty Requirements: Refer to Contract Documents.

1.10 EXTRA MATERIALS

A. Spare parts and maintenance products: Refer to Contract Documents.

B. Furnish two sets of faucet washers, flush valve service kits, and lavatory supply fittings.

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

2.01 MANUFACTURERS - WATER CLOSETS

A. Wall Mounted Bowl Manufacturers:
   1. American Standard Plumbing Model Afwall FloWise™ 3351.128.
   2. Kohler Co.
   3. Zurn Industries.

B. Wall Mounted Bowl Manufacturers (Physically Disabled):
   1. American Standard Plumbing Model Madera FloWise™ 3351.128.
   2. Kohler Co.
   3. Zurn Industries.

C. Flush Valve Manufacturers (Water Closet):
   1. American Standard Plumbing Model SELECTRONIC FloWise™ 6065.121.002.
   2. Kohler Co.
   3. Zurn Industries.

D. Seat Manufacturers:
   1. American Standard Plumbing Model 5901.100.
   2. Kohler Co.
   3. Zurn Industries.
   4. Church

E. Carrier Manufacturers:
   1. Zurn Industries, Inc.; Model Z-1203-N or Z-1203-H
   2. Josam.
   3. J.R. Smith.

2.02 WALL MOUNTED WATER CLOSET (WC-1)

A. Bowl: ASME A112.19.2; 1.28 GPF, high efficiency, wall mounted, elongated, vitreous china, siphon jet action, 1 1/2-inch top spud.

B. Seat: White hydraulically compressed plastic, elongated open front less cover, self-sustaining, with stainless steel hinge posts and concealed check.

C. Sensor Flush Valves: ASME A112.19.2; Exposed, chrome plated brass, piston or diaphragm type, battery powered, infrared automatic flush sensor, manual over-ride button, 3-second flush delay, automatic flush after 24 hours of non use, 1-inch IPS screwdriver angle stop, with protective chrome-plated metal cover, adjustable tailpiece, vacuum breaker flush connection and spud coupling for 1 1/2-inch top spud, wall and spud flanges, 6-volt lithium battery or equivalent, “low battery” flashing LED, infrared sensor range adjustment screw, 1.28 gallons per flush.

D. Carrier: Coated cast iron, horizontal, no-hub or hub and spigot connection, designed for right-hand, left-hand, or double main fitting with 2-inch vent; adjustable, gasketed face plate, universal floor mounted foot supports, corrosion resistant adjustable ABS coupling with integral test cap, fixture bolts, trim and stud protectors, rear anchor tie-down and bonded gasket;

2.03 WALL MOUNTED WATER CLOSET (WC-1A)

A. Bowl: ASME A112.19.2/CSA B45.1-08; Physically Disabled; 1.28 GPF, high efficiency, wall mounted, elongated, vitreous china, siphon jet action, 1 1/2-inch top spud.

B. Seat: White hydraulically compressed plastic, elongated open front less cover, self-sustaining, with stainless steel hinge posts and concealed check.

C. Sensor Flush Valves: ASME A112.19.2; Exposed, chrome plated brass, piston or diaphragm type, battery powered, infrared automatic flush sensor, manual over-ride button, 3-second flush delay, automatic flush after 24 hours of non use, 1-inch IPS screwdriver angle stop, with protective chrome-plated metal cover, adjustable tailpiece, vacuum breaker flush connection and spud coupling for 1 1/2-inch top spud, wall and spud flanges, 6-volt lithium battery or equivalent, “low battery” flashing LED, infrared sensor range adjustment screw, 1.28 gallons per flush.

D. Carrier: Coated cast iron, horizontal, no-hub or hub and spigot connection, designed for right-hand, left-hand, or double main fitting with 2-inch vent; adjustable, gasketed face plate, universal floor mounted foot supports, corrosion resistant adjustable ABS coupling with integral test cap, fixture bolts, trim and stud protectors, rear anchor tie-down and bonded gasket;

2.04 MANUFACTURERS - URINALS

A. Urinal System:
   1. American Standard Plumbing; Model Washbrook FloWise™ 6590.525.
   2. Kohler Co.
   3. Zurn Industries, Inc.

B. Urinal Carrier
   1. Zurn Industries, Inc.; Model Z-1222
   2. Josam.
   3. J.R. Smith.

2.05 URINALS (UR-1/UR-1A)

A. Urinal: ASME A112.19.2; 0.125 GPF, high efficiency, vitreous china, wall hung washout flush, integral trap, 3/4 inch top spud, 2" threaded outlet connection, steel supporting hanger.

B. Sensor Flush Valve: ASME A112.18.1; exposed, chrome plated, piston or diaphragm type, battery operated solenoid operator, infrared sensor and over-ride button, 3/4" screwdriver stop, adjustable tailpiece, 3/4" top spud, wall and spud flanges and escutcheons, flushes on 0.125 gallons.

C. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.06 MANUFACTURERS - LAVATORIES

A. Lavatory:
1. American Standard Plumbing; Model 0355.012 Lucerne.
2. Kohler Co.
3. Zurn Industries, Inc.

B. Faucet:
1. American Standard Plumbing; Model 6055.105.
2. Kohler Co.
3. Zurn Industries, Inc.

C. Trim:
1. McGuire Manufacturing.
2. Kohler Co.
3. Zurn Industries, Inc.

D. Carrier:
1. Zurn Industries, Inc.; Model Z-1231
2. Josam Mfg.
3. J. R. Smith

E. Trim Insulation Package:
1. Tru-Bro, Inc.; Model Z-1231
2. Pro-Wrap
3. Substitutions: Refer to Contract Documents.

2.07 WALL MOUNTED LAVATORIES (LAV-1/LAV-1A)

A. Bowl: ASME A112.19.2; Vitreous china wall hung lavatory 20 x 18 inch minimum, with 4 inch high back, drillings on 4 inch centers, rectangular basin with splash lip, front overflow, and soap depression.

B. Sensor Faucet: Battery powered, chrome-plated brass construction, 4-inch deck plate, infrared proximity sensor, circuit control module, sensor range adjustment screw, variable time-out settings, low battery LED indicator light, integrated strainer, water resistant solenoid enclosure, solenoid valve, chrome plated grid strainer with 1 1/4-inch outlet tube, metal jacket wire protection for sensor leads, two back checks for hot and cold supplies, Lithium batteries, 0.5 gpm flow with vandal resistant aerator.

1. Mixing Valve: Thermostatic mixing valve; 605XTMV
2. Stainless steel flex hose with 3/8” compression connection, 15” length.

C. Trim:
1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon; Model 8088.
2. Chrome plated, wheel handle, 3/8 inch angle valve.

D. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, concealed arm supports, bearing plate and studs.

2.08 MANUFACTURERS – MOP SERVICE BASIN (MSB-1)

A. Mop Service Basin:
1. Fiat Plumbing Products
2. Stern-Williams
3. Substitutions: Refer to Contract Documents.

B. Faucet:
1. Fiat Plumbing Products
2. Stern-Williams
3. Substitutions: Refer to Contract Documents.

C. Trim:
1. Fiat Plumbing Products
2. Stern-Williams
3. Substitutions: Refer to Contract Documents.

D. Mop Service Basin:
1. Floor mounted molded stone and resin one piece homogeneous unit, 36 x 24 x 10 inch size, with cadmium plated brass drain body and stainless steel combination dome strainer/line basket; Model MSB-3624.
2. Service Faucet: Chrome-plated with vacuum breaker, integral stops, wall brace, pail hook and 3/4" hose thread on spout, four arm handles, body inlets, 8" centers; Model 830-AA.
3. Trim: Vinyl Bumper Guard, 30 inch of 5/8 inch diameter rubber hose, stainless steel hose clamp, stainless steel mop hanger; Model E-77-AA, No. 832-AA, No. 889-CC.

2.09 MANUFACTURERS - ELECTRIC WATER COOLERS

A. Water Cooler:
1. Elkay Manufacturing Co.; Model EZS8
2. Haws Drinking Faucet Co.
3. EBCO Manufacturing Co.

B. Carrier:
1. Zurn Industries; Model Z-1225

2. Josam
3. J.R. Smith

C. Trim:
1. McGuire Manufacturing; Model 165 LK, Model 8088
2. Kohler Co.
3. Zurn Industries, Inc.

2.10 ELECTRIC WATER COOLERS (FOR PHYSICALLY DISABLED)(EWC-1)

A. Barrier Free, wall mounted, delivering 8.0 gallons per hour of 50 degrees F. water at 80 degrees F. inlet water at 90 degrees F. room temperature. Cooling system including: compressor, insulated tank, refrigerant control and thermostat, environmentally friendly 134a refrigerant. Lead free water system. Bubbler valve activated with front/side push pads, built-in pressure regulator, stainless steel basin with integral strainer. Cabinet constructed of heavy gauge steel with finish of vinyl laminated on steel.

B. Capacity: 8.0 gpm of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.

C. Electrical: Power cord and plug for connection to electric wiring system including grounding connector.

D. Carrier: Coated rectangular steel uprights with welded feet, adjustable top and bottom support plates and mounting fasteners.

E. Supply Pipe: 3/8-inch angle valve, wheel handle, 3/8-inch male threaded inlet, escutcheon, flexible tube riser, chrome finish.

F. Drain: Adjustable cast brass P-trap, swivel-ell, 1-1/4-inch inlet, 1-1/4-inch outlet, cleanout plug, chrome finish.

2.11 MANUFACTURER – SHOWER CONTROLS

A. Shower Controls:
1. Symmons; Model S-96-300-B30-L-V-X
2. Powers
3. Substitutions: Refer to Procurement Documents.

2.12 SHOWER CONTROLS (SH-1)

A. Trim: ASME A112.18.1; concealed shower supply with pressure balanced mixing valves, integral service stops, hand held shower with 60 inch metal clad hose and 30 inch slide bar, female inlet.

2.13 MANUFACTURER – SHOWER CONTROLS

A. Shower Controls:

1. Symmons; Model S-96-300-B30-L-V-X
2. Powers
3. Substitutions: Refer to Contract Documents.

2.14 SHOWER CONTROLS (SH-1A)

A. Trim: ASME A112.18.1; concealed shower supply with pressure balanced mixing valves, integral service stops, hand held shower with 60 inch metal clad hose and 30 inch slide bar, female inlet.

2.15 MANUFACTURERS - SINKS

A. Sink:
1. Elkay; Model LR-3122.
2. Just Mfg. Co.
3. Moen

B. Faucet:
1. Elkay; Model LK4O6GNO5T4.
2. Just Mfg. Co.
3. Moen

C. Trim:
1. McGuire Manufacturing.
2. Kohler Co.
3. Zurn Industries, Inc.

2.16 SINKS (S-1)

A. Sink: ASME A112.19.3; 31 x 32 x 7 1/2 inch outside dimensions, 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 3-1/2 inch crumb cup and tailpiece, ledge back drilled for trim.

B. Faucet: ASME A112.18.1; chrome plated brass supply with 5” high gooseneck swing spout, water economy aerator with maximum 2.2 gpm flow, indexed 4” wrist blade handles.

C. Trim:
1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon; Model 8089
2. Chrome plated wheel handle angle stops and flexible supplies: Model 165LK

2.17 WASHER/DRYER BOX (WD-1)

A. Space Saver (Washing Machine) (P-16B)
1. 20 gauge galvanized steel box with 18 gauge cover plate and epoxy finish, mounting holes and screws, ½ inch hot and cold water brass shut-off valves, MIP

connections, bottom inlet, 2-inch PVC drain fitting with rubber washer; Model T200TPPVC.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Refer to Contract Documents.

B. Verify walls and floor finishes are prepared and ready for installation of fixtures.

C. Verify electric power is available and of correct characteristics.

D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Install Work in accordance with State of Maryland standards.

B. Install each fixture with trap, easily removable for servicing and cleaning.

C. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.

D. Install components level and plumb.

E. Install and secure fixtures in place with wall supports or wall carriers and bolts.

F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 00, color to match fixture.

G. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

H. For ADA accessible water closets, install flush valve with handle to wide side of stall.

3.04 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

3.05 ADJUSTING

A. Adjusting Requirements: Refer to Contract Documents.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

A. Cleaning Requirements: Refer to Contract Documents.

B. Clean plumbing fixtures and equipment.

3.07 PROTECTION OF INSTALLED CONSTRUCTION

A. Protection of Installed Construction Requirements: Refer to Contract Documents.

B. Do not permit use of fixtures before final acceptance.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

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

1.2 SUMMARY

A. Section Includes:
   1. Firestopping relating to HVAC work.
   2. Firestopping accessories.

1.3 SYSTEM DESCRIPTION

A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

1.4 SUBMITTALS

A. Shop Drawings: Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

B. Product Data for Pipe and Equipment Identification: Submit for mechanical identification manufacturers catalog literature for each product required.

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.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

A. Install plastic nameplates with adhesive.

B. Install plastic tags with corrosion resistant metal chain.

3.3 INSTALLATION - SLEEVES

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

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

C. Install chrome plated steel escutcheons at finished surfaces.

3.4 INSTALLATION - FIRESTOPPING

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

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section includes single- and three-phase motors for application on equipment provided under other sections.

B. Related Sections:
1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCES

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

B. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

C. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

D. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

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

B. Testing Agency: Company specializing in testing products specified in this section with minimum years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.

D. For extended outdoor storage, remove motors from equipment and store separately.

1.6 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.

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 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

A. Acceptable Manufacturers:
   1. Baldor Electric Company.
   2. Eaton Corp.
   3. General Electric Co.
   4. Marathon Electric Mfg. Corp.
   5. U.S. Motors.

B. Motors 3/4 hp and Larger: Three-phase motor as specified below.

C. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

D. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
   1. Voltage: As indicated on Drawings.
   2. Service Factor: 1.15
   3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
   4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   5. Insulation System: NEMA Class F.
   6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
   7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
   8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
   9. Sound Power Levels: Conform to NEMA MG 1.

E. Single Phase Motors:
   1. Permanent split-capacitor types where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
   2. Voltage: 115 volts, single phase, 60 Hz.

F. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

2.2 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

PART 3 EXECUTION

3.1 EXISTING WORK

A. Disconnect and remove abandoned motors.

B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.

C. Clean and repair existing motors to remain or are to be reinstalled.

3.2 INSTALLATION

A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

B. Install engraved plastic nameplates in accordance with Section 26 05 53.

C. Ground and bond motors in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

A. Field inspecting, testing, adjusting, and balancing. Refer to Contract Documents.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

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

B. Related Sections:
1. Section 03 10 00 - Concrete Forms and Accessories: Execution requirements for placement of sleeves in concrete forms specified by this section.
2. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
3. Section 07 84 00 – Penetration Firestop Systems: Product requirements for firestopping for placement by this section.
4. Section 07 92 00 - Joint Sealants: Product requirements for sealant materials for placement by this section.
5. Section 09 90 00 - Painting & Finishing: Product and execution requirements for painting specified by this section.
6. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and execution requirements for vibration isolators.
7. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

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

B. American Society of Mechanical Engineers:
1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

C. ASTM International:
1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.

2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

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

E. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

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 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

H. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

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 E814 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.
2. Surface Burning: ASTM E84 with maximum flame spread / smoke developed rating of 25/450.

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

1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.

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

1.6 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents

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. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

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

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

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

1.7 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. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage 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.

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

D. 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.

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

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

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

1.8 QUALIFICATIONS

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

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

1.9 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting. Refer to Contract Documents.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

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. Product Requirements: Environmental conditions affecting products on site. 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 WARRANTY

A. Warranty: Refer to Contract Documents.

B. Furnish one year manufacturer warranty for pipe hangers and supports.

1.14 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 PIPE HANGERS AND SUPPORTS

A. Acceptable Manufacturers:
   1. Anvil International, Inc.
   2. Carpenter & Paterson Inc.
   3. Flex-Weld, Inc.
   4. Michigan Hanger Co.

B. Hydronic Piping:
   1. Conform to MSS SP58.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
   4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
   5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
   6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
   8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
   9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
   10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
   11. Vertical Support: Steel riser clamp.
   12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
   15. Copper Pipe Support: Copper-plated, carbon steel ring, adjustable.

2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 SLEEVES

A. Sleeves for Pipes through Non-fire Rated Floors: 18 gage thick galvanized steel.

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

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

E. Sealant: Acrylic.

2.4 FORMED STEEL CHANNEL

A. Acceptable Manufacturers:
   1. Allied Tube & Conduit Corp. Model.
   2. B-Line Systems Model.
   3. Midland Ross Corporation, Electrical Products Division Model.
   4. Unistrut Corp. Model.

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

2.5 FIRESTOPPING

A. Acceptable 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. Project Management & Coordination Requirements: Verification of existing conditions before starting work. Refer to Contract Documents.

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

D. Do not drill or cut structural members.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with MSS SP 58.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

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

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

F. Support vertical piping at every floor.

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 91 00 – Painting & Finishing. 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 23 07 00 – HVAC Insulation.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00 – Cast-in-Place Concrete.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 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 or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with 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.

3.6 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, 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. Fire Rated Surface:
   1. Seal opening at wall, partition, 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.

2. Where conduit, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

E. Non-Rated Surfaces:

1. Seal opening through non-fire rated wall, partition 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.
4. Interior partitions: Seal pipe penetrations at telecommunication rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.7 FIELD QUALITY CONTROL

A. Field inspecting, testing, adjusting, and balancing. Refer to Contract Documents.

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

3.8 CLEANING

A. Requirements for cleaning. Refer to Contract Documents.

B. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

A. Requirements for protecting finished Work. Refer to Contract Documents.

B. Protect adjacent surfaces from damage by material installation.

3.10 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 2)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4
10	18	22	3/4	7/8
12	19	23	3/4	7/8
14	22	25	7/8	1
16	23	27	7/8	1
18	25	28	1	1
20	27	30	1	1-1/4
24	28	32	1-1/4	1-1/4

B. Plastic and Ductile Iron Pipe Hanger Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
ABS (All sizes)	4	3/8
FRP (All Sizes)	4	3/8
Ductile Iron (Note 2)		
PVC (All Sizes)	4	3/8

C. Note 1: Refer to manufacturer’s recommendations for grooved end piping systems.

D. Note 2: 20 feet maximum spacing, minimum of one hanger for each pipe section close to joint behind bell. Provide hanger at each change of direction and each branch connection. For pipe sizes 6 inches and smaller, subjected to loadings other than weight of pipe and contents, limit span to maximum spacing for water service steel pipe.

END OF SECTION

SECTION 23 05 48

VIBRATION NOISE AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vibration isolators.

B. Related Sections:
   1. Section 07 92 00 – Joint Sealants: Product requirements for joint sealers specified for placement by this section.
   2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports.
   3. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC Equipment: Requirements for sound and vibration measurements performed independent of this section.

1.2 REFERENCES

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

B. Air Movement and Control Association International, Inc.:
   1. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

C. American National Standards Institute:
   1. ANSI S1.4 - Sound Level Meters.
   2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
   3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
   4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

D. Air-Conditioning and Refrigeration Institute:
   1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.

E. American Society of Heating, Refrigerating and:
   1. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
   2. ASHRAE Handbook - HVAC Applications.

F. ASTM International:

1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.

G. Sheet Metal and Air Conditioning Contractors':
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
2. SMACNA – SEISMIC RESTRAINT MANUAL – Guidelines for Mechanical Systems

1.3 PERFORMANCE REQUIREMENTS

A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping and ductwork.

B. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

C. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook., HVAC Applications
1. Offices
   a. Executive: 30
   b. Conference rooms: 30
   c. Private: 30
   d. Open-plan areas: 40
   e. Computer/business machine areas: 45
   f. Public circulation: 40

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

C. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.

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

E. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.5 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of cross-talk silencers. Record actual locations of hangers including attachment points.

1.6 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. Perform Work in accordance with AMCA 300 standards and recommendations of ASHRAE 68.

1.7 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.

1.8 PRE-INSTALLATION MEETINGS

A. Pre-installation: Refer to Contract Documents.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Warranty: Refer to Contract Documents.

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 VIBRATION ISOLATORS

A. Acceptable Manufacturers:
   1. Flex-Weld/ Keflex, Inc.
   2. Mason Industries
   3. Vibration Mountings and Controls, Inc.

B. Spring Hanger:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
   4. Misalignment: Capable of 20 degree hanger rod misalignment.

C. Neoprene Pad Isolators:
   1. Rubber or neoprene-waffle pads.
      a. 30 durometer.
      b. Minimum 1/2 inch thick.
      c. Maximum loading 40 psi.
      d. Height of ribs: not to exceed 0.7 times width.
   2. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

D. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

E. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

PART 3 EXECUTION

3.1 EXAMINATION

A. Project Management & Coordination: Refer to Contract Documents.

B. Verify equipment, ductwork and piping is installed before work in this section is started.

3.2 INSTALLATION

A. Install isolation for motor driven equipment.

B. Adjust equipment level.

C. Install spring hangers without binding.

D. Support piping connections to isolated equipment resiliently for scheduled distance. as follows:
   1. Up to 4 inch Diameter: First three points of support.
   2. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

A. Close-out Procedures: Field inspecting, testing, adjusting, and balancing. Refer to Contract Documents.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

D. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Pipe markers.
   4. Ceiling tacks.
   5. Labels.

B. Related Sections:
   1. Section 09 90 00 - Painting & Finishing: Execution requirements for painting specified by this section.

1.2 REFERENCES

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

B. American Society of Mechanical Engineers:
   1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit manufacturers 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.

1.4 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

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

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. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

1.6 QUALIFICATIONS

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

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

1.7 PRE-INSTALLATION MEETINGS

A. Pre-installation meetings: Refer to Contract Documents.

1.8 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.9 EXTRA MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

1.10 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 NAMEPLATES

A. Acceptable Manufacturers:
   1. Brady Corporation
   2. Champion America, Inc.
   3. Craftmark Identification Systems
   4. Seton Identification Products

B. Product Description: Laminated three-layer plastic with engraved white letters on black background color.

2.2 TAGS

A. Metal Tags:
   1. 18-gage stainless steel with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

B. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1. Coordinate with Section 09 90 00.

B. Plastic Pipe Markers:
   1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

2.4 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color-coded head.

B. Color code as follows:
   1. HVAC equipment: Yellow.
   2. Fire dampers/smoke dampers: Red.
   3. Plumbing valves: Green.
   4. Heating/cooling valves: Blue.

2.5 LABELS

A. Description: Aluminum, size 1.9 inches x 0.75 inches, adhesive backed with printed identification.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Identify air terminal units and radiator valves with numbered tags.

I. Tag automatic controls, instruments, and relays. Key to control schematic.

J. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

K. Identify ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

L. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of hydronic systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.

B. Related Sections:
1. Section 23 09 23 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
2. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 REFERENCES

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

B. Associated Air Balance Council:
1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

D. Natural Environmental Balancing Bureau:
1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or NEBB Report forms.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or Copy of NEBB Certificate of Conformance Certification.

F. Submit draft copies of report for review prior to final acceptance of Project.

G. Furnish reports in hard soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of balancing valves and rough setting.

C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

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. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

C. Prior to commencing Work, calibrate each instrument to be used.

1.6 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC or Certified by NEBB. Perform Work under supervision of

AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.7 PRE-INSTALLATION MEETINGS

A. Pre-installation Meetings: Refer to Contract Documents.

1.8 SEQUENCING

A. Summary of Work: Work sequence. Refer to Contract Documents.

B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

A. Project Management & Coordination: Refer to Contract Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Adjusting: Refer to Contract Documents.

B. Verify recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

E. Report defects and deficiencies noted during performance of services, preventing system balance.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. At modulating damper locations, take measurements and balance at extreme conditions.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.

M. Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Balance systems similar to constant-volume air systems.
   2. Set terminal units and supply fan at full-airflow condition.
   3. Adjust inlet dampers of each terminal unit to design airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   4. Readjust fan airflow for final maximum readings.
   5. Measure operating static pressure at the sensor that controls the bypass damper and verify operation of the static-pressure controller.
   6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
   7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.6 WATER SYSTEM PROCEDURE

A. Adjust water systems, after air balancing, to obtain design quantities.

B. Use calibrated fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.

C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing, when included in the Project, includes, but may not be limited to:
   1. Plumbing and Heating Pumps.
   2. Split System Air Conditioning Units.
   3. Energy Recovery Units.
   4. Terminal Heat Transfer Units.
   5. Fans.
   6. Air Inlets and Outlets.

B. Report Forms
   1. Title Page:
      a. Name of Testing, Adjusting, and Balancing Agency
      b. Address of Testing, Adjusting, and Balancing Agency
      c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
      d. Project name
      e. Project location
      f. Project Architect
      g. Project Engineer
      h. Project Contractor
      i. Project altitude

j. Report date

2. Summary Comments:
   a. Design versus final performance
   b. Notable characteristics of system
   c. Description of systems operation sequence
   d. Summary of outdoor and exhaust flows to indicate building pressurization
   e. Nomenclature used throughout report
   f. Test conditions
3. Instrument List:
   a. Instrument
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Range
   f. Calibration date
4. Electric Motors:
   a. Manufacturer
   b. Model/Frame
   c. HP/BHP and kW
   d. Phase, voltage, amperage; nameplate, actual, no load
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
   h. Sheave Make/Size/Bore
5. V-Belt Drive:
   a. Identification/location
   b. Required driven RPM
   c. Driven sheave, diameter and RPM
   d. Belt, size and quantity
   e. Motor sheave diameter and RPM
   f. Center to center distance, maximum, minimum, and actual
6. Pump Data:
   a. Identification/number
   b. Manufacturer
   c. Size/model
   d. Impeller
   e. Service
   f. Design flow rate, pressure drop, BHP and kW
   g. Actual flow rate, pressure drop, BHP and kW
   h. Discharge pressure
   i. Suction pressure
   j. Total operating head pressure
   k. Shut off, discharge and suction pressures
   l. Shut off, total head pressure
7. Air Moving Equipment:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number

e. Arrangement/Class/Discharge
f. Air flow, specified and actual
g. Return air flow, specified and actual
h. Outside air flow, specified and actual
i. Total static pressure (total external), specified and actual
j. Inlet pressure
k. Discharge pressure
l. Sheave Make/Size/Bore
m. Number of Belts/Make/Size
n. Fan RPM

8. Return Air/Outside Air Data:
   a. Identification/location
   b. Design air flow
   c. Actual air flow
   d. Design return air flow
   e. Actual return air flow
   f. Design outside air flow
   g. Actual outside air flow
   h. Return air temperature
   i. Outside air temperature
   j. Required mixed air temperature
   k. Actual mixed air temperature
   l. Design outside/return air ratio
   m. Actual outside/return air ratio
9. Exhaust Fan Data:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Air flow, specified and actual
   f. Total static pressure (total external), specified and actual
   g. Inlet pressure
   h. Discharge pressure
   i. Sheave Make/Size/Bore
   j. Number of Belts/Make/Size
   k. Fan RPM
10. Duct Traverse:
   a. System zone/branch
   b. Duct size
   c. Area
   d. Design velocity
   e. Design air flow
   f. Test velocity
   g. Test air flow
   h. Duct static pressure
   i. Air temperature
   j. Air correction factor
11. Terminal Unit Data:
   a. Manufacturer
   b. Type, constant, variable, single, dual duct

c. Identification/number
d. Location
e. Model number
f. Size
g. Minimum static pressure
h. Minimum design air flow
i. Maximum design air flow
j. Maximum actual air flow
k. Inlet static pressure

12. Air Distribution Test Sheet:
    a. Air terminal number
    b. Room number/location
    c. Terminal type
    d. Terminal size
    e. Area factor
    f. Design velocity
    g. Design air flow
    h. Test (final) velocity
    i. Test (final) air flow
    j. Percent of design air flow
13. Sound Level Report:
    a. Location
    b. Octave bands - equipment off
    c. Octave bands - equipment on
    d. RC level - equipment on

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Piping system insulation.
2. Pipe insulation jackets.
3. Ductwork insulation.
4. Insulation accessories including vapor retarders and accessories.

B. Related Sections:
1. Section 07 84 00 – Penetration Firestop Systems: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 – Painting & Finishing: Execution requirements for painting insulation jackets and covering specified by this section.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and Execution requirements for inserts at hanger locations.
4. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for HVAC piping and equipment identification.

1.2 REFERENCES

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

B. ASTM International:
1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
10. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
11. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
12. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
13. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
14. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
15. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
16. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
17. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
18. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
19. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
20. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
21. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
22. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
23. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
24. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
25. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
26. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

C. Sheet Metal and Air Conditioning Contractors':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

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

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. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.

1.5 QUALIFICATIONS

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

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

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. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements: Refer to Contract Documents.

B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

C. Maintain temperature during and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Product warranties and product bonds. Refer to Contract Documents.

B. Furnish five year manufacturer warranty for man-made fiber.

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 CELLULAR GLASS

A. Acceptable Manufacturers:
   1. Pittsburgh Corning

B. Insulation: ASTM C552, Type II - pipe and tubing insulation, Class 2 - Jacketed.
   1. 'K' ('ksi') factor: ASTM C177 or ASTM C518, 0.29 at 75 degrees F.

2.2 RIGID GLASS FIBER

A. Acceptable Manufacturers:
   1. CertainTeed Corporation
   2. Johns Manville
   3. Knauf Insulation

B. Insulation: ASTM C612 Glass Fiber Pipe Insulation, Type I, 850 degrees F.

C. Insulation: ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' factor: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 650 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.

D. Vapor Retarder Jacket:
   1. ASTM C1136, White Kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Vapor Retarder Lap Adhesive:
   1. Compatible with insulation.

G. Insulating Cement/Mastic:
   1. ASTM C195; hydraulic setting on mineral wool.

H. Glass Fiber Fabric:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.
   3. Weave: 5 x 5.

2.3 GLASS FIBER, FLEXIBLE

A. Acceptable Manufacturers:
   1. CertainTeed Corporation
   2. Johns Manville
   3. Knauf Insulation

B. Insulation: ASTM C553 Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications, Type II.

C. Vapor Retarder Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm.
   3. Secure with pressure sensitive tape.

D. Vapor Retarder Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.4 ELASTOMERIC CELLULAR FOAM

A. Acceptable Manufacturers:
   1. Armacell
   2. Rubatex

B. Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular form: ASTM C534; Type I, Tubular form.

C. Elastomeric Foam Adhesive:
   1. Air dried, contact adhesive, compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Project Management & Coordination Requirements: Refer to Contract Documents.

B. Verify piping, equipment and ductwork has been tested before applying insulation materials.

C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Exposed Piping: Locate insulation and cover seams in least visible locations.

B. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

C. Cellular glass insulated pipes conveying fluids below ambient temperature:
   1. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Cover with 0.016” aluminum jacket.

D. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

E. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

F. Inserts and Shields:
   1. Application: Piping or Equipment 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under finish jacket.
   4. Insert configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
   5. Insert material: Compression resistant insulating material suitable for planned temperature range and service.

G. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 10 – Penetration Firestop Systems for penetrations of assemblies with fire resistance rating greater than one hour.

H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

I. Factory Insulated Equipment: Do not insulate.

J. Exposed Equipment: Locate insulation and cover seams in least visible locations.

K. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

L. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

M. Insulated equipment containing fluids below ambient temperature: Insulate entire system.

N. Cellular glass insulated equipment containing fluids below ambient temperature: rigid pre-molded cellular glass.

O. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

P. Glass fiber insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor retarder, factory-applied or field-applied. Finish with glass cloth and adhesive.

Q. Finish insulation at supports, protrusions, and interruptions.

R. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

S. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

T. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

U. Insulated ductwork conveying air below ambient temperature (including exposed ductwork):
   1. Provide insulation with vapor retarder jackets.
   2. Finish with tape and vapor retarder jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.

4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

V. Insulated ductwork conveying air above ambient temperature:
1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
3. Ductwork conveying air above ambient temperature exposed in the space it is serving does not require insulation.

3.3 SCHEDULES

A. Heating Systems:
1. Heating Water Supply and Return:
a. Glass Fiber Insulation:
1) Pipe Size Range: 3” and smaller
2) Thickness: 1 inch.
b. Glass Fiber Insulation:
1) Pipe Size Range: 4” and larger
2) Thickness: 1-1/2 inch.

B. Cooling Systems:
1. Chilled Water Supply and Return:
a. Cellular Glass Insulation:
1) All Pipe Sizes:
2) Thickness: 2 inch
2. Refrigerant Suction:
a. Elastomeric Cellular Foam:
1) All Pipe Sizes:
2) Thickness: 1 inch

C. Exhaust Ducts Within 10 feet of Exterior Openings: Man Made Mineral Fiber, Flexible; thickness1-1/2-inches.

D. Supply Ducts: Man Made Mineral Fiber, Flexible; thickness1-1/2-inches.

E. Return and Relief Ducts: Man Made Mineral Fiber, Flexible; thickness1-1/2-inches.

F. HVAC condensate drains above suspended ceilings: ½” Elastomeric cellular foam.

END OF SECTION

SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section includes control equipment and software.

B. Related Sections:
1. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
2. Section 26 05 00 – Common Work Results for Electrical: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

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

B. American National Standards Institute:
1. ANSI MC85.1 - Terminology for Automatic Control.

1.3 SYSTEM DESCRIPTION

A. Provide computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

B. Refer to individual equipment specification sections.

C. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.

D. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate the following:
1. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.

2. Connected data points, including connected control unit and input device.
3. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations. Submit demonstration diskette containing graphics.
4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
5. Description and sequence of operation for operating, user, and application software.
6. Use terminology in submittals conforming to ASME MC85.1.
7. Coordinate submittals with information requested in Section 23 09 93.
8. Product Data:
    a. Submit data for each system component and software module. Additionally, provide catalog cuts for the lighting low voltage switch identification nameplates, include drawings of nametags.

C. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.

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

1.5 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
2. Submit data specified in "Submittals" in final "Record Documents" form.

C. Operation and Maintenance Data:
1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered system components and devices.
2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

1.6 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.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities based within 100 miles of Project.

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

1.8 PRE-INSTALLATION MEETINGS

A. Pre-installation Meetings: Refer to Contract Documents.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Product warranties and product bonds. Refer to Contract Documents.

B. Furnish five year manufacturer warranty for direct digital controls.

1.11 MAINTENANCE SERVICE

A. Requirements for maintenance service. Refer to Contract Documents.

B. Furnish service and maintenance of control systems for one year from Date of Substantial Completion.

C. Furnish complete service of controls systems, including callbacks. Make minimum of two complete normal inspections of approximately four hours duration in addition to normal service calls to inspect, calibrate, and adjust controls. Submit written report after each inspection.

D. Furnish two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls. Submit written report after each inspection.

E. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

F. Perform work without removing units from service during building normal occupied hours.

G. Provide emergency call back service during working hours for this maintenance period.

H. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

I. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

J. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.12 EXTRA MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

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 and construction 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 DIRECT DIGITAL CONTROLS - GENERAL DESCRIPTION

A. Acceptable Manufacturers:
   1. Automated Logic
   2. Johnson Controls Inc.
   3. Trane Inc.
   4. Honeywell

B. Automatic temperature controls, field monitoring and control system using field programmable microprocessor based units.

C. Provide computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

D. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.

E. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.2 PORTABLE OPERATOR'S TERMINAL

A. Furnish device capable of accessing system data and capable of being connected to any point on system network or connected directly to any controller for programming, set-up, and troubleshooting. Portable Operators Terminal uses Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135, to communicate with BACnet objects in internetwork. Objects supported include: Analog input, analog output, analog value, binary input, binary output, binary value, device.

2.3 CONTROL UNITS

A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.

B. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.

C. Control Units Functions:
   1. Monitor or control each input/output point.
   2. Completely independent with hardware clock/calendar and software to maintain control independently.
   3. Acquire, process, and transfer information to operator station or other control units on network.
   4. Accept, process, and execute commands from other control unit's or devices or operator stations.
   5. Access both data base and control functions simultaneously.
   6. Record, evaluate, and report changes of state or value occurring among associated points. Continue to perform associated control functions regardless of status of network.
   7. Perform in stand-alone mode:
      a. Start/stop.
      b. Duty cycling.
      c. Automatic Temperature Control.
      d. Demand control via a sliding window, predictive algorithm.
      e. Event initiated control.
      f. Calculated point.
      g. Scanning and alarm processing.
      h. Full direct digital control.
      i. Trend logging.
      j. Global communications.
      k. Maintenance scheduling.

D. Global Communications:
   1. Broadcast point data onto network, making information available to other system controls units.
   2. Transmit input/output points onto network for use by other control units and use data from other control units.

E. Input/output Capability:
   1. Discrete/digital input (contact status).
   2. Discrete/digital output.
   3. Analog input.
   4. Analog output.
   5. Pulse input (5 pulses/second).
   6. Pulse output (0-655 seconds in duration with 0.01-second resolution).

F. Monitor, control, or address data points. Include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs. Furnish control units with minimum 30 percent spare capacity.

G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.

H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard-wired LAN or 60 seconds over voice grade phone lines.

I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
   1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from workstation.
   2. Control output points but change only database state or value; leave external field hardware unchanged.
   3. Enable control-actions on output points but change only data base state or value.

J. Local display and adjustment panel: Integral to control-unit containing digital display, and numerical keyboard. Display and adjust:
   1. Input/output point information and status.
   2. Controller set points.
   3. Controller tuning constants.
   4. Program execution times.
   5. High and low limit values.
   6. Limit differential.
   7. Set/display date and time.
   8. Control outputs connected to the network.
   9. Automatic control outputs.
   10. Perform control unit diagnostic testing.

K. Points in "Test" mode.

2.4 LOCAL AREA NETWORKS (LAN):

A. Furnish communication between control units over local area network (LAN).

B. LAN Capacity: Not less than 60 stations or nodes.

C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.

D. LAN Data Speed: Minimum 19.2 Kb.

E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

G. Network Support: Time for global point to be received by any station, less than 3 seconds. Furnish automatic reconfiguration when station is added or lost. In event transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.5 OPERATING SYSTEM SOFTWARE

A. Input/output Capability From Operator Station:
1. Request display of current values or status in tabular or graphic format.
2. Command selected equipment to specified state.
3. Initiate logs and reports.
4. Change analog limits.
5. Add, delete, or change points within each control unit or application routine.
6. Change point input/output descriptors, status, alarm descriptors, and unit descriptors.
7. Add new control units to system.
8. Modify and set up maintenance scheduling parameters.
9. Develop, modify, delete or display full range of color graphic displays.
10. Automatically archive select data even when running third party software.
11. Capability to sort and extract data from archived files and to generate custom reports.
12. Support two printer operations.
13. Alarm printer: Print alarms, operator acknowledgments, action messages, system alarms, operator sign-on and sign-off.
14. Data printer: Print reports, page prints, and data base prints.
15. Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
16. Print selected control unit database.

B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.

C. Data Base Creation and Support: Use standard procedures for changes. Control unit automatically checks workstation data base files upon connection and verify data base match. Include the following minimum capabilities:
   1. Add and delete points.
   2. Modify point parameters.
   3. Change, add, or delete English language descriptors.
   4. Add, modify, or delete alarm limits.
   5. Add, modify, or delete points in start/stop programs, trend logs, and other items.
   6. Create custom relationship between points.
   7. Create or modify DDC loops and parameters.
   8. Create or modify override parameters.
   9. Add, modify, and delete applications programs.
   10. Add, delete, develop, or modify dynamic color graphic displays.

D. Dynamic Color Graphic Displays:
   1. Utilizes custom symbols or system supported library of symbols.
   2. Sixteen (16) colors.
   3. Sixty (60) outputs of real-time live dynamic data for each graphic.
   4. Dynamic graphic data.
   5. 1,000 separate graphic pages.
   6. Modify graphic screen refresh rate between 1 and 60 seconds.

E. Operator Station:
   1. Accept data from LAN as needed without scanning entire network for updated point data.
   2. Interrogate LAN for updated point data when requested.
   3. Allow operator command of devices.
   4. Allow operator to place specific control units in or out of service.
   5. Allow parameter editing of control units.
   6. Store duplicate data base for every control unit and allow down loading while system is on line.
   7. Control or modify specific programs.
   8. Develop, store and modify dynamic color graphics.
   9. Data archiving of assigned points and support overlay graphing of this data using up to four (4) variables.

F. Alarm Processing:
   1. Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state or value and alarms causing automatic dial-out.
   2. Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
   3. Print on line changeable message, up to 60 characters in length, for each alarm point specified.
   4. Display alarm reports on video. Display multiple alarms in order of occurrence.
   5. Define time delay for equipment start-up or shut down.
   6. Allow unique routing of specific alarms.
   7. Operator specifies when alarm requires acknowledgment.
   8. Continue to indicate unacknowledged alarms after return to normal.

9. Alarm notification:
10. Print automatically.
11. Display indicating alarm condition.
12. Selectable audible alarm indication.

G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change of state, specified state, or alarm occurrence or return to normal.

H. Automatic Restart: Automatically start field equipment on restoration of power. Furnish time delay between individual equipment restart and time of day start/stop.

I. Messages:
1. Automatically display or print user-defined message subsequent to occurrence of selected events.
2. Compose, change, or delete message.
3. Display or log message at any time.
4. Assign any message to event.

J. Reports:
1. Manually requested with time and date.
2. Long term data archiving to hard disk.
3. Automatic directives to download to transportable media including floppy diskettes for storage.
4. Data selection methods to include data base search and manipulation.
5. Data extraction with mathematical manipulation.
6. Data reports to allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
7. Generating reports either normally at operator direction, or automatically under workstation direction.
8. Either manually display or print reports. Automatically print reports on daily, weekly, monthly, yearly or scheduled basis.
9. Include capability for statistical data manipulation and extraction.
10. Capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.

K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.

L. Data Collection:
1. Automatically collect and store in disk files.
2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2-year period.
3. Daily consumption for up to 30 meters over a 2 year period.
4. Daily billable electrical energy consumption and time for up to 1024 zones over a 10 year period.
5. Archiving of stored data for use with system supplied custom reports.

M. Graphic Display: Support graphic development on work station with software features:
   1. Page linking.
   2. Generate, store, and retrieve library symbols.
   3. Single or double height characters.
   4. Sixty (60) dynamic points of data for each graphic page.
   5. Pixel level resolution.
   6. Animated graphics for discrete points.
   7. Analog bar graphs.
   8. Display real time value of each input or output line diagram fashion.

N. Maintenance Management:
   1. Run time monitoring, for each point.
   2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
   3. Equipment safety targets.
   4. Display of maintenance material and estimated labor.
   5. Target point reset, for each point.

O. Advisories:
   1. Summary containing status of points in locked out condition.
   2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
   3. Report of power failure detection, time and date.
   4. Report of communication failure with operator device, field interface unit, point and programmable control unit.

2.6 LOAD CONTROL PROGRAMS

A. General: Support inch-pounds and S.I. metric units of measurement.

B. Demand Limiting:
   1. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
   2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
   3. Forecast demand (kW): Predicted by sliding window method.
   4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
   5. Demand Target: Minimum of 3 for each demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
   6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
   7. Limits: Include control band (upper and lower limits).
   8. Output advisory when loads are not available to satisfy required shed quantity, advise shed requirements and requiring operator acknowledgment.

C. Duty Cycling:

1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by equal quantity off portion is reduced.
3. Set and modify following parameters for each individual load.
    a. Minimum and maximum off time.
    b. On/Off time in one-minute increments.
    c. Time period from beginning of interval until cycling of load.
    d. Manually override the DDC program and place a load in an On or Off state.
    e. Cooling Target Temperature and Differential.
    f. Heating Target Temperature and Differential.
    g. Cycle off adjustment.

D. Automatic Time Scheduling:
1. Self-contained programs for automatic start/stop/scheduling of building loads.
2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
3. Special day's schedule supporting up to 30 unique date/duration combinations.
4. Number of loads assigned to time program; with each load having individual time program.
5. Each load assigned at least 16 control actions for each day with 1 minute resolution.
6. Furnish the following time schedule operations:
    a. Start.
    b. Optimized Start.
    c. Stop.
    d. Optimized Stop.
    e. Cycle.
    f. Optimized Cycle.
7. Capable of specifying minimum of 30 holiday periods up to 100 days in length for the year.
8. Create temporary schedules.
9. Broadcast temporary "special day" date and duration.

E. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
2. Adaptive and self-tuning, adjusting to changing conditions unattended.
3. For each point under control, establish and modify:
    a. Occupancy period.
    b. Desired temperature at beginning of occupancy period.
    c. Desired temperature at end of occupancy period.

F. Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set-point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.

G. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.
   1. Employ arithmetic, algebraic, Boolean, and special function operations.
   2. Treat calculated values like any other analog value; use for any function where a "hard wired point" might be used.

H. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.
   1. Define time interval between each control action between 0 to 3600 seconds.
   2. Output may be analog value.
   3. Provide for "skip" logic.
   4. Verify completion of one action before proceeding to next action. When not verified, program capable of skipping to next action.

I. Direct Digital Control: Furnish with each control unit Direct Digital Control software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
   1. Control loops: Defined using "modules" are analogous to standard control devices.
   2. Output: Paired or individual digital outputs for pulse width modulation, and analog outputs.
   3. Firmware:
      a. PID with analog or pulse-width modulation output.
      b. Floating control with pulse-width modulated outputs.
      c. Two-position control.
      d. Primary and secondary reset schedule selector.
      e. Hi/Low signal selector.
      f. Single pole double-throw relay.
      g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
   4. Direct Digital Control loop: Downloaded upon creation or on operator request. On sensor failure, program executes user defined failsafe output.
   5. Display: Value or state of each of lines interconnecting DDC modules.

J. Fine Tuning Direct Digital Control PID or floating loops:
   1. Display information:
      a. Control loop being tuned.
      b. Input (process) variable.
      c. Output (control) variable.
      d. Set-point of loop.
      e. Proportional band.
      f. Integral (reset) Interval.
      g. Derivative (rate) Interval.
   2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" versus "variable".

K. Trend logging:
   1. Each control unit capable of storing samples of control unit's data points.
   2. Update file continuously at operator assigned intervals.

3. Automatically initiate upload requests and then stores data on hard disk.
4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
5. Co-ordinate sampling with specified on/off point- state.
6. Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

2.7 HVAC CONTROL PROGRAMS

A. General:
1. Support Inch-pounds and S.I. metric units of measurement.
2. Identify each HVAC Control system.

B. Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
4. Use outside air temperature to determine early shut down with ventilation override.
5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
6. Operator commands:
   a. Define term schedule.
   b. Add/delete fan status point.
   c. Add/delete outside air temperature point.
   d. Add/delete mass temperature point.
   e. Define heating/cooling parameters.
   f. Define mass sensor heating/cooling parameters.
   g. Lock/unlock program.
   h. Request optimal run-time control summary.
   i. Request optimal run-time mass temperature summary.
   j. Request HVAC point summary.
   k. Request HVAC saving profile summary.
7. Control Summary:
   a. HVAC Control system begin/end status.
   b. Optimal run time lock/unlock control status.
   c. Heating/cooling mode status.
   d. Optimal run time schedule.
   e. Start/Stop times.
   f. Selected mass temperature point ID.
   g. Optimal run-time system normal start-times.
   h. Occupancy and vacancy times.
   i. Optimal run time system heating/cooling mode parameters.
8. Mass temperature summary:
   a. Mass temperature point type and ID.
   b. Desired and current mass temperature values.

c. Calculated warm-up/cool-down time for each mass temperature.
d. Heating/cooling season limits.
e. Break point temperature for cooling mode analysis.

9. HVAC point summary:
   a. Control system identifier and status.
   b. Point ID and status.
   c. Outside air temperature point ID and status.
   d. Mass temperature point ID and status.
   e. Calculated optimal start and stop times.
   f. Period start.

2.8 PROGRAMMING APPLICATION FEATURES

A. Trend Point:
   1. Sample points, real or computed, with each point capable of collecting samples at intervals specified in minutes, hours, days, or month.
   2. Output trend logs as line-graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern color, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:
   1. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totaled point's warning limit, hardware elements advisories.
   2. Output assigned alarm with "message requiring acknowledgment".
   3. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:
   1. Automatically initiate equipment or system commands, based on selected time schedule for points specified.
   2. Program times for each day of week, for each point, with one minute resolution.
   3. Automatically generate alarm output for points not responding to command.
   4. Allow for holidays, minimum of 366 consecutive holidays.
   5. Operator commands:
      a. System logs and summaries.
      b. Start of stop point.
      c. Lock or unlock control or alarm input.
      d. Add, delete, or modify analog limits and differentials.
      e. Adjust point operation position.
      f. Change point operational mode.
      g. Open or close point.
      h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
      i. Begin or end point totals.
      j. Modify total values and limits.

k. Access or secure point.
l. Begin or end HVAC or load control system.
m. Modify load parameter.
n. Modify demand limiting and duty cycle targets.

6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:

1. Permit events to occur, based on changing condition of one or more associated master points.
2. Binary contact, high/low limit of analog point or computed point capable of being used as master. Master capable of monitoring or commanding multiple slaves.
3. Operator commands:
   a. Define single master/multiple master interlock process.
   b. Define logic interlock process.
   c. Lock/unlock program.
   d. Enable/disable interlock process.
   e. Execute terminate interlock process.
   f. Request interlock type summary.

2.9 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Section 26 05 03.

B. Disconnect Switch: Factory-mount in control panel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify conditioned power supply is available to control units and to operator workstation.

C. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93 – Sequence of Operations for HVAC Controls.

C. Install with 120 volts alternating current, 15 amps dedicated emergency power circuit to each programmable control unit.

D. Install conduit and electrical wiring in accordance with Section 26 05 00 - Common Work Results for Electrical and Section 26 27 26 – Wiring Devices.

E. Install electrical material and installation in accordance with appropriate requirements of Division 26.

3.3 MANUFACTURER'S FIELD SERVICES

A. Manufacturer’s Field Services: Refer to Contract Documents.

B. Start and commission systems. Allow adequate time for start-up and commissioning prior to placing control systems in permanent operation.

C. Furnish service technician employed by system installer to instruct Owner's representative in operation of systems plant and equipment for a 2 day period.

3.4 DEMONSTRATION AND TRAINING

A. Requirements for demonstration and training. Refer to Contract Documents.

B. Furnish basic operator training for 4 persons on data display, alarm and status descriptors, requesting data, execution commands and log requests. Include a minimum of 40 hours instructor time. Furnish training on site.

C. Demonstrate complete and operating system to Owner.

END OF SECTION

SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes sequence of operation for:

1. Safety Devices
2. Hot water boilers and heating system.
3. Air-cooled chiller.
4. In-row coolers.
5. Split system air conditioning units.
6. Energy recovery systems.
7. Electric heaters.
8. Gas unit heaters.
9. Exhaust fans.
10. VAV terminals
11. Ductless split systems.
12. Air curtains.
13. Fuel Oil Tank – Leak Detection Alarm

B. Related Sections:
1. Section 23 09 23 - Direct-Digital Control System for HVAC: For equipment, devices, system components, and software to implement sequences of operation.

1.2 REFERENCES

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

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate mechanical system controlled and control system components.
1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
2. Submit flow diagrams for each control system, graphically depicting control logic.

3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
4. Coordinate submittals with information requested in Section 23 09 23 Direct-Digital Control System for HVAC.

1.4 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

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.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 SAFETY DEVICES:

A. Freeze Protection: Stop fans and close outside air dampers on all air handling units or other devices with water coils, if temperature before supply fan is below 37 degrees F; signal alarm.

B. High Temperature Protection: Stop fans and close outside dampers on all fuel-fired devices, if temperature in return air is above 140 degrees F; signal alarm.

C. Smoke Detector: Stop fans, close outside and relief dampers if smoke is detected; signal alarm.
1. Provide smoke detector in return air duct of systems over 2,000 CFM in accordance with mechanical code (IMC, latest edition). This includes return, exhaust, and relief air systems and equipment.
2. Provide smoke detector in supply air duct of systems over 2,000 CFM in accordance with NFPA 90A.

3.2 HEATING HOT WATER CONTROL

A. The hot water pump(s) and the boiler(s) shall be energized below 65 degrees F outdoor temperature and de-energized above 65 degrees F (adjustable).

B. Control heating water supply temperature set at 180 degrees F in accordance with outdoor reset schedule by modulating three-way control valve.
   1. Control heating water at maximum 180 degrees F at outdoor temperature of 0 degrees F and minimum 120 degrees F at outdoor temperature of 65 degrees F, with straight-line relationship between.

C. Provide a return water sensor input to the DDC controller.

D. When a boiler is energized, the two-position, spring return, normally closed, motor operated damper(s) shall open to provide combustion air.

3.3 AIR-COOLED CHILLERS

A. Chillers and Chilled Water Circulating Pumps
   1. Air cooled chillers and associated pumps shall be controlled by micro-processor controller furnished by equipment manufacturer. Furnish and install all controls and control wiring in accordance with manufacturer's installation instructions.

3.4 IN-ROW COOLERS

A. In-row coolers shall be controlled by micro-processor controller furnished by equipment manufacturer. Furnish and install all controls and control wiring in accordance with manufacturer's installation instructions.

3.5 SPLIT SYSTEM AIR CONDITIONING AND HEAT PUMP UNITS

B. Occupied mode:
   1. The outside air damper will open to the set position, and supply fan energized.
   2. Space temperature will be controlled by:
      a. DX coil in cooling mode
      b. Control valves associated with duct coils.
      c. Set points 70F heating, 75F cooling (adjustable).

C. Unoccupied mode:
   1. The outside air damper will close, and supply fan deenergized.
   2. A reduced space temperature will be controlled by:
      a. Control valves associated with duct coils.
      b. Cycling supply air fan to maintain 55F (adjustable).
      c. Cooling locked out.

3.6 ENERGY RECOVERY SYSTEMS

A. General: The units shall be indexed to the occupied/unoccupied/warm-up positions from the DDC System. Units shall operate on a lead-lag arrangement, with weekly alternation. Freeze detection thermostat shall de-energize the unit fan and close outdoor air damper upon sensing a coil discharge temperature below its setting. Duct smoke detector mounted in return air and discharge air ducts shall, upon sensing alarm conditions, completely shut down the unit supply fan and exhaust fan, close outside air damper and open return air damper. A

current sensing switch on supply fan and exhaust fan shall alarm the DDC System whenever the fan fails. A differential pressure switch across units filter bank shall display filter pressure drop and alarm the DDC System when filter pressure exceeds a high limit setpoint.

B. Warm-Up: The unit supply fan shall run continuously. The exhaust fan shall be off. The outdoor air damper shall remain closed and the unit shall operate on full return air. The return air thermostat shall modulate a 3-way ATC hot water valve to maintain room temperature. The outside air and exhaust air bypass dampers shall be closed. The recirculation damper shall be open.

C. Occupied: The unit supply fan and exhaust fan shall run continuously. The energy wheel shall be energized with outdoor air and recirculation damper open. The hot water control valve and DX cooling shall modulate as required to maintain return air setpoint of 75F (adjustable). If outdoor air enthalpy level is acceptable, total energy wheel shall be de-energized and outdoor air shall bypass total energy wheel (economizer mode).

D. Unoccupied: Outdoor air damper shall be closed, return air damper open. Exhaust fan and total energy wheel shall be de-energized. Hot water coil ATC valve shall be open. On a call for heat by room thermostat supply fan shall cycle to maintain unoccupied setpoint of 55F (adjustable). The outside air and exhaust air bypass dampers shall be closed. The recirculation damper shall be open.

E. Points List:
- Supply Leaving Air Temperature (AI)
- Discharge Air Temperature – Wheel outlet (AI)
- Entering Air Temperature – Wheel Inlet (AI)
- Heating Coil Control Valve Position (AO)
- Chilled Water Control Valve Position (AO)
- Return Air, Smoke Detector (Normal/Alarm) (BI)
- Freezestat (Normal/Alarm) (BI)
- Dirty Filter (Normal/Alarm) (BI)
- Supply and Exhaust Fan (On/Off), Alarm (BO, BI)
- Exhaust Wheel Motor (On/Off), Alarm (BO, BI)
- Outdoor Air Damper (2) (AO)
- Outdoor Air Bypass Damper (AO)
- Exhaust Bypass Damper (AO)
- Recirculation Damper (AO)

3.7 ELECTRIC HEATERS

A. Electric unit heaters, wall heaters and radiant ceiling panel heaters will be controlled by self-contained thermostats furnished by unit manufacturer.

B. Unit heaters will be energized as needed to maintain zone heating temperature setpoint of 70 deg. F. (adj.).

3.8 UNIT HEATERS – GAS-FIRED

A. Gas unit heaters will be controlled by a local, wall mounted thermostat.

B. Unit heaters will be energized as needed to maintain zone heating temperature setpoint of 70 deg. F. (adj.).

3.9 EXHAUST FANS

A. Where indicated, fans shall be tied into DDC system and be energized only during the occupied cycle.

B. Where indicated, fans shall be controlled by means of wall mounted carbon monoxide (CO) sensor.

C. Where indicated, fans shall be controlled by means of a reverse acting thermostat which shall energize upon a rising space temperature to 85°F (adjustable).

3.10 VAV TERMINALS

During the occupied mode, primary air control damper shall modulate to maintain space temperature of 75F (adjustable). On a call for heat, air control damper shall go to heat position and reheat coil valve shall modulate to maintain space temperature setpoint of 70F (adjustable).

3.11 DUCTLESS SPLIT SYSTEMS

A. Ductless split systems to be controlled with manufacturer's programmable controller/sensor.

3.12 AIR CURTAINS

A. Air curtain turns on when door is opened and shuts off when door is closed; unit remains on until set delay time expires.

B. Install and wire all controls furnished by air curtain manufacturer.

3.13 FUEL OIL TANK – LEAK DETECTION ALARM

A. Upon detection of fuel oil in storage tank interstitial space the dry contacts in the leak detection module will close.

B. The control system to detect a closed circuit on the leak detection circuit and generate a general alarm: 'CHECK FUEL OIL TANK LEAK".

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Natural gas piping buried within 5 feet of building.
2. Natural gas piping above grade.
3. Unions and flanges.
4. Valves.
5. Pipe hangers and supports.
6. Strainers.
7. Natural gas pressure regulators.
8. Natural gas pressure relief valves.

B. Related Sections:
1. Division 31 - Soils for Earthwork: Soils for backfill in trenches.
2. Division 31 - Aggregates for Earthwork: Aggregate for backfill in trenches.
3. Division 31 - Excavation and Fill: Product and execution requirements for excavation and backfill required by this section.
4. Division 31 - Backfill: Requirements for backfill to be placed by this section.
5. Division 31 - Trenching: Execution requirements for trenching required by this section.
6. Section 05 12 00 - Structural Steel: Product requirements for touch-up painting of structural steel.
7. Section 07 84 00 – Firestopping: Product requirements for firestopping for placement by this section.
8. Section 09 90 00 - Paints and Coatings: Product requirements for painting for placement by this section.
9. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
10. Section 22 05 93 - Identification for Plumbing Piping and Equipment: Product requirements for valve and pipe identification for placement by this section.

1.02 REFERENCES

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

B. American National Standards Institute (ANSI):
1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

C. American Society of Mechanical Engineers (ASME):
   1. ASME B16.3 - Malleable Iron Threaded Fittings.
   2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
   3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2" – 2").
   4. ASME B31.9 - Building Services Piping.
   5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

D. ASTM International (ASTM):
   1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
   3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
   4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
   6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

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

F. American Water Works Association:
   1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

G. 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 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
   4. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

H. National Fire Protection Association:
   1. NFPA 54 - National Fuel Gas Code.

I. Underwriters Laboratories Inc.:
   1. UL 842 - Valves for Flammable Fluids.

1.03 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.

C. Provide pipe hangers and supports in accordance with Section 22 05 29 Hangers and Supports for Plumbing Piping and Equipment.

D. Use plug or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.04 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers 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. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
   a. Strainers.
   b. Natural gas pressure regulators.
   c. Natural gas pressure relief valves.

C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.05 CLOSEOUT SUBMITTALS

A. Closeout Submittals: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of valves, piping system, and system components.

C. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

1.06 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. Perform natural gas Work in accordance with NFPA 54.

C. Perform work in accordance with applicable code and local gas company requirements.

D. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

E. Perform Work in accordance with applicable code and authority having jurisdiction AWS D1.1 for welding hanger and support attachments to building structure.

F. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.

1.07 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 experience.

1.08 PRE-INSTALLATION MEETINGS

A. Project Management & Coordination: Pre-installation meeting. Refer to Contract Documents.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements: Refer to Contract Documents.

B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 COORDINATION

A. Project Management & Coordination: Refer to Contract Documents.

1.13 WARRANTY

A. Warranty Requirements: Refer to Contract Documents.

1.14 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

2.01 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Steel Pipe: ASTM A53 Schedule 40 black.
   1. Fittings: ASTM A234 forged steel welding type.
   2. Joints: ASME B31.9, welded.
   3. Jacket: AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.02 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53 Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234 forged steel welding type.
   2. Joints: Threaded for pipe 2-inch and smaller; welded for pipe 2-1/2 inches and larger.

2.03 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
   1. Ferrous Piping: Class 150, malleable iron, threaded.
   2. Copper Piping: Class 150, bronze unions with soldered or brazed joints.

3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:
1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.04 BALL VALVES

A. Acceptable Manufacturers:
1. NIBCO, Inc.
2. Apollo Valves
3. Milwaukee Valve Company.

B. 1/4 inch to 1 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, full port.

C. 1-1/4 inch to 3 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, conventional port.

2.05 PLUG VALVES

A. Acceptable Manufacturers:
1. DeZURIK, Unit of SPX Corp.
2. Flow Control Equipment, Inc.
3. Homestead Valve.

B. 2 inches and Smaller: MSS SP 78, Class 150, semi-steel construction, round or square port, full pipe area, pressure lubricated, Teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.

C. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, round or square port, pressure lubricated, Teflon packing, flanged ends. Furnish wrench-operated.

2.06 NATURAL GAS PRESSURE REGULATORS

A. Acceptable Manufacturers:
1. Maxitrol RV Series
2. Sensus
3. Substitutions: Refer to Contract Documents.

B. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
1. Temperatures: minus 20 degrees F to 150 degrees F.

2. Body: Cast iron or Steel.
3. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
4. Disk, diaphragm, and O-ring: Nitrile.
5. Maximum inlet pressure: 150 psig.
6. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

PART 3 EXECUTION

3.01 EXAMINATION

A. Project Management & Coordination Requirements: Coordination and project conditions. Refer to Contract Documents.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

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

B. Remove scale and dirt, on inside and outside, before assembly.

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

3.03 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Install natural gas piping in accordance with NFPA 54.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Group piping whenever practical at common elevations.

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

G. Sleeve pipe passing through partitions, walls and floors. Refer to Section 220529.

H. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 220529.

I. Provide clearance for installation of insulation and access to valves and fittings.

J. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083113.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer. Refer to Section 051200 and Section 052100.

L. Provide support for utility meters in accordance with requirements of utility company.

M. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood.

N. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 099100.

O. Install identification on piping systems including underground piping. Refer to Section 220593.

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

Q. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

R. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors.

S. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 2 psi. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

3.04 FIELD QUALITY CONTROL

A. Field Quality Requirements. Refer to Contract Documents.

B. Inspect, test and purge gas piping in accordance with applicable codes and local gas company requirements.

C. When pressure tests do not meet specified requirements, remove defective work, replace and retest.

END OF SECTION

SECTION 23 13 00

FUEL STORAGE TANKS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aboveground fuel storage tanks.
   2. Leak detection and location system.

B. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete pads for aboveground tank for placement by this section.

1.2 REFERENCES

A. American Petroleum Institute:
   1. API 650 - Welded Steel Tanks for Oil Storage.
   2. API 2000 - Venting Atmospheric and Low-Pressure Storage Tanks: Nonrefrigerated and Refrigerated.

B. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. National Fire Protection Association:
   1. NFPA 30 - Flammable and Combustible Liquids Code.
   2. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.

D. Petroleum Equipment Institute:
   1. PEI 100 - Recommended Practices for Installation of Underground Liquid Storage Systems.

E. Underwriters Laboratories Inc.:
   1. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids.
   2. UL 567 - Pipe Connectors for Flammable Liquids and Combustible Liquids and LP-Gas.
   3. UL 913 - Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous Locations.
   4. UL 2085 - Standard for Safety for Insulated Aboveground Tanks Flammable and Combustible Liquids.

1.3 SYSTEM DESCRIPTION

A. Provide aboveground tank of double wall welded steel construction.

B. Provide leak detection system.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings:
   1. Tanks: Indicate for fuel oil tanks dimensions; number, size, and location of openings; number, size, and location of manholes; number and location of hold down straps, and accessories. Indicate dimensions, reinforcing steel size, and reinforcing steel location of pads.

C. Product Data:
   1. Tanks: Submit manufacturer’s catalog information including capacity.
   2. Leak Detection and Location System: Submit manufacturer’s catalog information for controller, alarm unit, cable type.

D. Test Reports: Submit written test results for tank pressure test.

E. Manufacturer's Installation Instructions: Submit tanks, and leak detection and location system data.

F. Manufacturer's Certificate:
   1. Certify Products meet or exceed specified requirements.
   2. Submit certificate of evaluation of leak detection and location system by independent third party.

1.5 CLOSEOUT SUBMITTALS

A. Closeout procedures: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of manholes, tanks, and leak detection and location system.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Operation and Maintenance Data: Submit spare parts lists for tanks, leak detection and location system.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 31.

B. Evaluate leak detection and location system by independent third party according to Third Party Procedures developed according to US EPS's "Standard Test Procedure for Evaluating Leak Detection Methods: Liquid-Phase Out-of-Tank Product Detectors." Evaluation results to verify system manufacturer's claim regarding sensitivity, range and other performance data.

1.7 QUALIFICATIONS

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

B. Above Ground Fuel Storage Tanks: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

C. Leak Detection Systems: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

D. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting: Refer to Contract Documents.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Product storage and handling requirements: Refer to Contract Documents.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 COORDINATION

A. Requirements for coordination: Refer to Contract Documents.

B. Coordinate aboveground tank foundations with requirements of Section 03 30 00.

1.12 WARRANTY

A. Product warranties and product bonds: Refer to Contract Documents.

B. Furnish one year manufacturer warranty for tanks and leak detection system.

PART 2 PRODUCTS

2.1 ABOVEGROUND FUEL STORAGE TANKS

A. Manufacturers:
   1. Highland Tank.
   2. Substitutions: Refer to Contract Documents.

B. Product Description: Tank constructed of multiple layers consisting of inner steel tank and outer steel tank to meet requirements of UL 142.

C. Tank Configuration: Cylindrical, vertical.

D. Primary Tank: Single wall steel tank constructed in accordance with UL 142 not less than 7 gage thick.

E. Outer Tank: Single wall steel tank constructed in accordance with UL 142 not less than 10 gage walls and 7 gage bottom thicknesses.

F. Finish: Factory painted with industrial epoxy and urethane coating with dry film thickness of 10 mils. Color: white.

G. Fill Connection: Furnish with hinged locking cover, stainless steel hinges, handle, safety chain, and lock hasp.

H. Normal Vent: Furnish primary tank with 2 inch updraft venting device exhausting upward at elevation of at least 12 feet aboveground. Size vent in accordance with NFPA 30.

I. Emergency Vent: Furnish primary tank with emergency vent sized in accordance with NFPA 30. Do not use access openings for emergency venting purposes.

J. Monitor Port: Minimum 2 inch steel pipe with locking cap to be used for detecting leaks between primary and outer tanks.

K. Accessories:
   1. Level Gage: Mechanical float activated level gage capable of indicating approximate fluid level in tank reading in feet and inches.
   2. Tank Decals: Furnish tank identification signs located prominently on tank following local fire code requirements.
   3. Access Steps: Furnish galvanized access platform with working surface of minimum of 24 inches in width, 20 inches in length, and 36 inches below top of tank.

L. Capacity:
   1. Volume: 1000 gallons.
   2. Diameter: 64 inches.
   3. Overall Length: 72 inches.
   4. Accessories:
      a. Four 4-inch threaded fittings.
      b. One 6-inch emergency vent fitting.
      c. One 6-inch interstitial emergency vent fitting.
      d. Overfill protection sump; 7 gallon capacity.
      e. 4”x4”x ½” clip angle anchors.

2.2 LEAK DETECTION AND LOCATION SYSTEM

A. Manufacturers:
   1. Veeder Root

2. Substitutions: Refer to Contract Documents.

B. Product Description: Microprocessor based monitoring unit, sensor cable, probes, and auxiliary equipment to provide continuous monitoring of sensing strings for leaks, shorts, breaks, and probe activation. When any of these conditions occur at any point along cable, alarm sounds, type of condition is identified and location displayed. System monitors interstitial space of double contained tanks. Construct system to meet requirements of UL 913.

C. Performance:
   1. Detect and identify location of first leak within 0.2 percent of sensor string length or 5 feet, whichever is greater. Identify type of alarm.
   2. Sensing String Length: Monitor up to 2,000 feet of cable for each sensor string from single monitoring unit.
   3. Multiple Leaks: Detect and locate multiple leaks or additional liquid on sensor cable.
   4. Breaks and Shorts: Identify location of breaks and shorts on cable. When faults occur, sound alarm, and display on front of monitoring unit type of fault and location of fault.
   5. Liquids Detected: Detect liquids, including aqueous, hydrocarbon, conductive, and nonconductive liquids.
   6. Remote Annunciation: Furnish relays for remote indication of alarm conditions. Relays indicate no alarm conditions exist, alarm condition exists but has not yet been acknowledged, and alarm condition exists and has been acknowledged. Communications available via RS-232 and ASCII communication protocols to allow central point monitoring and control via remote computer.
   7. Archives: Record significant events in nonvolatile memory with capacity of 900 events. When memory becomes full, recorded events are deleted from memory on first-in-first-out basis. Each recorded event includes time and date event occurred. Archives retrievable through RS-232 and ASCII communication protocols.
   8. System Status: Continuously give positive indication of monitoring sensing string and status of sensing string. System clock indicates time and date on LCD of monitoring panel. System clock is programmable. Include time and date indication for events recorded in memory.
   9. Security: Assignable password security for varying levels of system access. Minimum of 20 passwords available within system. System to not allow unauthorized modifications to sensing string to be made without causing alarm condition.
   10. Sensor Types: Capable of monitoring sensor cables, probe sensors, and switch sensors such as float switches, and pressure switches, from same monitoring panel. English language displays indicate status of sensors.
   11. Sensitivity: System to not detect incidental liquid contact. Sensitivity field adjustable to increase or decrease amount of wetted cable needed to cause alarm.

D. Components:
   1. Monitoring Unit:
      a. Indicates when liquid comes in contact with sensor cable by sounding alarm, actuating output relays, displaying message leak has been detected and giving location of leak on sensing string.

b. Unit furnished with green LED on panel front indicates unit is powered. Furnish two line by forty character backlit LCD visible from front of unit to provide system data. Red LED on panel front indicates alarm condition has occurred. Unit power requirements: 120/240 VAC, 100 VA, 50/60 Hz, single phase. Equip with RS-232 communication port and minimum of one common and one SPDT output relay for each cable, rated for 250 VAC, 10 amp.
c. Enclose in modified NEMA 250 Type 12 enclosure. UL listed to provide connections for intrinsically safe sensor circuits for use in hazardous locations. Ability to locate leak does not depend on battery backed up functions. In event of power failure, store system conditions and parameters in nonvolatile memory allowing unit to automatically resume monitoring, without resetting, upon restoration of power. Furnish on-off switch in panel.

2. Sensor Cable: Coaxial construction consisting of insulated copper center conductor, spacer material, and outer braid. Center conductors not less than 20 AWG for mechanical strength. Cables field repairable.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify tank foundation is ready for tank installation.

3.2 INSTALLATION - ABOVEGROUND TANKS

A. Install aboveground tanks in accordance with NFPA 30 and NFPA 31.

B. Check factory installed equipment and accessories for loosening during transit.

C. Clean and flush tanks prior to delivery to site. Seal until pipe connections are made.

D. Install aboveground tanks on concrete foundation. Refer to Section 03 30 00. Secure with anchor bolts.

E. Install grounding for aboveground tanks in accordance with Section 26 05 26.

F. Install piping connections to tanks. Provide venting in accordance with API 2000.

G. Tank Accessories:
1. Install tank accessories shipped loose with tank.
2. Install the following tank accessories: anti-siphon devices, overfill shutoff and alarms, vents, emergency vents.

H. Fill tanks completely at Project turnover with appropriate fuel.

3.3 INSTALLATION - LEAK DETECTION AND LOCATION SYSTEM

A. Install cable on flat surfaces with hold down clips every 8 feet and cable tags every 50 feet.

B. Direct Buried of Hydrocarbon Sensing Cable:
   1. Replace cable damaged during installation.
   2. Seal cable ends to prevent moisture ingress.
   3. Install cable so connectors are accessible in junction boxes at grade or in manholes, valve pits or other locations.
   4. Install cable from underground to grade using PVC pipe.

3.4 FIELD QUALITY CONTROL

A. Field inspecting, testing, adjusting, and balancing: Refer to Contract Documents.

B. Pressure test aboveground tanks in accordance with the following:
   1. Pressure test tank with air to 5 psig.
   2. Repair leaks.
   3. Retest until no leaks are detected.

C. Field Testing Leak Detection System:
   1. Perform tests to demonstrate ability of system to detect and locate breaks, shorts and probes on sensor string.
   2. Perform leak testing in accordance with the following procedure to verify operation and ability to work with condensation pools or other static moisture:
      a. Wet sensor cable near start of sensor string and acknowledge detection or location alarm and recheck system.

3.5 MANUFACTURER'S FIELD SERVICES

A. Requirements for manufacturer’s field services: Refer to Contract Documents.

B. Furnish factory trained representative for 8 hours of on-site time during final checkout of aboveground tanks installation.

C. Furnish factory trained representative of system supplier for 8 hours of on-site time during final checkout of leak detection and location system.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Heating water piping, above ground.
2. Equipment drains and over flows.
3. Unions and flanges.
4. Valves.

B. Related Sections:
1. Section 07 84 00 – Penetration Firestop Systems: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 – Painting & Finishing: Product requirements Painting for placement by this section.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
4. Section 23 05 48 - Vibration Noise and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
5. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
6. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.

1.2 REFERENCES

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

B. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Gray Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B31.1 - Power Piping.
6. ASME B31.9 - Building Services Piping.
7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM B32 - Standard Specification for Solder Metal.
6. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
7. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
8. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
9. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
10. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
11. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
12. ASTM D2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
13. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
14. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
15. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
16. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
17. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
18. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
19. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
20. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
21. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
22. ASTM D3309 - Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems.
23. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
24. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
25. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

26. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
27. ASTM F845 - Standard Specification for Plastic Insert Fittings for Polybutylene (PB) Tubing.
28. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
29. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot-and Cold-Water Distribution Systems.
30. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

D. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

E. American Water Works Association:
1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
2. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

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 67 - Butterfly Valves.
3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
4. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
5. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
6. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
7. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
8. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
9. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
10. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or

apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Provide pipe hangers and supports in accordance with ASME B31.9, MSS SP 58, and MSS SP 89.

D. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Use ball valves for throttling, bypass, or manual flow control services.

F. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data:
   1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers 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.

C. Test Reports: Indicate results of piping system pressure test.

D. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

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

F. Welders' Certificate: Include welders' certification of compliance with AWS D1.1.

1.5 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

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

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 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. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

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

1.7 QUALIFICATIONS

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

1.8 PRE-INSTALLATION MEETINGS

A. Project Management & Coordination: Pre-installation meeting. Refer to Contract Documents.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements: Refer to Contract Documents.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 COORDINATION

A. Requirements for coordination: Refer to Contract Documents.

1.13 WARRANTY

A. Close-out Procedures: Product warranties and product bonds. Refer to Contract Documents.

B. Furnish five year manufacturer warranty for valves excluding packing.

1.14 EXTRA MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

B. Furnish two packing kits for each size and valve type.

1.15 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 HEATING WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
   1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
   2. Joints: Threaded for pipe 2 inches and smaller; welded for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M, Schedule 40, black, cut grooved ends.
   1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, or ASTM A234/A234M carbon steel, grooved ends.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, hot dipped galvanized, compatible with steel piping sizes, flexible type.
      b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
      c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L, hard drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
   2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
   3. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

D. Copper Tubing: ASTM B88, Type L, hard drawn, rolled grooved ends.
   1. Fittings: ASME B16.18 cast copper alloy, or ASME B16.22 wrought copper and bronze, or ASTM B584 bronze sand castings, grooved ends.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
      a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
      b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
      c. Accessories: Steel bolts, nuts, and washers.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tubing: ASTM B88, Type DWV, hard drawn.
   1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26, polyvinyl chloride (PVC) material.
   1. Fittings: ASTM D2466, Schedule 40, PVC.
   2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.3 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:
   1. Ferrous Piping: Class 150, malleable iron, threaded.
   2. Copper Piping: Class 150, bronze unions with soldered.
   3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
   4. PVC Piping: PVC.
   5. CPVC Piping: CPVC.

B. Flanges for Pipe 2-1/2 inches and Larger:
   1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
   2. Copper Piping: Class 150, slip-on bronze flanges.
   3. PVC Piping: PVC flanges.
   4. CPVC Piping: CPVC flanges.
   5. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.4 BALL VALVES

A. Acceptable Manufacturers:
   1. Crane Valve, North America
   2. Hammond Valve
   3. Milwaukee Valve Company
   4. NIBCO, Inc.
   5. Stockham Valves & Fittings

B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, type 316 stainless steel ball, regular port, teflon seats, blow-out proof stem, solder or threaded ends, lever handle with balancing stops.

2.5 CHECK VALVES

A. Horizontal Swing Check Valves:
   1. Acceptable Manufacturers:
      a. Crane Valve, North America
      b. Hammond Valve
      c. Milwaukee Valve Company
      d. NIBCO, Inc.
      e. Stockham Valves & Fittings
   2. 2 inches and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N disc, solder or threaded ends.
   3. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

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 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 - ABOVE GROUND PIPING SYSTEMS

A. Install heating water piping in accordance with ASME B31.9.

B. Route piping parallel to building structure and maintain gradient.

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

D. Group piping whenever practical at common elevations.

E. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

F. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 07 84 10 – Penetration Firestop Systems.

G. Install pipe identification in accordance with Section 23 05 53 – Identification for HVAC Piping and Equipment.

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

I. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 91 00 – Painting & Finishing.

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

M. Insulate piping; refer to Section 23 07 00 – HVAC Insulation.

3.4 FIELD QUALITY CONTROL

A. Close-out Procedures: Field inspecting, testing, adjusting, and balancing. Refer to Contract Documents.

B. Test heating water piping system in accordance with ASME B31.9.

END OF SECTION

SECTION 23 21 16

HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pressure gages.
2. Pressure gage taps.
3. Thermometers.
4. Thermometer supports.
5. Test plugs.
6. Flexible connectors.
7. Diaphragm-type expansion tanks.
8. Flexible Pipe Connectors.
9. Air vents.
10. Air separators.
11. Strainers.
12. Relief valves.
13. Chilled water buffer tank.
14. Glycol feed system.
15. Glycol solution.

B. Related Sections:
1. Section 23 21 13 - Hydronic Piping: Execution requirements for piping connections to products specified by this section.
2. Section 23 21 23 - Hydronic Pumps: Execution requirements for piping connections to products specified by this section.
3. Section 23 07 00 – HVAC Insulation: Requirements for equipment insulation for products specified by this section.

1.2 REFERENCES

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

B. American Society of Mechanical Engineers:
1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

C. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

D. American Water Works Association:
   1. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
   2. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
   3. AWWA C702 - Cold-Water Meters - Compound Type.
   4. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
   5. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

E. Underwriters Laboratories Inc.:
   1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
   2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.3 PERFORMANCE REQUIREMENTS

A. Flexible Connectors: Provide at or near motorized equipment where piping configuration does not absorb vibration.

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit for manufactured products and assemblies used in this Project.
   1. Manufacturer’s data indicating use, operating range, total range, accuracy, and location for manufactured components.
   2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
   3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
   4. Submit electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

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

1.5 CLOSEOUT SUBMITTALS

A. Close-out Submittals: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of actual locations of components and instrumentation, flow controls.

C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.6 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.

1.7 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.

1.8 PRE-INSTALLATION MEETINGS

A. Pre-Installation Meetings: Refer to Contract Documents.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Product Requirements: Refer to Contract Documents.

B. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements: Environmental conditions affecting products on site. Refer to Contract Documents.

B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.11 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

1.12 WARRANTY

A. Warranty Procedures: Refer to Contract Documents.

B. Furnish one year manufacturer warranty for piping specialties.

1.13 MAINTENANCE SERVICE

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

1.14 MAINTENANCE MATERIALS

A. Spare parts and maintenance materials. Refer to Contract Documents.

1.15 EXTRA MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

B. Furnish two pressure gages with pulsation damper.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:
   1. H. O. Trerice Model 600CB
   2. Marsh Instrument
   3. Taylor Instrument
   4. Substitutions: Refer to Contract Documents.

B. Gage: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
   1. Case: Cast aluminum.
   2. Bourdon Tube: Phosphor bronze.
   3. Dial Size: 4-1/2 inch diameter.
   4. Mid-Scale Accuracy: One percent.
   5. Scale: Psi.

2.2 PRESSURE GAGE TAPS

A. Manufacturers:
   1. H. O. Trerice
   2. Marsh Instrument
   3. Taylor Instrument
   4. Substitutions: Refer to Contract Documents.

B. Needle Valve: Brass, 1/4 inch NPT for minimum 300 psi.

C. Ball Valve: Brass, 1/4 inch NPT for 250 psi.

D. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.

E. Siphon: Brass, 1/4 inch NPT angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. H. O. Trerice Model BX9.
2. Marsh Instrument
3. Taylor Instrument
4. Substitutions: Refer to Contract Documents.

B. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
1. Size: 9 inch scale.
2. Window: Clear Lexan.
3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
4. Accuracy: 2 percent.
5. Calibration: Degrees F Both degrees F and degrees C.

2.4 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 TEST PLUGS

A. 1/4 inch NPT or 1/2 inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:
1. Neoprene core for temperatures up to 200 degrees F.
2. Nordel core for temperatures up to 350 degrees F.
3. Viton core for temperatures up to 400 degrees F.

B. Test Kit:
1. Carrying case, internally padded and fitted containing:
   a. Two 2-1/2 inch diameter pressure gages.
      1) Scale range: 0 to 100 psi
      2) Scale range: 0 to 200 psi
      3) Two gage adapters with 1/8 inch probes.
   b. Two 1-1/2 inch dial thermometers.
      1) Scale range: 0 to 100 degrees F.
      2) Scale range: 50 to 250 degrees F.

2.6 DIAPHRAGM-TYPE EXPANSION TANKS

A. Manufacturers:
1. Amtrol Inc.
2. Bell & Gossett
3. Taco
4. Substitutions: Refer to Contract Documents.

B. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure

of 125 psig, with flexible butyl diaphragm sealed into tank, and steel support stand.

C. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 12 psig.

D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure back flow prevention device, test cocks, strainer, vacuum breaker, and by-pass valves.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Keflex Incorporated, Type KFC.
   2. The Metraflex Company
   3. Anaconda Metal Hose Division, Anaconda American Brass Company
   4. Substitutions: Refer to Contract Documents.

B. Connector construction of corrugated bronze or stainless inner liner covered by wire braid of same alloy.
   1. End connections threaded on 2-1/2-inch and smaller diameters, and flanged on three inch and larger diameters.
   2. Connector length at 2-1/2 times nominal pipe diameter on piping smaller than 10-inches diameter, and 2 times on piping 10-inches and larger.

2.8 AIR VENTS

A. Manufacturers:
   1. Bell & Gossett
   2. Taco
   3. Amtrol
   4. Substitutions: Refer to Contract Documents.

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

C. Float Type:
   1. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.9 AIR SEPARATORS

A. Manufacturers:
   1. Spirovent Model VDT.
   2. Substitutions: Refer to Contract Documents.

B. In-line Air/Dirt Separators: Steel for sizes 2 inch and larger; tested and stamped in accordance with ASME Section VIII; for 150 psig operating pressure.

C. Combination air/dirt coalescing type air eliminator and dirt separator; maximum entering velocity 4 fps at specified GPM. Unit includes internal copper tube bundle, venting chamber with integral full port float actuated brass venting mechanism; valved side connection for flushing dirt.

2.10 STRAINERS

A. Manufacturers:
   1. Mueller Steam Specialty
   2. Keckley Co.
   3. Hoffman Specialty
   4. Substitutions: Refer to Contract Documents.

B. Size 2 inch and Smaller:
   1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:
   1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
   1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.11 COMBINATION PUMP DISCHARGE VALVES

A. Manufacturers:
   1. Bell & Gossett Model 3DS
   2. Taco
   3. Armstrong Pump
   4. Substitutions: Refer to Contract Documents.

B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.12 RELIEF VALVES

A. Manufacturers:
   1. Bell & Gossett
   2. Kunkle Valve Co.
   3. Watts Regulator
   4. Substitutions: Refer to Contract Documents.

B. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

2.13 CHILLED WATER BUFFER TANK

A. Manufacturers:
   1. John Wood Company
   2. Weben-Jarco
   3. Hansen Tank
   4. Substitutions: Refer to Contract Documents.

B. Vertical factory insulated storage tank with ASME rating of 125 PSI with capacity and accessories as follows:
   1. Capacity: as indicated on Drawings.
   2. Support: Base ring support tack welded to the tank. Support to include three 4" x 6 inch openings 120 degrees apart and four angle iron clips to secure base to floor.
   3. Connections: Pipe connections shall be extra heavy flat type forged flanges with screwed fittings. Provide a minimum four (4) 2 inch pipe fittings with one on the bottom, top, bottom side and top side. In addition, provide a 1-1/2 inch fitting on the top.
   4. Finish: Tank shall be galvanized inside and out.
   5. Insulation: 2 inch thick closed cellular fiber or polyurethane foam insulation. Insulation shall cover all tank exterior surfaces.
      a. Wrap in an aluminum jacket.
   6. Baffles: Tank shall include a minimum of three (2) plate baffles to prevent short circuiting of the chilled water.
   7. At the contractor's option, the tank can be field insulated and jacketed in accordance with Section 23 07 00.

2.14 GLYCOL FEED SYSTEM

A. Manufacturers:
   1. Neptune
   2. ITT Bell & Gossett
   3. Armstrong International, Inc
   4. Substitutions: Refer to Contract Documents.

B. Packaged, Automatic Glycol Solution Make Up Unit:
   1. Unit shall consist of a base, industrial grade 55 gallon capacity polyethylene tank with removable lid, 2" vent/fill opening, and visible solution level scale in gallons and liters.
   2. Includes y-strainer, isolation valve, pump, open drip-proof motor, pump isolation, check and balance valve, expansion tank, discharge pressure gauge, motor contactor, pressure control, necessary interconnecting piping and a 3/4" NPT system piping connection.
   3. Pump shall start based on falling pressure and shall provide 10 GPM and maintain a fill pressure of 30 psi.
   4. Green light shall indicate power supplied to unit. System shall require a 115/1/60 single power connection.
   5. Low level cutout, with red indicator light and a dry contact for alarm indication, to stop the pump during low level condition.
   6. Pressure cut off provides protection from excessive pressure. Cut in 10-45 psi and cut out 20-60 psi.

7. Contractor shall provide application specific pressure reducing valve between pump discharge and connection to system piping.

2.15 GLYCOL SOLUTION

A. Manufacturers:
   1. Dowtherm Model SR-1.
   2. Haughton Chemical
   3. Univar
   4. Substitutions: Refer to Contract Documents.

B. Inhibited propylene glycol and water solution mixed 25 percent glycol – 75 percent water, suitable for operating temperatures from 10 degrees F to 250 degrees F.

PART 3 EXECUTION

3.1 INSTALLATION - THERMOMETERS AND GAGES

A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping

C. Install pressure gages with pulsation dampers. Provide needle valve or ball valve to isolate each gage. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.

E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.

F. Coil and conceal excess capillary on remote element instruments.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs adjacent to pressure gages and pressure gage taps.

B. Where large air quantities accumulate, provide enlarged air collection standpipes.

C. Install manual air vents at system high points.

D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

E. Provide air separator on suction side of system circulation pump and connect to expansion tank.

F. Provide drain and hose connection with valve on strainer blow down connection.

G. Provide combination pump discharge valve on discharge side of centrifugal pumps.

H. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

I. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

J. Pipe relief valve outlet to nearest floor drain.

K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

L. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12 psig.

3.3 FIELD QUALITY CONTROL

A. Section 2.17 – Inspection and Testing: Field inspecting, testing, adjusting, and balancing.

3.4 CLEANING

A. Requirements for cleaning. Refer to Contract Documents.

B. Clean and flush hydronic system before adding glycol solution.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. Requirements for protecting installed construction. Refer to Contract Documents.

B. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. In-line circulators.

B. Related Sections:
1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
2. Section 23 05 48 - Vibration Noise and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibrations isolators installed with pumps.
3. Section 23 21 13 - Hydronic Piping: Execution requirements for connection to pumps specified by this section.
4. Section 26 05 00 – Common Work Results for Electrical: Execution requirements for electrical connections to pumps specified by this section.

1.2 REFERENCES

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

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. Underwriters Laboratories Inc.:
1. UL 778 - Motor Operated Water Pumps.

1.3 PERFORMANCE REQUIREMENTS

A. Provide pumps to operate at system fluid temperatures indicated on Drawings without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when

applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.

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

1.5 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

1.6 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.

1.7 QUALIFICATIONS

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

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

1.8 PRE-INSTALLATION MEETINGS

A. Pre-Installation Meetings: Refer to Contract Documents.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Warranty Procedures: Refer to Contract Documents.

B. Furnish one year manufacturer warranty for pumps.

1.12 EXTRA MATERIALS

A. Extra Materials: Refer to Contract Documents.

B. Furnish one set of mechanical seals for each pump.

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 manufacturers 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 IN-LINE CIRCULATORS

A. Acceptable Manufacturers:
   1. Bell & Gossett
   2. Taco
   3. Armstrong Pump

B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psig maximum working pressure.

C. Casing: Cast iron, with flanged pump connections.

D. Impeller: Bronze, keyed to shaft.

E. Bearings: Two, oil lubricated bronze sleeves.

F. Shaft: Carbon steel with replaceable bronze sleeve, integral thrust collar.

G. Seal: Carbon rotating against stationary ceramic seat, 225 degrees F maximum continuous operating temperature.

H. Drive: Close coupled.

I. Electrical Characteristics and Components:
   1. Electrical Characteristics: In accordance with Section 26 05 00 – Common Work Results for Electrical.
   2. Motors: In accordance with Section 23 05 13 – Common Motor Requirements for HVAC Equipment. 1750 rpm unless indicated otherwise.
   3. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Install flexible connectors at or near pumps where piping configuration does not absorb vibration. Refer to Section 23 21 13 – Hydronic Piping.

C. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve on pump discharge.

D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.

E. Provide air cock and drain connection on horizontal pump casings.

F. Lubricate pumps before start-up.

3.2 FIELD QUALITY CONTROL

A. Field Quality Control: Refer to Contract Documents.

3.3 SCHEDULES

A. See Contract Drawings

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Refrigerant piping.
2. Refrigerant filter-driers.

B. Related Sections:
1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 - Painting and Coating: Product requirements for painting for placement by this section.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
5. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
6. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

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

B. Air-Conditioning and Refrigeration Institute:
1. ARI 495 - Refrigerant Liquid Receivers.
2. ARI 710 - Liquid-Line Driers.
3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

D. American Society of Mechanical Engineers:

1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B31.5 - Refrigeration Piping.
4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

E. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
6. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.

F. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

G. 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.

H. Underwriters Laboratories Inc.:
1. UL 429 - Electrically Operated Valves.

1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide pipe hangers and supports in accordance with ASME B31.5, MSS SP 58, MSS SP 69, and MSS SP 89.

C. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.4 SUBMITTALS

A. Submittal procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.

C. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories.
2. Hangers and Supports: Submit manufacturers catalog information including load capacity.
3. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
    a. Refrigerant filter-driers.

D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Test Reports: Indicate results of refrigerant leak test and piping system pressure test.

F. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

G. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

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

B. Project Record Documents: Record actual locations of equipment and refrigerant accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 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. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

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

1.7 QUALIFICATIONS

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

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Administrative Requirements: Refer to Contract Documents.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Product Requirements: Refer to Contract Documents.

B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.

C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

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.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Product Requirements: Refer to Contract Documents.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 COORDINATION

A. Requirements for coordination: Refer to Contract Documents.

1.13 MAINTENANCE MATERIALS

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

1.14 EXTRA MATERIALS

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

B. Furnish two refrigerant filter-dryer cartridges of each type.

PART 2 PRODUCTS

2.1 REFRIGERANT PIPING

A. Copper Tubing: ASTM B280, drawn.
   1. Fittings: ASME B16.22 wrought copper.

2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

2.2 REFRIGERANT FILTER-DRIERS

****
In this article, list manufacturers acceptable for this Project.
****

A. Manufacturers:
   1. Parker Hannifin.
   2. Emerson Climate Technologies.
   3. Substitutions: Refer to Contract Documents.

B. Replaceable Cartridge Angle Type:
   1. Shell: ARI 710, UL listed, [**brass,**] [**steel,**] removable cap, for maximum working pressure of [**350**] [**500**] psig, <_____**>** inches outside diameter size connections.
   2. Filter Cartridge: Pleated media with integral end rings, stainless steel support, <_____**>** sq in filter area [**ARI 730 rating for <_____> tons**].
   3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina, <_____**>** sq in filter area [**ARI 730 rating for <_____> tons**].
   4. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets, <_____**>** sq in filter surface area, <_____**>** cu in desiccant [**ARI 710 moisture rating of <_____> drops**].

C. Permanent Straight Through Type:
   1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of [**350**] [**400**] [**500**] psig.
   2. Rating: [**ARI 710 moisture rating of <_____> drops**] [**ARI 710 flow capacity of <_____> tons**] [**ARI 730 flow capacity of <_____> tons**].

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside 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 - PIPE HANGERS AND SUPPORTS

A. Install pipe hangers and supports in accordance with Section 23 05 29.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.

E. Install pipe identification in accordance with Section 23 05 53.

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

G. Provide access where valves and fittings are not exposed.

H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Flood refrigerant piping system with nitrogen when brazing.

J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 90 00.

K. Insulate piping; refer to Section 23 07 00.

L. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.

M. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

N. Fully charge completed system with refrigerant after testing.

O. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

P. Install refrigerant piping in accordance with ASME B31.5.

3.5 INSTALLATION - REFRIGERANT SPECIALTIES

A. Filter-Dryers:

1. Install permanent filter-dryer in systems containing hermetic compressors.
2. Install replaceable cartridge filter-dryer vertically in liquid line adjacent to receivers.
3. Install replaceable cartridge filter-dryer upstream of each solenoid valve.

3.6 FIELD QUALITY CONTROL

A. Field Quality Requirements: Refer to Contract Documents.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test refrigeration system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using electronic leak detector.

D. Repair leaks.

E. Retest until no leaks are detected.

3.7 SCHEDULES

A. Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	MINIMUM HANGER ROD DIAMETER COPPER TUBING Inches	MINIMUM HANGER ROD DIAMETER STEEL PIPE Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2	9	11	1/2	1/2
3	10	12	1/2	1/2
4	10	12	1/2	5/8
5	10	12	1/2	5/8
6	10	12	5/8	3/4

END OF SECTION

SECTION 23 31 00

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Duct Materials.
2. Insulated flexible ducts.
3. Transverse duct connection system.
4. Ductwork fabrication.

B. Related Sections:
1. Section 09 91 00 – Painting & Finishing: Execution requirements for Weld priming, weather resistant, paint or coating specified by this section.
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
3. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.2 REFERENCES

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

B. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
4. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for. Refer to Contract Documents.
5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
6. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

8. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
9. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
10. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
11. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Air Duct Leakage Test Manual.
2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:
1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 PERFORMANCE REQUIREMENTS

A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission.

B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire rated and other walls.
7. Terminal unit, coil, and humidifier installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Product Data: Submit data for duct materials, duct connectors, and accessories.

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

1.5 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 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. Perform work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

C. Construct ductwork to NFPA 90A standards.

1.7 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.

1.8 PRE-INSTALLATION MEETINGS

A. Pre-Installation Meetings: Refer to Contract Documents.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements. Refer to Contract Documents.

B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Close-out Procedures: Product warranties and product bonds. Refer to Contract Documents.

1.12 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 manufacturers 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 DUCT MATERIALS

A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90/A90M.

B. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

C. Fasteners: Rivets, bolts, or sheet metal screws.

D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 INSULATED FLEXIBLE DUCTS

A. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical wound spring steel wire; fiberglass insulation; aluminized vapor barrier film.
   1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
   2. Maximum Velocity: 4000 fpm.

3. Temperature Range: -20 degrees F to 210 degrees F.
4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.3 TRANSVERSE DUCT CONNECTION SYSTEM

A. Acceptable Manufacturers:
1. Ductmate Industries, Inc.
2. Substitutions: Refer to Contract Documents.

B. Product Description: SMACNA "F" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.4 DUCTWORK FABRICATION

A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards), and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inches cemented slip joint, brazed or electric welded. Prime coat welded joints.

F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

C. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inches and smaller.

D. Install duct hangers and supports in accordance with Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

E. Use double nuts and lock washers on threaded rod supports.

F. Connect flexible ducts to metal ducts with draw bands.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.

B. Connect air outlets and inlets to supply ducts with five foot maximum length of flexible duct. Do not use flexible duct to change direction.

3.4 CLEANING

A. Final cleaning. Refer to Contract Documents.

B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.

C. Clean duct systems with high power vacuum machines. Protect equipment with potential to be harmed by excessive dirt with filters, or bypass during cleaning. Install access openings into ductwork for cleaning purposes.

3.5 SCHEDULES

A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply (Heating Systems)	Steel
Supply (System with Cooling Coils)	Steel

Return and Relief	Steel
General Exhaust	Steel
Outside Air Intake	Steel
Combustion Air	Steel

B. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Constant Volume Supply	1 inch wg regardless of velocity.
Supply (Heating Systems)	1 inch wg
Supply (System with Cooling Coils)	1 inch wg
Return and Relief	1 inch wg regardless of velocity.
General Exhaust	1 inch wg regardless of velocity.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Duct access doors.
2. Static fire dampers.
3. Volume control dampers.
4. Air Terminal Units
5. Flexible duct connections.
6. Duct test holes.

B. Related Sections:
1. Section 23 09 23 - Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
2. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.

1.2 REFERENCES

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

A. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:
1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:
1. UL 555 - Standard for Safety for Fire Dampers.
2. UL 555C - Standard for Safety for Ceiling Dampers.
3. UL 555S - Standard for Safety for Smoke Dampers.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers duct access doors and duct test holes.

C. Product Data: Submit data for shop fabricated assemblies and hardware used.

D. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
   1. Fire dampers including locations and ratings.
   2. Flexible duct connections.
   3. Volume control dampers.
   4. Duct access doors.
   5. Duct test holes.

E. Product Data: For fire dampers submit the following:
   1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
   2. Indicate materials, construction, dimensions, and installation details.
   3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

F. Manufacturer's Installation Instructions: Submit for Fire Dampers.

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

1.4 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of access doors.

C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

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. Dampers tested, rated and labeled in accordance with the latest UL requirements.

C. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

1.6 QUALIFICATIONS

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

1.7 PRE-INSTALLATION MEETINGS

A. Pre-Installation: Refer to Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Protect dampers from damage to operating linkages and blades.

C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

D. Storage: Store materials in a dry area indoor, protected from damage.

E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 COORDINATION

A. Project Management & Coordination: Refer to Contract Documents.

1.11 WARRANTY

A. Warranty: Refer to Contract Documents.

B. Furnish one year manufacturer warranty for duct accessories.

1.12 EXTRA MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

B. Furnish two of each size and type of fusible link.

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.

PART 2 PRODUCTS

2.1 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
   1. Less than 12 inches square, secure with sash locks.
   2. Up to 18 inches Square: Furnish two hinges and two sash locks.
   3. Up to 24 x 48 inches: Three hinges and two compression latches.
   4. Larger Sizes: Furnish additional hinge.
   5. Access panels with sheet metal screw fasteners are not acceptable.
   6. Access panels to be same gage as duct.

2.2 STATIC FIRE DAMPERS

A. Acceptable Manufacturers:
   1. Ruskin Model IBD20
   2. Greenheck
   3. Prefco, Inc.

B. Fabricate in accordance with NFPA 90A and UL 555.

C. Fire Resistance: 1-1/2 hours.

D. Construction:

1. Integral Sleeve Frame: Minimum 20 gage roll formed galvanized steel. Length: 12 inches.
2. Blades:
   a. Style: Curtain type.
   b. Action: Spring or gravity closure upon fusible link release.
   c. Material: Minimum 24 gage roll formed galvanized steel.
3. Closure Springs: Type 301 stainless steel, constant force type, if required.

E. Fusible Link Release Temperature: 165 degrees F.

F. Mounting: Vertical or horizontal as indicated on Drawings.

G. Duct Transition Connection, Damper Style:
1. B style - rectangular connection, blades out of air stream, high free area.
2. CR style - round connection, sealed.
3. LR style - round connection, blades out of air stream, non-sealed.

H. Finish: Mill galvanized.

2.3 VOLUME CONTROL DAMPERS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

B. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
4. Single Blade Dampers: Fabricate for duct sizes up to 12 x 48 inches.

C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inches. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.

D. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches w.g.; Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.4 AIR TERMINAL UNITS

A. VARIABLE AIR VOLUME (VAV) TERMINALS

1. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems.

2. Identification: Each marked with label and air flow indicator, including unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

3. Basic Assembly:
   a. Casings: Minimum 22 gauge galvanized steel.
   b. Lining: Minimum 1/2 inch thick neoprene or vinyl coated fiberglass insulation.
   c. Plenum Air Inlets: Round stub connections for duct attachment.
   d. Plenum Air Outlets: S-slip and drive connections.
   e. Primary Air Valve: Construct of minimum 22 gauge galvanized steel cylindrical body that includes embossment rings for rigidity. The damper blade shall be connected to a solid shaft by integral molded sleeve. The damper shall pivot in self lubricating bearings. The damper actuator shall be mounted on the exterior of the terminal for ease of service. The air valve leakage shall not exceed 1% of maximum inlet rated airflow at 3" W.G. inlet pressure.
   f. Primary Airflow Sensor: For inlets 6" or greater, the differential pressure airflow sensor shall traverse the duct along two perpendicular diameters. A minimum of 12 total pressure sensing points shall be utilized.
4. Automatic Damper Operator:
   a. Electric Actuator: 24 volt with remote temperature read and reset capability.
5. Thermostat: Wall-mounted Electronic type with appropriate mounting hardware.
6. Controls: Provide option for connection to BMS and DDC controls.
7. Manufacturers:
   a. Johnson Controls
   b. The Trane Co.
   c. Anemostat Air Products
   d. Substitutions: Refer to Contract Documents.

2.5 FLEXIBLE DUCT CONNECTIONS

A. Acceptable Manufacturers:
   1. Duro-Dyne Corporation
   2. Dynair Carlisle
   3. Substitutions: Refer to Contract Documents.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.

C. Connector: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
   2. Net Fabric Width: Approximately 3 inches wide.
   3. Metal: 3 inches wide, 24 gage galvanized steel.

2.6 DUCT TEST HOLES

A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with gasketed screw cap. Furnish extended neck fittings to clear insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify rated walls are ready for fire damper installation.

C. Verify ducts and equipment installations are ready for accessories.

D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 – HVAC Ducts and Casings for duct construction and pressure class.

B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.

C. Access Doors: Install access doors at the following locations and as indicated on Drawings:
   1. Before and after each automatic control damper.
   2. Before and after each fire damper.

D. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated on Drawings. Install 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

E. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

F. Install fire dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
   1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
   2. Install dampers square and free from racking with blades running horizontally.
   3. Do not compress or stretch damper frame into duct or opening.

4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

G. Support terminal units individually from structure. Do not support from adjacent ductwork.

3.3 DEMONSTRATION

A. Demonstration and training. Refer to Contract Documents.

B. Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Centrifugal roof fans.
2. Cabinet fans.
3. Circulator (destratification) fans.
4. Propeller wall fans.

B. Related Sections:
1. Section 07 72 00 – Roof Accessories
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
3. Section 23 07 00 - HVAC Insulation: Product requirements for power ventilators for placement by this section.
4. Section 23 09 00 - Instrumentation and Control for HVAC: Product requirements for control components to interface with fans.
5. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
6. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
7. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
8. Section 26 05 00 – Common Work Results for Electrical: Execution and product requirements for connecting equipment specified by this section.

1.2 REFERENCES

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

B. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. Air Movement and Control Association International, Inc.:
1. AMCA 99 - Standards Handbook.
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

D. American Refrigeration Institute:
   1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.

E. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.
   2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

F. Underwriters Laboratories Inc.:
   1. UL 705 - Power Ventilators.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit fan manufacturer’s instructions.

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

1.4 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

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. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

D. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

E. Balance Quality: Conform to AMCA 204.

1.6 QUALIFICATIONS

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

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

1.7 PRE-INSTALLATION MEETINGS

A. Pre-Installation Meeting: Refer to Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Protect motors, shafts, and bearings from weather and construction dust.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Warranty: Refer to Contract Documents.

1.11 MAINTENANCE SERVICE

A. Close-out Procedures: Refer to Contract Documents.

B. Furnish service and maintenance of fans for one year from Date of Substantial Completion.

C. Examine each fan and components. Clean, adjust, and lubricate equipment.

D. Include systematic examination, adjustment, and lubrication of fans, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

E. Perform work without removing fans from service during building normal occupied hours.

F. Provide emergency call back service during working hours for this maintenance period.

G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

H. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.12 EXTRA MATERIALS

A. Extra Materials: Refer to Contract Documents.

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.

PART 2 PRODUCTS

2.1 DOWNBLAST CENTRIFUGAL ROOF FANS

A. Acceptable Manufacturers:
   1. Greenheck Corp.
   2. Loren Cook Company
   3. Penn Barry
   4. Substitutions: Refer to Contract Documents.

B. Fan Unit: Downblast type. V-belt or direct drive, with spun aluminum housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Motor: Open drip proof.

E. Roof Curb: 18 inch high of galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, and factory installed nailer strip; furnished by fan manufacturer.

F. Disconnect Switch: Factory wired, non-fusible, in fan housing for thermal overload protected motor, NEMA 250 Type 1, lockable enclosure.

G. Accessories:
   1. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.

H. Performance: As scheduled.

I. Electrical Characteristics and Components:
   1. Electrical Characteristics: In accordance with Section 26 05 00

2.2 CABINET FANS

A. Acceptable Manufacturers:
   1. Greenheck Corp.
   2. Loren Cook Company
   3. Penn Barry
   4. Substitutions: Refer to Contract Documents.

B. Configuration: Inline.

C. Centrifugal Fan Unit: Direct driven with injection molded resin galvanized steel housing lined with 1/2 inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge opening, integral inlet and outlet duct collar.

D. Disconnect Switch: Cord and plug in housing Fan mounted toggle switch for thermal overload protected motor.

E. Wheel: Double width, double inlet Centrifugal forward curved type constructed of injection molded or polypropylene resin.

F. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection, mounted on rubber-shear isolators.

G. Electrical Characteristics: In accordance with Section 26 05 03

2.3 CIRCULATOR FAN

A. Acceptable Manufacturers:
   1. Air-Row Model F-18
   2. Substitutions: Refer to Contract Documents.

B. Destratification fan with thermal shut-off switch; adjustable temperature control and remote solid state speed controller.

2.4 PROPELLER FANS

A. Acceptable Manufacturers:
   1. Greenheck Corp.
   2. Loren Cook Company.
   3. Penn Barry.
   4. Substitutions: Refer to Contract Documents.

B. Construction:
   1. Impeller: Shaped steel or steel reinforced aluminum blade with hubs, statically and dynamically balanced, locked to shaft, directly connected to motor or furnished with V-belt drive.
   2. Frame: One piece, square steel with die formed venturi orifice, mounting flanges and supports, with baked enamel finish.
   3. Drive Shafts and Motors: Drive shafts shall run in permanently lubricated ball bearings in heavy duty cast iron pillow blocks. Motors UL-listed and of totally enclosed fan cooled design. Belt drive or direct drive as shown on the drawings.

C. Accessories:
   1. Back-draft Damper: Multiple blade with offset hinge pin, blades linked.
   2. Safety Screens: Expanded galvanized metal over inlet, motor, and drive; to comply with OSHA regulations.
   3. Fan speed controller for 120 volt fans.
   4. Disconnect Switch

D. Electrical Characteristics and Components:

   1. Electrical Characteristics: In accordance with Section 26 05 00
   2. Motors: Open drip proof
   3. Disconnect Switch: NEMA 250 Type 1 enclosure.

PART 3 EXECUTION

3.1 EXAMINATION

A. Project Management & Coordination: Refer to Contract Documents.

B. Verify roof curbs are installed and dimensions are as shown on shop drawings. Coordinate roof curbing with Section 07 72 00 – Roof Accessories.

3.2 INSTALLATION

A. Secure roof fans with stainless steel lag screws to roof curb.

B. Install backdraft dampers on inlet to roof and wall exhaust fans.

C. Install safety screen where inlet or outlet is exposed.

D. Install backdraft dampers on discharge of exhaust fans and as indicated on Drawings.

E. Provide sheaves required for final air balance.

3.3 CLEANING

A. Cleaning: Refer to Contract Documents.

B. Vacuum clean coils and inside of fan cabinet.

3.4 DEMONSTRATION

A. Demonstation: Refer to Contract Documents.

B. Demonstrate fan operation and maintenance procedures.

3.5 PROTECTION OF FINISHED WORK

A. Protection of Finished Work: Refer to Contract Documents.

B. Do not operate fans until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Diffusers.
2. Registers
3. Grilles.
4. Roof hoods.
5. Louvers.

B. Related Sections:
1. Division 04 – Masonry
2. Section 07 92 00 – Joint Sealants
3. Section 09 90 00 – Painting & Finishing: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
4. Section 23 33 00 – Air Duct Accessories: Volume dampers for inlets and outlets.

1.2 REFERENCES

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

B. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
2. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2007.
3. AMCA 511 - Certified Ratings Program for Air Control Devices; Air Movement and Control Association International, Inc.; 2007.
4. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2005.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. American Society of Testing and Materials:
   1. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2006.
   2. ASTM B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2006.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit sizes, finish, and type of mounting.
   1. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
   2. Submit louver performance information including maximum recommended air velocity, design free area, materials and finishes including color.

C. Shop Drawing: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blank out areas required, and frames.

D. Test Reports:
   1. Rating of air outlet and inlet performance.
   2. Independent agency reports showing compliance with specified performance criteria.

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

1.4 CLOSEOUT SUBMITTALS

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. Closeout submittals: Refer to Contract Documents.

C. Project Record Documents: Record actual locations of air outlets and inlets.

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. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

1.6 QUALIFICATIONS

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

1.7 PRE-INSTALLATION MEETINGS

A. Project Management & Coordination: Refer to Contract Documents.

1.8 PROJECT CONDITIONS

A. Coordinate work of this section with installation of masonry flashings.

B. Coordinate work of this section with installation of mechanical ductwork and electrical services to motorized devices.

1.9 WARRANTY

A. Warranty: Refer to Contract Documents.

B. Furnish one year manufacturer warranty for air outlets and inlets.

C. Provide twenty year manufacturer warranty with louvers against distortion, metal degradation, and failure of connections.
   1. Finish: Include coverage against degradation of exterior finish.

1.10 EXTRA MATERIALS

A. Execution Requirements: Refer to Contract Documents.

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 RECTANGULAR CEILING DIFFUSERS

A. Manufacturers:
   1. Titus Model TMSA
   2. Anemostat Air Products.
   3. Tuttle and Bailey.
   4. Price
   5. Substitutions: Refer to Contract Documents.

B. Type: Square and rectangular, multi-louvered diffuser to discharge air in one-, two-, three- or four-way pattern as indicated.

C. Frame: Surface mounted type. In plaster ceilings, furnish plaster frame and ceiling frame.

D. Fabrication: Extruded aluminum with baked enamel finish, color selected by Architect.

E. Accessories:
   1. Radial opposed-blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.2 SUPPLY REGISTERS/GRILLES

A. Manufacturers:
   1. Titus
   2. Anemostat Air Products.
   3. Tuttle and Bailey.
   4. Price
   5. Substitutions: Refer to Contract Documents.

B. Type: Streamlined and individually adjustable blades to discharge air along face of grille, two-way deflection.

C. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, with factory enamel finish, color selected by Architect.

E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.3 EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
   1. Titus
   2. Anemostat Air Products.
   3. Tuttle and Bailey.
   4. Price
   5. Substitutions: Refer to Contract Documents.

B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, horizontal face.

C. Frame: 1-1/4 inch margin with countersunk screw mounting.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, with factory enamel finish, color selected by Architect.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.4 GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:
   1. Titus Model 50F
   2. Anemostat Air Products.
   3. Tuttle and Bailey.
   4. Price
   5. Substitutions: Refer to Contract Documents.

B. Type: Fixed grilles of 1/2 x 1/2 x 1/2 inch louvers.

C. Fabrication: Aluminum with factory enamel finish, color selected by Architect.

D. Frame: 1-1/4 inch margin with countersunk screw mounting.

E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.5 ROOF HOODS

A. Acceptable Manufacturers:
   1. Greenheck Corp.
   2. Loren Cook Company
   3. Penn Barry
   4. Substitutions: Refer to Contract Documents.

B. Fabricate air inlet or exhaust hoods in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

C. Fabricate of reinforced aluminum, minimum 16 gage base and 18 gage hood. Furnish removable hood; bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and mill finish.

D. Fabricate hood outlet area minimum of twice throat area.

E. Roof Curb: 18 inch high galvanized steel construction with continuously welded seams, 1 inch insulation and curb bottom, and factory installed nailer strip; furnished by hood manufacturer.

2.6 LOUVERS

A. Acceptable Manufacturers:
   1. Ruskin
   2. Airolite Company
   3. American Warming and Ventilating
   4. Construction Specialties, Inc
   5. Substitutions: Refer to Contract Documents.

B. Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified under AMCA 511.
   1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf without damage or permanent deformation.
   2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
   3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.
   4. Screens: Provide bird screens at exhaust louvers.

C. Stationary Louvers: Horizontal blade, extruded aluminum construction, with concealed intermediate mullions.
   1. Free Area: 50.4%, minimum.
   2. Static Pressure Loss: 0.10 inch w.g. maximum per square foot of free area at velocity of 600 fpm, when tested in accordance with AMCA 500-L.
   3. Blades: Sight proof with drainable edge design.
   4. Frame: 5 inches deep, channel profile; corner joints welded.
   5. Metal Thickness: Frame 0.081 inch; blades 0.081 inch.
   6. Finish: Fluoropolymer coating, finished after fabrication.
   7. Color: Provide full range of colors that comply with RAL color system. Architect to approve selection.

D. Materials:
   1. Extruded Aluminum: ASTM B 221 (ASTM B 221M), 6063 alloy, T5 temper.
   2. Bird Screen: Interwoven wire mesh of aluminum, 0.063 inch diameter wire, 1/2 inch open weave, diagonal design.

3. Polyvinylidene Fluoride Coating: Minimum 70 percent Kynar 500/Hylar 500 resin, two coat finish, complying with AAMA 2604.
4. Primer: Zinc chromate, alkyd type.

E. Accessories:
1. Blank-Off Panels: Same material as louver, painted black on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.
2. Screens: Frame of same material as louver, with reinforced corners; removable, screw attached; installed on inside face of louver frame.
3. Fasteners and Anchors: Stainless steel.
4. Flashings: Of same material as louver frame, formed to required shape, single length in one piece per location.
5. Sealant: type, as specified in Section 07 92 00 – Joint Sealants.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify inlet and outlet locations.

C. Verify ceiling systems are ready for installation.

D. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.

E. Verify that field measurements are as indicated.

3.2 INSTALLATION

A. Air Outlets and Inlets
1. Install diffusers to ductwork with airtight connection.
2. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00 – Air Duct Accessories.
3. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 91 00 – Painting & Finishing.

B. Louvers
1. Install louver assembly in accordance with manufacturer's instructions.
2. Install louvers level and plumb.
3. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
4. Secure louver frames in openings with concealed fasteners.
5. Install perimeter sealant and backing rod in accordance with Section 07 92 00 – Joint Sealants.

C. Cleaning
   1. Strip protective finish coverings.
   2. Clean surfaces and components.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 23 51 00

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Double wall metal stacks.

B. Related Sections:
1. Section 22 30 00 – Plumbing Equipment: Gas Vent Systems, Expansion Tanks, and Water heaters.
2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for draft fan motors for placement by this section.
3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers and supports for placement by this section.
4. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
5. Section 23 55 00 - Fuel-Fired Heaters: Fuel fired heaters using breeching, chimneys, and stacks.

1.2 REFERENCES

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

B. American National Standards Institute:
1. ANSI Z21.66 - Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
2. ANSI Z21.67 - Mechanically Actuated Automatic Vent Damper Device.
3. ANSI Z21.68 - Thermally Actuated Automatic Vent Damper Devices.
4. ANSI Z95.1 - Oil Burning Equipment, Installation.

C. ASTM International:
1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process. Refer to Contract Documents.

4. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
5. ASTM C401 - Standard Classification of Alumina and Alumina-Silicate Castable Refractories.

D. National Fire Protection Association:
1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
2. NFPA 54 - National Fuel Gas Code.
3. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment.
4. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.

E. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - Guide for Steel Stack Construction.
2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

F. Underwriters Laboratories Inc.:
1. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances.
2. UL 127 - Factory-Built Fireplaces.
3. UL 378 - Draft Equipment.
4. UL 441 - Gas Vents.
5. UL 641 - Type L Low-Temperature Venting Systems.
6. UL 959 - Medium Heat Appliance Factory Built Chimneys.

1.3 DEFINITIONS

A. Breeching: Vent Connector.

B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.

C. Smoke Pipe: Round, single wall vent connector.

D. Vent: Portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

E. Vent Connector: Part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breeching. Submit layout drawings indicating plan view and elevations.

C. Product Data: Submit data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

D. Product Data: Submit data on fans and accessories including fan curves with specified operating point plotted, power, RPM, and electrical characteristics and connection requirements.

E. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

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

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. Provide factory built vents and chimneys used for venting natural draft appliances complying with NFPA 211 and UL listed and labeled.

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.

1.7 PRE-INSTALLATION MEETINGS

A. Pre-Installation Meetings: Refer to Contract Documents.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Environmental Requirements. Refer to Contract Documents.

B. Maintain water integrity of roof during and after installation of chimney or vent.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Warranty: Refer to Contract Documents..

B. Furnish five year manufacturer warranty for manufactured units.

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 DOUBLE WALL METAL STACKS

A. Acceptable Manufacturers:
   1. American Metal Products (Ampco).
   2. Heat-Fab, Inc.
   3. Metal-Fab, Inc.
   4. Selkirk Inc.

B. Furnish double wall metal stacks, tested to UL 641 and UL listed, for use with building heating equipment, in compliance with NFPA 211.

C. Fabricate with 1 inch minimum air space between walls. Construct inner jacket of 20 gage ASTM A240/A240M or ASTM A666 Type 304 stainless steel. Construct outer jacket of aluminum coated steel 24 gage for sizes 10 inches to 24 inches and 20 gage for sizes 28 inches to 48 inches.

D. Accessories, UL labeled:
   1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
   2. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with NFPA 54.

B. For double wall stacks, maintain UL listed minimum clearances from combustibles. Assemble pipe and accessories for complete installation.

C. Install vent dampers, locating close to draft hood collar, and secured to breeching.

D. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.

E. Level and plumb chimney and stacks.

F. Clean breeching, chimneys, and stacks during installation, removing dust and debris.

G. Install slip joints allowing removal of appliances without removal or dismantling of breeching, breeching insulation, chimneys, or stacks.

H. Provide minimum length of breeching to connect appliance to chimney.

I. Extend vent above roof in accordance with applicable code.

J. Maximum Vent Horizontal Distance: 75 percent of vent vertical distance.

K. Where appliance requires draft hood or barometric control device, install manufacturer furnished listed devices in accordance with manufacturer's instructions and applicable code.

END OF SECTION

SECTION 23 52 23

CAST-IRON BOILERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Cast-iron boilers.
2. Boiler controls.
3. Hot water boiler trim.
4. Dual fuel burner.
5. Circulator.
6. Expansion Tank.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
2. Section 22 11 00 - Facility Water Distribution: Execution requirements for cold water piping connections to boilers specified in this section.
3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
4. Section 23 05 48 – Vibration Noise and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolators for placement by this section.
5. Section 23 11 23 – Facility Natural Gas Piping: Execution requirements for natural gas piping connections to boilers specified in this section.
6. Section 23 21 13 - Hydronic Piping: Execution requirements for hot water piping for piping connections to boilers specified in this section.
7. Section 23 51 00 - Breechings, Chimneys, and Stacks: Execution requirements for breeching, chimney, and stack connections to boilers specified in this section.
8. Section 26 05 00 – Common Work Results for Electrical: Execution requirements for electric connections to boilers specified in this section.

1.2 REFERENCES

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

B. American National Standards Institute:
1. ANSI Z21.13 - Gas-fired Low Pressure Steam and Hot Water Boilers.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. American Society of Mechanical Engineers:
   1. ASME Section I - Boiler and Pressure Vessel Code - Power Boilers.
   2. ASME Section IV - Boiler and Pressure Vessel Code - Heating Boilers.
   3. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

E. Hydronics Institute:
   1. H.I. Heating Boiler Standard - Testing and Rating Standard for Heating Boilers.

F. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

G. National Fire Protection Association:
   1. NFPA 54 - National Fuel Gas Code.
   2. NFPA 58 - Liquefied Petroleum Gas Code.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit capacities and accessories included with boiler. Include general layout, dimensions, size and location of water, fuel, electric and vent connections, electrical characteristics, weight and mounting loads.

C. Test Reports: Indicate boilers meet or exceed specified performance and efficiency. Submit results of combustion test.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

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

F. Manufacturers Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.

1.4 CLOSEOUT SUBMITTALS

A. Close-out Submittals: Refer to Contract Documents.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

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. Perform Work in accordance with the following:
   1. Maryland Boiler Inspection Division Regulations

C. Conform to ASME Section IV and ANSI Z21.13 Code for construction of boilers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

D. Boiler Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with H.I. Heating Boiler Standard.

E. Gas Train and Safety Controls: Conform to requirements of Factory Mutual (FM).

F. Unit Certification: AGA certified.

G. Conform to applicable code for internal wiring of factory wired equipment.

H. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for purpose specified and indicated.

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.

1.7 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting. Refer to Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Accept boilers and accessories on site in factory shipping packaging. Inspect for damage.

C. Protect boilers from damage by leaving packing in place until installation.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Product warranties and product bonds. Refer to Contract Documents.

B. Furnish five year manufacturer’s warranty for boilers.

1.11 MAINTENANCE SERVICE

A. Maintenance service: Refer to Contract Documents.

B. Furnish service and maintenance of boilers for one year(s) from Date of Substantial Completion.

C. Provide emergency call back service at all hours for this maintenance period.

D. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

E. Perform maintenance work using qualified personnel under supervision and in direct employ of or original installer.

1.12 MAINTENANCE MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

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.

PART 2 PRODUCTS

2.1 CAST-IRON BOILERS

A. Acceptable Manufacturers:
   1. Peerless Boiler
   2. Weil-McLain

3. Burnham Corporation
4. Smith Cast-Iron Boilers
5. Substitutions: Refer to Contract Documents.

B. Product Description: Hot Water boilers with forced draft burner, insulated jacket, sectional cast-iron heat exchanger, gas and oil burning system, refractory, controls and boiler trim.

C. Furnish water wall design consisting of water backed combustion area with water circulating around firebox. Refractory chamber or separate base not required.

D. Boiler Fabrication:
1. Assembly: Cast iron sections with 30 psig water ASME Section IV rating, assembled with push nipples or gaskets and draw rods.
2. Furnish access for flue passages for cleaning and flame observation ports.
3. Structural Base: Aluminized steel lined with high temperature mineral fiber insulating panels.
4. Jacket: Glass fiber insulated steel jacket, finished with factory applied baked enamel.

E. Hot Water Boiler Trim:
1. ASME rated pressure relief valve, 30 psig.
2. Combination water pressure and temperature gage. Furnish graduated pressure gage scale from 1-1/2 to 3 times pressure relief valve pressure setting.
3. Low water cut-off to prevent burner operation when boiler water falls below safe level.
4. Operating temperature controller to maintain boiler water temperature.
5. High limit temperature controller with manual reset for burner to prevent boiler water temperature from exceeding safe system temperature.
6. Boiler air vent.
7. Control transformer.
8. Drain valve.
9. Circulator relay.
10. Integral air separator.
11. Combination high and low limit control.

F. Boiler Fuel Burning System:
1. Burner Operation: On-off.
2. Combination Gas-Oil Burner: Burner for natural gas and No. 2 fuel oil built as unit, equipped with gas pressure regulator and oil-gas selector switch.
3. Collector and Draft Hood: Cast iron smoke hood with integral breeching damper.
4. Controls: Pre-wired, factory assembled electronic controls in control cabinet with flame scanner or detector, programming control, relays, and switches. Furnish pre-purge and post-purge ignition and shut down of burner in event of ignition pilot and main flame failure with manual reset.
5. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas

flow on ignition failure, energize blower motor, and after air flow proven and slight delay, allow gas valve to open.

2.2 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Section 26 05 00 and the following:

B. Motors: In accordance with Section 23 05 13.

C. Disconnect Switch: Factory-mount on equipment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Assemble boiler from knockdown configuration after transporting into boiler room. Perform pressure test on boiler after assembly in accordance with the following:
   1. Pressure test before connecting natural gas piping, electrical connections, and controls.
   2. Install boiler drain and pressure gage.
   3. Plug remaining openings.
   4. Fill boiler with water and vent air.
   5. Pressure test to 1-1/2 times working pressure for water boilers for 10 minutes with no leaks.
   6. Repair leaks and retest.
   7. After successful test, drain and remove plugs from openings to be used for piping connections and controls.

B. Install boilers plumb and level, to plus or minus 1/16 inch over boiler base.

C. Maintain manufacturer's recommended clearances around and over boilers.

D. Install boiler on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than boiler base on each side. Refer to Section 03 30 00 – Cast-in-Place Concrete.

E. Install boiler on vibration isolators in accordance with Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

F. Connect natural gas piping in accordance with NFPA 54.

G. Connect fuel oil piping to boiler. Arrange piping with clearances for burner removal and service.

H. Connect natural gas piping to boiler, full size of boiler gas train inlet. Arrange piping with clearances for burner removal and service.

I. Connect hot water piping to supply and return boiler connections.

J. Install the following piping accessories. Refer to Section 23 21 13 – Hydronic Piping.
   1. On supply:
      a. Thermometer well for temperature controller.
      b. Thermometer well and thermometer.
      c. Well for control system temperature sensor.
      d. Strainer.
      e. Nipple and flow switch.
      f. Pressure gage.
      g. Shutoff valve.
   2. On return:
      a. Thermometer well and thermometer.
      b. Well for control system temperature sensor.
      c. Pressure gage.
      d. Shutoff valve.

K. Install the following piping accessories on natural gas piping connections. Refer to Section 23 11 23 – Facility Natural Gas Piping.
   1. Strainer.
   2. Pressure gage.
   3. Shutoff valve.
   4. Check valve.
   5. Pressure reducing valve.

L. Install the following piping accessories on fuel oil piping connections.
   1. Strainer.
   2. Shutoff valve.
   3. Check valve.

M. Install discharge piping from relief valves and drain valves to nearest floor drain.

N. Install boiler trim and accessories furnished loose for field mounting.

O. Install electrical devices furnished loose for field mounting.

P. Install control wiring between boiler control panel and field mounted control devices.

Q. Connect flue to boiler outlet, full size of outlet.

3.2 PERMITS

A. Contractor shall obtain necessary permits including submitting, on behalf of owner, Notice of Installation of a Boiler or Pressure Vessel, to State of Maryland DLLR Boiler Inspection Section.

B. All permits and inspections to be the responsibility of contractor.

3.3 FIELD QUALITY CONTROL

A. Field Quality Control: Refer to Contract Documents.

B. Perform combustion test including boiler firing rate, over fire draft, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.

C. Arrange with local authorities having jurisdiction for inspection of boiler, piping, and for certificate of operation.

3.4 MANUFACTURER'S FIELD SERVICES

A. Manufacturer's Field Services: Refer to Contract Documents.

B. Start-up boilers according to manufacturer's start-up instructions and in presence of boiler manufacturer's representative. Test controls and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjusting: Refer to Contract Documents.

3.6 CLEANING

A. Cleaning: Refer to Contract Documents.

B. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

3.7 DEMONSTRATION

A. Demonstration: Refer to Contract Documents.

B. Demonstrate operation and maintenance procedures.

C. Furnish services for manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of boilers. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION

SECTION 23 55 00

FUEL-FIRED HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Gas fired unit heaters.
2. Gas fired air curtain.

B. Related Sections:
1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers for placement by this section.
3. Section 23 05 48 - Vibration Noise and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
4. Section 23 11 23 - Facility Natural Gas Piping: Product requirements for natural gas piping connected to gas-fired heaters.
5. Section 23 51 00 - Breechings, Chimneys, and Stacks: Product requirements for vents for placement by this section.
6. Section 26 05 00 – Common Work Result for Electrical: Execution requirements for electrical connections specified by this section.

1.2 REFERENCES

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

B. American National Standards Institute:
1. ANSI Z83.8 - Gas Unit Heaters.
2. ANSI Z83.9 - Gas-Fired Duct Furnaces.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. National Fire Protection Association:
1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
2. NFPA 54 - National Fuel Gas Code.
3. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

4. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
5. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.

C. Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

D. Manufacturer's Installation Instructions: Submit Indicate rigging and assembly.

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

1.4 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of thermostats or other products not mounted on unit.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

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. Gas-Fired Unit Heater Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with ANSI Z83.8.

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.

1.7 PRE-INSTALLATION MEETINGS

A. Project Management & Coordination: Refer to Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Product storage and handling requirements. Refer to Contract Documents.

B. Accept heaters and controls on site in factory packaging. Inspect for damage.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 WARRANTY

A. Product warranties and product bonds. Refer to Contract Documents.

B. Furnish five year manufacturer warranty for heat exchanger.

1.11 EXTRA MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

1.12 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 GAS FIRED UNIT HEATERS

A. Acceptable Manufacturers:
   1. Reznor Model UDAS
   2. The Trane Company
   3. Modine

B. Self-contained, high-efficiency, separated combustion type, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
   1. Heating fuel: Natural gas fired.
   2. Discharge Louvers: Individually adjustable vertical louvers mounted in downturn nozzle to match cabinet finish.
   3. Gas Control: Single stage.
   4. Ignition System: Electric ignition-pilot to main burner.
   5. Control Voltage: 24 volt, 60 hertz.
   6. Location: Suspended overhead.
   7. Combustion air/vent kit option including concentric adapter

C. Cabinet: Galvanized steel, easily removed and secured access panels, insulated or double panel construction.

D. Supply Fan: Propeller type with direct drive.

E. Heat Exchanger: Aluminized steel welded construction.

F. Gas Burner: Power vented to draw combustion air directly into unit from outside the building; combustion air supply and flue exhaust run in parallel to factory furnished concentric adaptor assembly to allow single roof penetration.

G. Gas Burner Safety Controls:
   1. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
   2. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic reset.

H. Electrical Characteristics and Components:
   1. Electrical Characteristics: In accordance with Section 26 05 00.
   2. Motors: In accordance with Section 23 05 13.
   3. Disconnect switch: factory mounted and wired.

2.2 AIR CURTAINS

A. Acceptable Manufacturers:
   1. Berner
   2. Powered Aire
   3. Mars

B. Construction: Provide factory-assembled units of sufficient structural strength to be supported from ends without intermediate support. Ship units completely assembled.

C. Cabinet:
1. Material: Minimum 16-gage aluminized steel with gray colored powder coat finish with mill aluminum inlet screen, all welded construction.
2. Mounting: Provide for top of wall mounting.

D. Motors: three (3) phase, single speed, double extended shafts with sealed bearings.

E. Fans: Balanced forward curved centrifugal type, double inlet, double width design, mounted in matched fan housings with aerodynamically formed air inlet venturis. Manufacture wheels and housings from galvanized steel.
1. Discharge Nozzles:
    1) Provide uniform velocity across width of air door.
    2) Aperture: 3-1/2 inches slot by width of air door.
2. Vanes: 1-1/2 inches minimum height; constructed of airfoil-shaped aluminum extrusions; adjustable plus or minus 20 degrees to deflect airflow.
3. Inlet:
    1) Location: Front
    2) Screen: Perforated pattern mill aluminum with border.
4. Air Inlet Filter: Flat-faced recleanable aluminum.

F. HEATING ELEMENTS
1. Indirect Gas Heater and Duct Transition:
    a. CSA listed.
    b. Fuel Type: Provide orifices for natural gas.
    c. Heat Exchanger and Burner: Stainless steel.
    d. Characteristics: 120-volt single point supply voltage, power exhaust vent, 120-volt limit control, 24-volt control voltage transformer, combustion air pressure switch, spark ignited intermittent safety pilot system with electronic flame supervision.
    e. Independently support each heater at least one (1) inch from each opening of factory-installed duct transition. Construct duct transition from 16-gage aluminized steel with access panels spanning entire width.

G. CONTROLS
1. Control Panel:
    a. UL listed, industrial type, pre-wired, with components consisting of motor starter, terminal strip, motor overloads, and control transformer with 24 volt fused secondary.
    b. Single power supply.
    c. Mounting: Unit mounted.
    d. Time Delay Relay: Adjustable in field from 0.1 second to 10 hour delay. Set delay for one (1) minute(s) unless otherwise indicated.

e. Disconnect Switch: Provide units with non-fused toggle disconnects based on number of power supplies required.
f. Remote Activation Devices:
1) Automatic Door Switch: Switch automatically activates unit when door opens and deactivates unit when door closes.
2) HAND-OFF-AUTOMATIC Switch: Switch allows manual on-off operation or operation controlled by automatic door switch that activates unit when door opens and deactivates unit when door closes.
3) HEAT-ON-OFF switch.
g. Thermostat: Prevents operation of heater when inside air temperature exceeds desired temperature.

H. MOUNTING ACCESSORIES
1. Provide brackets and other mounting accessories as required to permit installation and proper functioning of air door to meet project conditions of use.
2. Fabricate mounting accessories from powder coated aluminized steel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify space is ready for installation of units and openings are as indicated on shop drawings.

3.2 INSTALLATION

A. Install units in accordance with NFPA 90A gas fired units to NFPA 54.

B. Installation - Natural Gas Piping:
1. Connect natural gas piping in accordance with NFPA 54.
2. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
3. Install the following piping accessories on natural gas piping connections. Refer to Section 23 11 23 – Facility Natural Gas Piping.
a. Strainer.
b. Pressure gage.
c. Shutoff valve.
d. Pressure reducing valve.
e. Strainer.
f. Shutoff valve.

C. Install vent connections in accordance with NFPA 211. Install vents and stacks. Refer to Section 23 51 00 – Breechings, Chimneys, and Stacks.

D. Install unit heaters with vibration isolation. Refer to Section 23 05 48 – Vibration Noise and Seismic Controls for HVAC Piping and Equipment.

E. Install air curtains where indicated on Drawings and accordance with shop drawings and manufacturer's instructions. Provide clearance to permit servicing and maintenance.

F. Securely install air curtains plumb, level, and as close as practical to top of opening and face of wall.

G. Install door switches where indicated on Drawings.

H. Provide hangers and supports for suspended units. Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

I. Provide operating controls. Refer to Section 23 09 23 – Direct-Digital Control System for HVAC and Section 23 09 93 – Sequence of Operation for HVAC Controls.

J. Provide connection to electrical power systems. Refer to Division 26.

END OF SECTION

SECTION 23 64 11

PACKAGE WATER CHILLERS – AIR COOLED

PART 1 GENERAL

1.1 SUMMARY

A. Section includes chiller package, charge of refrigerant and oil, controls and control connections, chilled water connections, condenser water connections, refrigerant connections, auxiliary water connections, starters.

B. Related Sections:
1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for chillers specified in this section.
4. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and condenser water piping for placement by this section.
5. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
6. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection to chillers specified by this section.

1.2 REFERENCES

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

B. Air-Conditioning and Refrigeration Institute:
1. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. American Society of Mechanical Engineers:
1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

E. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 DEFINITIONS

A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system.

C. Product Data: Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include startup instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.

F. Manufacturer’s Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.

1.5 CLOSEOUT SUBMITTALS

A. Closeout Requirements: Refer to Contract Documents

B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

1.6 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. Conform to ARI 550/590 code for testing and rating of water chillers.

C. Performance Ratings: Coefficient of Performance (COP) and Integrated Part-Load Value (IPLV) not less than prescribed by ASHRAE 90.1.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

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

1.8 PRE-INSTALLATION MEETINGS

A. Administrative Requirements: Refer to Contract Documents.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contract Documents.

B. Accept chillers on site in factory packaging. Inspect for damage.

1.10 WARRANTY

A. Warranty: Refer to Contract Documents

B. Furnish five year manufacturer warranty to include coverage for complete assembly including materials and labor.

1.11 MAINTENANCE SERVICE

A. Requirements for maintenance service. Refer to Contract Documents

B. Furnish service and maintenance of chiller for one year from Date of Substantial Completion.

C. Examine unit components bi-monthly. Clean, adjust, and lubricate equipment.

D. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

E. Perform work without removing units from service during building normal occupied hours.

F. Provide emergency call back service during working hours for this maintenance period.

G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

H. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

1.12 MAINTENANCE MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents

B. Furnish two containers of lubricating oil.

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.

PART 2 PRODUCTS

2.1 PACKAGED WATER CHILLERS

A. Acceptable Manufacturers:
   1. Carrier as furnished by APC by Schneider Electric
   2. Substitutions Product Requirements: Refer to Contract Documents.

B. Product Description: Factory assembled and tested, packaged, air cooled, liquid chillers consisting of semi-hermetic screw compressors, compressor motor, condenser, evaporator, refrigeration accessories, instrument and control panel including gages and indicating lights, auxiliary components and accessories, and motor starters.

C. Unit Cabinet:
1. Frame shall be of heavy-gage galvanized steel.
2. Cabinet shall be galvanized steel casing with a baked enamel powder or pre-painted finish.
3. Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM (U.S.A.) B-117 standard.

D. Fans:
1. Condenser fans shall be direct-driven, 9-blade airfoil cross-section, reinforced polymer construction, shrouded-axial type, and shall be statically and dynamically balanced with inherent corrosion resistance.
2. Fan operation shall allow reduced sound levels during scheduled unoccupied operating periods. Manufacturers without unoccupied reduced sound capability shall submit 1/3 octave band data and sound power data as measured by ARI 370 as confirmation of unit sound characteristics.
3. Air shall be discharged vertically upward.
4. Fans shall be protected by coated steel wire safety guards.

E. Compressors:

1. Fully hermetic scroll type compressors.
2. Direct drive, 3500 rpm (60 Hz), protected by either line break device or discharge gas thermostat, depending on motor, suction gas cooled motor.
3. External vibration isolation – rubber in shear.
4. Each compressor shall be equipped with crankcase heaters to minimize oil dilution.

F. Cooler:

1. Cooler shall be rated for a refrigerant working side pressure of 565 psig and shall be tested for a maximum fluid-side pressure of 150 psig.
2. Cooler shall be single-pass, ANSI type 316 stainless steel, brazed plate construction.
3. Cooler shell shall be insulated with ¾-in. (19 mm) closed-cell, polyvinyl-chloride foam with a maximum K factor of 0.28.
4. Cooler shall Incorporate two independent refrigerant circuits on sizes 120 & 167; sizes 050 & 084 shall have one independent refrigerant circuit.
5. Cooler shall have factory-installed heater, to protect cooler from ambient temperature freeze down to -20°F (-29°C).

G. Condenser:

1. Coil shall be air-cooled with integral subcooler, and shall be constructed of aluminum fins mechanically bonded to seamless copper tubes.
2. Tubes shall be cleaned, dehydrated, and sealed.
3. Assembled condenser coils shall be leak tested and pressure tested at 656 psig.

H. Refrigeration Components:

Refrigerant circuit components shall include filter drier, moisture indicating sight glass, thermal expansion device, and complete operating charge of both refrigerant R-410A and compressor oil.

I. Controls, Safeties, and Diagnostics:
1. Unit controls shall include the following minimum components:
   a. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
   b. Separate terminal block for power and controls.
   c. Control transformer to serve all controllers, relays, and control components.
   d. ON/OFF control switch
   e. Replaceable solid-state controllers.
   f. Pressure sensors installed to measure suction and discharge pressure. Thermistors installed to measure cooler entering and leaving fluid temperatures. Provision for field installed accessory sensor to measure compressor return gas temperature.

2. Unit controls shall include the following functions:
   a. Automatic circuit lead/lag for dual circuit chillers.
   b. Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to 0.1°F (0.06°C).
   c. Limiting the chilled fluid temperature pull down rate at start-up to an adjustable range of 0.2°F to 2°F (0.11°C to 1.1°C) per minute to prevent excessive demand spikes at start-up.
   d. Seven-day time schedule.
   e. Leaving chilled fluid temperature reset from return fluid.
   f. Chiller water pump start/stop control and primary/standby sequencing to ensure equal pump run time.
   g. Dual chiller control for parallel chiller applications without addition of hardware modules, control panels, thermometer wells.
   h. Unoccupied low sound operation to limit condenser fan sound during scheduled periods.
   i. Timed maintenance scheduling to signal maintenance activities for pumps, condenser coil cleaning, strainer maintenance and user defined maintenance activities.
   j. Low ambient protection to energize cooler and hydronic system heaters.
   k. Periodic pump start to ensure pump seals are properly maintained during off-season periods.

3. Diagnostics
   a. The control panel shall include, as standard, a Scrolling Marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display.
   b. Information included for display shall be:
      1) Compressor lockout.
      2) Loss of charge.
      3) Low fluid flow.
      4) Cooler freeze protection
      5) Thermistor malfunction.
      6) Entering and leaving-fluid temperature.
      7) Evaporator and condenser pressure.
      8) Time of Day:
         a) Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.
         b) Diagnostics shall include the ability to review a list of the 20 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
         c) An alarm history buffer shall allow the user to store no less than 20 alarm events with clear language descriptions, time and date stamp event entry.
         d) The chiller controller shall include multiple connection ports for communicating with the local equipment network and the ability to access all chiller control functions from any point on the chiller.
         e) The control system shall allow software upgrade without the need for new hardware modules.

4. Safeties
   a. Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:
      1) Loss of refrigerant charge.
      2) Reverse rotation.
      3) Low chilled fluid temperature.
      4) Thermal overload.
      5) High pressure.
      6) Electrical overload.
      7) Loss of phase.
   a. Condenser fan and factory pump motors shall have external overcurrent protection.

J. Operating Characteristics:

   a. Unit shall be capable of starting and running at outdoor ambient temperatures from minus 20°F to 120°F.

b. Unit shall be capable of starting up with 95°F (35°C) entering fluid temperature to the cooler.

K. Motors:

Condenser fan motors shall be totally enclosed single speed, 3-phase type with permanently lubricated bearings and Class F insulation.

L. Electrical Requirements:

a. Unit primary electrical power supply shall enter the unit at a single location (some units have multiple poles).
b. Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.
c. Control points shall be accessed through terminal block.
d. Unit shall be shipped with factory installed control and power wiring installed.

M. Chilled Water Circuit:

a. Field pipe connections shall be copper NPT and shall be extended to the outside of the unit chassis.
b. Primary / Stand-by operation pump systems shall have pump discharge check valves.
c. Pumps shall be single stage design for installation in vertical or horizontal position and capable of being serviced without disturbing piping connections.
    1) Pump casing shall be of class 30 cast iron.
    2) The impeller shall be of cast bronze, closed type, dynamically balanced, keyed to the shaft and secured by locking cap screw.
    3) The liquid cavity shall be sealed off at the motor shaft by an internally flushed mechanical seal with ceramic seal seat and carbon seal ring
    4) Pump shall be rated for 150 psig working pressure.
    5) The pump case shall have gauge tappings at the suction and discharge nozzles and include drain ports.
    6) Motors shall be totally enclosed 3-phase type with grease lubricated ball bearings.
    7) Each pump shall be factory tested per Hydraulic Institute Standards
d. Fluid expansion tank shall be factory installed within the chiller cabinet insulates, pre-charged and rated for a maximum working pressure of 150 psig.
e. Water pressure gages (2) shall be factory installed across the cooler and rated for 150 psi.
f. Proof-of-flow switch shall be factory installed and rated for 150 psig.
g. Balancing valve shall be factory installed to set flow gage ports shall be factory installed and rated for 300 psig.
h. Hydronic assembly shall have factory supplied electric freeze protection to minus 20°F (-29°C).
i. Piping shall be type-L seamless copper tubing.
j. Copper body strainer with 20 mesh screen and ball type blow down.

N. Accessories

a. Low-Ambient Operation:
Unit shall be capable of starting and running at outdoor ambient temperatures down to -20°F (-29°C) with the addition of antifreeze in the cooler circuit, wind baffles, and field installed or factory installed solid-state controller with condenser coil temperature sensor.

b. Unit-Mounted Non-Fused Disconnect:
Unit shall be supplied with factory-installed, non-fused electrical disconnect for main power supply.

c. Minimum Load Control:
Unit shall be equipped with factory installed, microprocessor-controlled, minimum load control that shall permit unit operation down to a minimum of 15% capacity.

d. Coil Protection Grilles:
Unit shall be supplied with factory (or field) installed, PVC-coated grilles to protect the condenser coil from physical damage.

e. Vibration Isolation:
Vibration isolation pads shall be supplied for field installation at unit mounting points. Pads shall help to reduce vibration transmission into the occupied space.

f. Wind Baffles: (factory supplied and installed)
Required if wind velocity is anticipated to be greater than 5 mph (8 km/h) in low ambient operation

g. Modbus LEI Bacnet Protocol
A Modbus communication card shall be installed at the chiller and set up to interface with a secondary controls system.

2.2 CHILLER PERFORMANCE

A. As scheduled on Drawings.

2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Section 26 05 03 and the following:
1. Motors: In accordance with Section 23 05 13.
2. Disconnect Switch: Factory mount on equipment.

2.4 SOURCE QUALITY CONTROL (AND TESTS)

A. Testing, inspection and analysis requirements. Refer to Contract Documents

B. Furnish shop inspection and testing for package chillers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install packaged outdoor chiller on concrete foundation minimum 6 inches thick and 6 inches wider than equipment base on each side.

B. Install units on vibration isolation. Refer to Section 23 05 48.

C. Install the following piping accessories on evaporator chilled water piping connections. Refer to Section 23 21 16 and Section 23 21 13.
   1. On inlet:
      a. Thermometer well for temperature controller.
      b. Thermometer.
      c. Strainer.
      d. Flow switch.
      e. Flexible pipe connection.
      f. Pressure gage.
      g. Shut-off valve.
   2. On outlet:
      a. Thermometer.
      b. Flexible pipe connection.
      c. Pressure gage.
      d. Balancing valve.

D. Install auxiliary water piping for oil cooling units and purge condensers.

E. Arrange piping for easy dismantling to permit tube cleaning.

F. Install piping from chiller safety relief valve to outdoors. Size as recommended by manufacturer.

G. Install chiller accessories furnished loose for field mounting.

H. Install electrical devices furnished loose for field mounting.

I. Install control wiring between chiller control panel and field mounted control devices.

J. Provide connection to electrical service. Refer to Section 26 05 03.

3.2 FIELD QUALITY CONTROL

A. Field inspecting, testing, adjusting, and balancing. Refer to Contract Documents

B. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

3.3 MANUFACTURER'S FIELD SERVICES

A. Manufacturers' field services. Refer to Contract Documents

B. Furnish services of factory trained representative for minimum of one days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.

C. Furnish initial charge of refrigerant and oil.

3.4 ADJUSTING

A. Requirements for starting and adjusting. Refer to Contract Documents

B. Adjust and balance chilled water flow. Refer to Section 23 05 93.

3.5 DEMONSTRATION AND TRAINING

A. Requirements for demonstration and training. Refer to Contract Documents

B. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

END OF SECTION

SECTION 23 72 13

ENERGY RECOVERY UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
1. Energy wheel air-to-air energy recovery ventilators.
2. Split system energy recovery units.

B. Related Sections:
1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
2. Section 23 05 48 – Vibration Noise and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
5. Section 23 33 00 - Air Duct Accessories: Product requirements for flexible duct connections for placement by this section.
6. Section 26 05 00 – Common Work Results for Electrical: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

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

B. American Bearing Manufacturers Association:
1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. Air Movement and Control Association International, Inc.:
1. AMCA 99 - Standards Handbook.
2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
5. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

D. Air-Conditioning and Refrigeration Institute:

1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
2. ARI 430 - Central-Station Air-Handling Units.
3. ARI 610 - Central System Humidifiers for Residential Applications.
4. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.

E. National Electrical Manufacturers Association:
1. NEMA MG 1 - Motors and Generators.

F. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

G. Underwriters Laboratories Inc.:
1. UL 900 - Air Filter Units.
2. UL - Fire Resistance Directory.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Product Data, Submit the following:
1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.
4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
5. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.
6. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.

D. Manufacturer's Installation Instructions: Submit.

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

1.4 CLOSEOUT SUBMITTALS

A. Close-out Procedures: Refer to Contract Documents.

B. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

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.
   1. Units shall be AMCA Certified for air flow. AMCA certification of individual components is not acceptable.
   2. Units shall be ETL Certified per U.L. 1995 and bear an ETL sticker.
   3. Energy Wheels shall be AHRI Certified: Standard 1060.

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.

1.7 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting. Refer to Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Product storage and handling requirements. Refer to Contract Documents.

B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 WARRANTY

A. Close-out Procedures: Refer to Contract Documents.

B. Furnish one year manufacturer warranty for make-up air units.

1.10 EXTRA MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

B. Furnish two sets of fan belts for each unit.

C. Furnish two sets of filters for each unit.

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 ENERGY RECOVERY VENTILATOR

A. Acceptable Manufacturers:
   1. Greenheck Fan Corporation Model ERV
   2. Semco
   3. Substitutions: Refer to Contract Documents.

B. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, energy wheel, motorized intake damper, motorized exhaust damper, modulating wheel frost control, filter assembly for intake and exhaust air, supply air blower assembly, exhaust air blower assembly and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

2.2 CASING

A. Materials: Formed single wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
   1. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish.
   2. Internal assemblies:18 gauge, galvanized (G90) steel except for motor supports which shall be minimum14 gauge galvanized (G90) steel.

B. Access doors shall be hinged.

C. Shall have factory-installed duct flanges on all duct openings.

D. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
   1. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
      a. Thickness: 1 inch (25 mm)
      b. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
      c. Location and application: Full coverage of entire cabinet exterior to include walls, roof and floor of unit. Insulation shall be of semi-rigid type and installed between inner and outer shells of all cabinet exterior components.

E. Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt with a five year warranty. The wheel media shall be a polymer film matrix in a stainless steel framework and be comprised of individual segments removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.

F. Supply Air and Exhaust Air blower assemblies: Blower assemblies consist of an electric motor and a belt driven blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on 1.125 inch thick neoprene vibration isolators.

G. Control panel / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections

H. Frost control: modulating wheel type with factory installed VFD.

I. Modulating frost control. Control system shall include an outdoor air thermostat and pressure sensor on the wheel assembly to initiate frost control sequence

J. Motorized dampers for Exhaust Air and Intake Air: Motorized dampers of low leakage type shall be factory installed.

2.3 FANS

A. Blower section construction, Supply Air and Exhaust Air: Belt drive motor and blower shall be assembled onto a 14 gauge galvanized steel platform and must have neoprene vibration isolation devices.

B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

C. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.

D. Forward curved blower fan wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.

E. Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, “Laboratory Methods of Testing Fans for Rating”.

2.4 MOTORS

A. Refer to Section 23 05 13 – Common Motor Requirements for HVAC Equipment for motor requirements.

B. General: Blower motors greater than ¾ horsepower shall be "NEMA Premium™" unless otherwise indicated. Minimum compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley.

2.5 UNIT CONTROLS:

A. The unit shall be constructed so that it can function as a stand-alone system with a run signal provided by others, or integrated into the building management system through a field installed and wired controller, provided by others.
B. Variable Frequency Drive (VFD): unit shall have factory installed variable frequency drives for modulation of the blower motors The VFDs shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
C. Sensors
   1. CO2 Sensor shipped loose for field installation and wiring.
   2. Rotation Sensor

2.6 FILTERS

A. Unit shall have MERV 8 disposable pleated filters shall be provided in the intake air stream and MERV 8 filters in the exhaust air stream.

2.7 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Section 26 05 00.

B. Disconnect Switch: Factory mount on equipment.

2.8 SPLIT SYSTEM ENERGY RECOVERY UNITS

A. Acceptable Manufacturers:
   1. AAON, Inc.
   2. Substitutions: Refer to Contract Documents.

B. Description: Factory assembled air handling units designed to the performance scheduled and including components as shown on the drawings.

C. Construction: Cabinet shall be constructed entirely of G90 galvanized steel 1 inch double wall panels with foam insulation providing a minimum R-Value of 6.25.

The panel construction shall provide a thermal break to eliminate any metal conductive path through the panel.

1. The completed cabinet shall provide an air leakage of less than 1% when tested at 6" static pressure.
2. Unit specific color-coded wiring diagrams shall match the unit color-coded wiring and will be provided in both point-to-point and ladder form.
3. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.
4. Access to filters, blower, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with quarter turn latches or removable access panel.
5. Hinged access doors shall have stainless steel hinges with removable pin and full perimeter gasketing and open against air pressure.
6. Unit shall have decals and tags to indicate service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit.

D. Supply Fan Module:

1. The fan module(s) shall be provided as shown on the drawing and shall be belt drive, single width, single inlet, un-housed, airfoil centrifugal plenum fans. Fans shall have all aluminum construction. Adjustable V-belt drive shall be provided with a minimum rating of 140% of the motor nameplate brake horsepower when the adjustable pulley is at the minimum RPM. The fan shaft drive end bearing shall have a grease fitting, and the opposite drive end bearing shall be permanently lubricated. Motor bearings shall be rated for 200,000 hours service and shall have a grease fitting. Fan, motor, and drive shall be dynamically balanced, and the entire fan assembly mounted on rubber-in-shear isolators. Supply air shall be from the top of the cabinet. The fan module shall have an electrical control panel for the basic air handling unit.
    a. Fan motors shall be premium efficiency. Motors for use with VFD shall be premium efficiency inverter rated only. Motor bearings shall be ball bearing and shall have grease fittings.
    b. VFD drive shall be factory mounted and wired to the fan motor.

E. Control Module:

1. The control module(s) shall be provided as shown on the drawing(s). The control panel module size shall be required as necessary or optionally selected, and shall be selected to provide adequate space for power and control options.

F. Coil Module:

Refrigerant (DX) Evaporator Coils

1. The refrigerant evaporator coil module(s) shall be provided as shown on the drawing and shall include a sloped, double wall, foam insulated, stainless steel drain pan. The coil(s) shall be selected to meet the scheduled performance. Coil construction shall include:
    a. Copper tube with aluminum fins mechanically bonded to the tubes.
    b. Evaporator coils shall be rated in accordance with ARI Standard 410.
    c. Galvanized steel end casings.
    d. Evaporator coils shall have equalizing type vertical tube headers.
    e. Evaporator coils shall be furnished with a thermostatic expansion valve.
    f. A 1" MPT condensate drain connection shall be provided on the access side of the unit.
    g. Unit shall include a dual circuit evaporator coil

G. Heat Module:

1. The heat module(s) shall be provided as shown on the drawings and include hot water heat to meet the performance as scheduled.
    a. Hot Water Coil
        1. Module shall be provided with a 2 row hot water heating coil with copper and tube aluminum fins mechanically bonded to the tubes. A 1" MPT drain connection shall be provided on the access side of the unit.

H. Energy Recovery Module:

1. The heat recovery module shall be provided as shown on the drawing and shall have a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
2. The energy recovery cassette shall be rated in accordance with ARI Standard 1060 and shall bear the ARI certification symbol.
3. The energy recovery cassette shall contain a total energy recovery heat wheel constructed of a light weight polymer material with permanently bonded desiccant coating. The energy recovery wheel media shall be capable of removal from the cassette and replacement without the use of tools. Wheel media shall be cleanable using hot water or light detergent without degrading the latent efficiency.
4. Energy recovery wheel cassette shall carry a 5 year non-prorated warranty.

I. Filter Module:

1. The filter module(s) shall be provided as shown on the drawing and shall include filters as specified. The filter rack shall be constructed of galvanized steel and shall be an integral part of the module.

J. Mixing Box Modules:

1. The mixing box module(s) shall be provided as shown on the drawing. The damper blades shall be extruded aluminum, hollow core, air foil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 25 CFM of leakage per sq. ft. of damper area when subjected to 2 in. w.g. air pressure differential across the damper.

   Options include:

   a. Fully modulating damper operator

K. Controls:

1. Standard Mechanical Controls

Wattmaster VCM Control Functions:

a. Constant Volume Unit Controller
   1. The unit shall include a programmable controller which provides 7 day, 2 events per day scheduler, 14 day holiday schedule, optimal start and outputs for heating, cooling, and economizer. The unit manufacturer shall provide the supply air temperature sensor, outside air temperature sensor, outside air humidity sensor and space temperature sensor for field installation by others.

2.9 CONDENSING UNITS

A. Unit Description: Provide and install as shown on the plans, factory assembled, air-cooled scroll compressor condensing units in the quantity specified. Each unit shall consist of an air-cooled condenser section and isolated control compartment containing: hermetic scroll compressors, control system, suction and liquid connection valves, and all components necessary for safe and controlled unit operation when connected to the specified low side equipment.

B. Construction:

1. Unit shall be completely factory assembled, piped, and wired and shipped in one section.

2. Unit shall be specifically designed for outdoor application.

3. The condenser coil shall be mechanically protected from physical damage by painted galvanized steel louvers covering the full area of the coil.

4. Paint finish shall be capable of withstanding at least 2500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

C. Compressor:

1. The compressors shall be sealed hermetic scroll type, with inherent thermal overload protection and shall be mounted on rubber vibration isolators.

2. Each compressor shall be furnished with a crankcase heater.

3. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit(s) which shall be capable of modulation from 10-100% of its capacity.

D. Condenser:

1. The condenser coils shall consist of seamless copper tubes mechanically bonded into plate type aluminum fins. The fins shall have full drawn collars to completely cover the tubes. A subcooling section shall be an integral part of the main condenser coil.

2. Unit shall include a dual circuit condenser coil

3. The condenser fan(s) shall be propeller type arranged for vertical air discharge, and driven by a direct drive fan motor. The fan discharge area shall be equipped with a heavy-gauge fan guard.

4. Fan motor(s) shall be weather protected, single-phase, direct drive, 1100 rpm, open drip-proof type.

E. Refrigerant Circuit:

1. The condensing unit shall operate with R-410A refrigerant. The condensing unit shall be furnished with liquid line filter driers and service valves for liquid and suction connections. The finished field installed refrigerant circuit furnished by the contractor shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line and insulated suction line.

F. Control System:

1. A centrally located weatherproof control panel shall be isolated from condenser coil airflow, and shall contain the field power connection points, control terminal block and control system.

2. Control circuit transformer and wiring shall provide 24V control voltage from the line voltage provided to the unit.

3. Power and starting components shall include fan motor contactors, 5 minute off time delay relay(s) for the compressor(s), inherent fan motor overload protection and unit power terminal blocks for connection to remote disconnect switch. Safety and operating controls shall include a manually reset high pressure switch and an automatic reset low pressure switch. Barrier panels shall be furnished to protect against accidental contact with line voltage when accessing the control system.

G. Wiring Diagrams:

1. Color-coded and marked wiring diagrams shall be provided in both “point-to-point” and “ladder” to match the color and markings of the unit wiring.

2. Diagrams shall be laminated in plastic and permanently fixed to the control compartment door.

3. Installation, Operation, and Maintenance manual shall be supplied with unit within the control compartment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with ARI 430.

B. Install flexible connections between unit and inlet and discharge ductwork. Install metal bands of connectors parallel with minimum 1 inch flex between ductwork and fan while running. Refer to Section 23 33 00 – Air Duct Accessories.

C. Install assembled units with vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads.

D. Provide fixed sheaves required for final air balance.

3.2 INSTALLATION HOT WATER HEATING COIL

A. Make connections to coils with unions or flanges.

B. Connect water supply to leaving airside of coil (counter flow arrangement).

C. Locate water supply at bottom of supply header and return water connection at top.

D. Install water coils to allow draining and install drain connection at low points.

E. Install valves and piping specialties in accordance with details as indicated on Drawings.

F. Install manual air vents at high points.

3.3 MANUFACTURER'S FIELD SERVICES

A. Requirements for manufacturer's field services. Refer to Contract Documents.

B. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Section 23 05 93 Testing, Adjusting and Balancing and comply with provisions therein.

3.4 CLEANING

A. Requirements for cleaning. Refer to Contract Documents.

B. Vacuum clean coils and inside of unit cabinet.

C. Install new throwaway filters in units at Substantial Completion.

3.5 DEMONSTRATION

A. Requirements for demonstration and training. Refer to Contract Documents.

B. Demonstrate unit operation and maintenance.

3.6 PROTECTION OF FINISHED WORK

A. Requirements for protecting finished Work. Refer to Contract Documents.

B. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Air handling unit.
2. Condensing unit.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete foundations specified by this section.
2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Vibration isolators.
3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
5. Section 23 21 13 - Hydronic Piping: Execution requirements for connection to hot water and drain piping specified by this section.
6. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
7. Section 23 33 00 - Air Duct Accessories: Flexible connections.
8. Section 26 05 03 - Equipment Wiring Connections: Electrical connection to units.

1.2 REFERENCES

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

B. Air-Conditioning and Refrigeration Institute:
1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
5. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
6. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ASTM International:
   1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

E. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

F. National Fire Protection Association:
   1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Product Data: Submit data indicating:
   1. Cooling and heating capacities.
   2. Dimensions.
   3. Weights.
   4. Rough-in connections and connection requirements.
   5. Duct connections.
   6. Electrical requirements with electrical characteristics and connection requirements.
   7. Controls.
   8. Accessories.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

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

E. Manufacturer’s Field Reports: Submit start-up report for each unit.

1.4 CLOSEOUT SUBMITTALS

A. Closeout Requirements: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of controls installed remotely from units.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

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. Performance Requirements: , Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.

C. Cooling Capacity: Rate in accordance with ARI 210/240.

D. Sound Rating: Measure in accordance with ARI 270.

E. Insulation and adhesives: Meet requirements of NFPA 90A.

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.

1.7 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting. Refer to Contract Documents.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Requirements for transporting, handling, storing, and protecting products. Refer to Contract Documents.

B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 COORDINATION

A. Requirements for coordination. Refer to Contract Documents.

B. Coordinate installation of condensing units with concrete pad.

C. Coordinate installation of air handling units with building structure.

1.10 WARRANTY

A. Requirements for warranties. Refer to Contract Documents.

B. Furnish five year manufacturer’s warranty for compressors.

1.11 MAINTENANCE SERVICE

A. Requirements for maintenance service. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments. Refer to Contract Documents.

B. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period. Furnish capability of response time within four hours.

1.12 MAINTENANCE MATERIALS

A. Requirements for maintenance materials. Refer to Contract Documents.

B. Furnish one set for each unit of filters.

PART 2 PRODUCTS

2.1 SPLIT SYSTEM AIR CONDITIONING UNITS

A. Manufacturers:
   1. Trane Company
   2. Carrier
   3. JCI/York
   4. Substitutions: Refer to Contract Documents.

2.2 AIR HANDLING UNIT

A. Cabinet:
   1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
   2. Insulation: Factory applied to each surface to insulate entire cabinet. one inch thick neoprene coated glass fiber with edges protected from erosion. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.

B. Evaporator Coil: Constructed of seamless copper tubes expanded onto aluminum fins. Factory leak tested to 425 psig under water. Removable, PVC construction, double-sloped drain pan with piping connections on both sides.

C. Refrigeration System: Single refrigeration circuits controlled by factory installed thermal expansion valve.

D. Air Handling Unit Accessories:
   1. Discharge Plenum: with construction and finish matching unit casing. Integral grille of aluminum construction and adjustable louvers.

2. Return Air Grille: mounted in return air opening of aluminum construction and fixed louvers.
3. Mounting Subbase with construction and finish matching unit casing. Vibration Isolators: Neoprene-in-shear type As specified in Section 23 05 48.

2.3 CONDENSING UNIT

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.

C. Compressor: Single refrigeration circuit with rotary or hermetic reciprocating type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.

D. Condenser Coil: Constructed of seamless copper tubing mechanically bonded to aluminum fins, factory leak and pressure tested to 425 psig.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.

F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.

G. Condensing Unit Accessories: Furnish the following accessories:
   1. Controls to provide low ambient cooling to 0 degrees F.
   2. Time delay relay.
   3. Anti-short cycle timer.
   4. Disconnect switch. Vibration isolators.
   5. Hot gas bypass kit.
   6. Coil with corrosion resistant coating capable of withstanding salt spray test of 500 hours in accordance with ASTM B117.
   7. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
   8. Suction and discharge pressure gauges. Refrigeration specialties: Furnish the following:
   9. Charge of compressor oil.
   10. Holding charge of refrigerant.
   11. Replaceable core type filter drier.
   12. Liquid line sight glass and moisture indicator.
   13. Shut-off valves on suction and liquid piping.
   14. Liquid line solenoid valve.

15. Charging valve.
16. Oil level sight glass.
17. Crankcase heater.
18. Hot gas muffler.
19. Pressure relief device.

H. Refrigerant: Furnish charge of refrigerant.

2.4 CONTROLS

A. Furnish interface to Direct Digital Control System specified in Section 23 09 23.

2.5 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Section 26 05 03.

B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of existing conditions before starting work. Refer to Contract Documents.

B. Verify concrete pad for condensing unit is ready for unit installation.

3.2 INSTALLATION - AIR HANDLING UNIT

A. Install air handling units on vibration isolators. Refer to Section 23 05 48.

B. Install floor mounted units on concrete housekeeping pads at least 3-1/2 inches high and 6 inches wider than unit. Refer to Section 03 30 00.

C. Connect air handling units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.

D. Install condensate piping with trap and route from drain pan to condensate drainage system. Refer to Section 23 21 13.

E. Install components furnished loose for field mounting.

F. Install connection to electrical power wiring in accordance with Section 26 05 03.

G. Installation - Hot Water Heating Coil: Make connections to coils with unions or flanges.
1. Connect water supply to leaving airside of coil (counter flow arrangement).
2. Locate water supply at bottom of supply header and return water connection at top.
3. Install water coils to allow draining and install drain connection at low points.

4. Install valves and piping specialties as indicated on Drawings.
5. Install manual air vents at high points complete with shutoff valve. Refer to Section 23 21 13.

3.3 INSTALLATION - CONDENSING UNIT

A. Install condensing units on vibration isolators. Refer to Section 23 05 48.

B. Install units on concrete foundations. Refer to Section 03 30 00.

C. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit. Refer to Section 23 23 00.

D. Evacuate refrigerant piping and install initial charge of refrigerant.

E. Install electrical devices furnished loose for field mounting.

F. Install control wiring between air handling unit, condensing unit, and field installed accessories.

G. Install connection to electrical power wiring in accordance with Section 26 05 03.

3.4 MANUFACTURER'S FIELD SERVICES

A. Requirements for manufacturer’s field services. Refer to Contract Documents.

B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.5 CLEANING

A. Requirements for cleaning. Refer to Contract Documents.

B. Vacuum clean coils and inside of unit cabinet.

C. Install new throwaway filters in units at Substantial Completion.

3.6 DEMONSTRATION

A. Requirements for demonstration and training. Refer to Contract Documents.

B. Demonstrate air handling unit operation and maintenance.

C. Demonstrate starting, maintenance, and operation of condensing unit including low ambient temperature operation. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.7 PROTECTION OF FINISHED WORK

A. Requirements for protecting finished Work. Refer to Contract Documents.

B. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 23 81 43

SPLIT SYSTEM UNITARY HEAT PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Ductless split system unitary heat pumps.

B. Related Sections:
1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
2. Section 23 05 48 – Vibration Noise and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
3. Section 23 09 23 - Direct-Digital Control System for HVAC: Execution requirements for connecting units to controls remote from unit specified in this section.
4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
5. Section 26 05 00 – Common Work Results for Electrical: Execution requirements for electrical connection to units specified by this section.

1.2 REFERENCES

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

B. Air-Conditioning and Refrigeration Institute:
1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

C. Air Movement and Control Association International, Inc.:
1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. Underwriters Laboratories, Inc.:
1. UL 1995 - Heating and Cooling Equipment.

1.3 DEFINITIONS

A. Coefficient of Performance (COP), heat pump, heating - Ratio of rate of heat delivered to rate of energy input, in consistent units, for complete heat pump system, including compressor and, if applicable, auxiliary heat, under designated operating conditions.

B. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions.

C. Heating Seasonal Performance Factor (HSPF) - Total heating output of heat pump during its normal annual usage period for heating (in Btu) divided by total electric energy input during the same period.

D. Seasonal Energy Efficiency Ratio (SEER) - Total cooling output of an air conditioner during its normal annual usage period for cooling (in Btu) divided by total electric energy input during the same period (in Wh).

1.4 SUBMITTALS

A. Submittal Procedures: Refer to Contract Documents.

B. Shop Drawings: Indicate dimensions, rough-in connections, and duct connections of manufactured products and assemblies. Indicate electrical service with connection requirements.

C. Product Data: Submit drawings indicating capacity, weights, electrical characteristics and connection requirements. Indicate electrical characteristics.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

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

1.5 CLOSEOUT SUBMITTALS

A. Submittal Closeout: Refer to Contract Documents.

B. Project Record Documents: Record actual locations of controls separate from units.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.6 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. Air Cooled Equipment:
   1. Cooling Performance Requirements: Conform to minimum EER prescribed by ASHRAE 90.1 when tested in accordance with ARI 210/240.
   2. Heating Performance Requirements: Conform to minimum HSPF prescribed by ASHRAE 90.1 when tested in accordance with ARI 210/240.

C. Sound Rating: Measure in accordance with ARI 270.

1.7 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.

1.8 PRE-INSTALLATION MEETINGS

A. Pre-installation meeting. Refer to Contract Documents.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Product storage and handling requirements. Refer to Contract Documents.

B. Accept heat pump units on site in factory packaging. Inspect for damage.

C. Protect heat pump units from damage by providing temporary covers until construction is complete in adjacent space.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.11 WARRANTY

A. Product warranties and product bonds. Refer to Contract Documents.

B. Furnish five year manufacturer’s warranty for Compressors.

1.12 MAINTENANCE SERVICE

A. Maintenance service. Refer to Contract Documents.

B. Furnish service and maintenance of packaged heat pump units for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, and controls checkout and adjustments. Furnish 24-hour emergency service on breakdowns and malfunctions.

1.13 EXTRA MATERIALS

A. Spare parts and maintenance products. Refer to Contract Documents.

B. Furnish one set of filters for each unit.

1.14 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 DUCTLESS SPLIT SYSTEM HEAT PUMP UNITS

A. Acceptable Manufacturers:
   1. EMI
   2. Substitutions: Refer to Contract Documents.

B. General: The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, controls, and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and emergency operation function and a test run switch.

C. Cabinet: Ceiling or wall mounted with multi directional air flow pattern; outside ventilation air connection where indicated.

D. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

E. Fan and Motor: Centrifugal fan, directly driven by three (3) speed motor with integral overload protection; resiliently mounted. Furnished with manual adjustable guide vane (left to right) and a motorized air sweep (up and down).

F. Filters: Permanent, cleanable.

G. Controls: Wireless controller to perform control functions. The microprocessor located on the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wireless controller, and controlling the outdoor unit. The system shall be capable of automatic restart when power is restored after a power interruption.

2.2 OUTDOOR UNIT

A. General: The outdoor unit designed specifically for use with the indoor unit. Unit equipped with a circuit board that interfaces to the indoor unit. Unit completely factory assembled, piped, and wired. Full charge of refrigerant shall be provided.

B. Cabinet: Galvanized steel, bonderized and finished with a powder coated baked enamel color, manufacturer's standard.

C. Refrigerant Coil: Seamless copper tube, pressure tested to 425 psig, with mechanically bonded aluminum fins, complying with ARI 210/240, and with refrigerant reversing valve. Furnished with an integral metal guard. Refrigerant flow from the condenser controlled by means of a metering orifice.

D. Compressor: High performance rotary with accumulator.
   1. Equipped with internal thermal overload.
   2. Compressor mounted to avoid transmission of vibration.
   3. Low ambient capability to 0 degrees F.

2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Division 26 – Electrical

B. Motors: In accordance with Section 23 05 13 – Common Motor Requirements for HVAC Equipment.

2.4 REFRIGERANT PIPING, ABOVEGROUND INSIDE AND OUTSIDE STRUCTURE

A. Service Requirements:
   1. Refrigerant Piping, Supply and Return; maximum operating pressure of 200 psig and maximum operating temperature of 200 degrees F.

B. Pipe: Type K Copper, Drawn ASTM B 88., ACR Grade; Nominal Size 2 in. and Smaller
   1. Joints: Brazed.
   2. Nipples: Same as Pipe.
   3. Fittings: Wrought Copper or Bronze Solder-Joint Pressure ANSI B16.22.
   4. Unions: Cast Bronze ANSI B16.18 or Wrought Copper ANSI B16.22 Sweat Type.
   5. Brazing Filler Metal: AWS Classification BCuP-4 or 5 and/or BAg-1.
   6. Flux: Water soluble, chloride based flux of component proportions based on the recommendation of the manufacturer of brazing filler metal being used.

C. Testing: Pressure Test at 100 psig.
   1. Disconnect equipment and inline devices prior to testing to avoid damage by test pressures.
   2. Apply test pressure and conduct soap suds solution test/examination to determine each joint and connection leak free.
   3. Testing considered successful when test pressure is maintained for 8 hours continuously with sources of pressure isolated or disconnected. Allowable pressure drop one psig, which includes changes in temperature in system.
   4. Pressure may be applied using a mixture of Refrigerant and nitrogen or with nitrogen alone.

D. Dehydrating / Charging: After piping is leak tested and proven tight, dehydrate and charge according to the following:
   1. Evacuate to 2.5 mm of mercury and hold vacuum for at least eight hours.
   2. Break vacuum with dry nitrogen and re-evacuate to 2.5 mm.
   3. Break vacuum with the system refrigerant and charge system in accordance with the equipment manufacturer's recommendations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contract Documents.

B. Verify concrete pad is sized and located correctly.

C. Verify piping rough-in is at correct location.

D. Verify electrical rough-in is at correct location.

3.2 INSTALLATION

A. Install outdoor unit on equipment rails as shown on drawings. Coordinate work on roof with GC.

B. Install refrigerant piping from indoor to outdoor unit. Install refrigerant specialties furnished with unit.

C. Install condensate piping from drain pan to point indicated on drawings.

D. Install accessories furnished loose for field mounting.

E. Install electrical devices furnished loose for field mounting.

F. Install control wiring between unit control panel and field mounted control devices.

3.3 CLEANING

A. Requirements for cleaning. Refer to Contract Documents.

B. After construction is completed, including painting, clean exposed surfaces of units.

C. Vacuum clean coils and inside of cabinets.

D. Touch up marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.

E. Install new filters in units after Substantial Completion.

3.4 DEMONSTRATION

A. Requirements for demonstration and training. Refer to Contract Documents.

B. Demonstrate unit operation and maintenance.

3.5 PROTECTION OF FINISHED WORK

A. Requirements for starting and adjusting. Refer to Contract Documents.

B. Protect finished surfaces of cabinets with protective covers during remainder of construction.

END OF SECTION

SECTION 23 82 00

CONVECTION HEATING AND COOLING UNITS GENERAL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Air coils.
2. Electric wall heaters.
3. Electric unit heaters.
4. Electric radiant heaters.
5. In-row cooling units.

B. Related Sections:
1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
2. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
3. Section 23 21 13 - Hydronic Piping: Execution requirements for connection of chilled water, hot water, and drain piping to units specified by this section.
4. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
5. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection of refrigerant piping to units specified by this section.
6. Section 23 31 00 - HVAC Ducts and Casings: Execution requirements for ducts specified by this section.
7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connection to units specified by this section.

1.2 REFERENCES

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

B. Air-Conditioning and Refrigeration Institute:
1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

A. Submittal Procedures: Refer to Contact Documents.

B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.

C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.

D. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

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

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.

1.5 CLOSEOUT SUBMITTALS

A. Closeout Submittals: Refer to Contact Documents.

B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.

C. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

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.

1.7 PRE-INSTALLATION MEETINGS

A. Pre-Installation Meetings: Refer to Contact Documents.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Storage and Handling: Refer to Contact Documents.

B. Accept units on site in factory packing. Inspect for damage. Store under roof.

C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 EXTRA MATERIALS

A. Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 AIR COILS

A. Manufacturers:
   1. Trane Company.
   2. Airtherm
   3. Substitutions: Refer to Contact Documents.

B. Heating Coils: Headers: Cast iron with tubes expanded into header, seamless copper tube with silver brazed joints, or prime coated steel pipe with brazed joints.
   1. Leak Testing: Air test under water to 200 psig for working pressure of 200 psig and 200 degrees F.
   2. Configuration: Self draining circuitry, with threaded plugs in headers for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.
   3. Fin Spacing: maximum 12 fins per inch.

C. Refrigerant Cooling Coils:
   1. Headers: Seamless copper tubes with silver brazed joints.
   2. Liquid Distributors: Brass or copper venturi or orifice type or removable nozzle type distributor with seamless copper distributor tubes.
   3. Leak testing: Air test under water at 450 psig for working pressure of 400 psig; dehydrate, and seal with dry air or nitrogen charge.
   4. Configuration: Self-draining, down feed with bottom non-oil trapping connection.
   5. Fin Spacing: maximum 12 fins per inch.

2.2 ELECTRIC RADIANT HEATERS

A. Manufacturers:
   1. QMark.
   2. Marley
   3. Substitutions: Refer to Contact Documents.

B. Heating Elements: Enclosed copper tube element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material, bonded to ceiling panel.

C. Ceiling Panels: 24 x 48 inch aluminum pans with silk-screened pattern matching ceiling tile; manufactured and assembled to configuration indicated.

2.3 ELECTRIC UNIT HEATERS

A. Manufacturers:
   1. Trane Company
   2. QMark
   3. Marley
   4. Substitutions: Refer to Contact Documents.

B. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material..

C. Cabinet: 0.0478-inch thick galvanized steel with easily removed front panel with integral air outlet and inlet grilles.

D. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

E. Fan: Direct-drive propeller type, statically and dynamically balanced, with fan guard.

F. Motor: Permanently lubricated, sleeve bearings for horizontal models; ball bearings for vertical models.

G. Control: Separate fan speed switch and thermostat heat selector switch, factory wired, with switches built-in behind cover. Furnish thermal overload.

H. Electrical Characteristics:
   1. Disconnect Switch: Factory mount.
   2. Refer to Section 26 05 03.

2.4 IN-ROW COOLERS

A. Manufacturers:
   1. APC Series ACRC
   2. Substitutions: Refer to Contact Documents.

B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 400 psi. Furnish primary and secondary drain pan under cooling coil, easily removable for cleaning, with condensate pump.

C. Cabinet: 18 gage steel with exposed corners and edges rounded, easily removed panels, foam insulation and perforated steel air outlet and inlet grilles.

D. Finish: Factory apply powder coated finish on visible surfaces of enclosure or cabinet.

E. Fans: Variable speed axial flow fans provide uniform airflow over face of coil; fans protected by guards on inlet and discharge.

F. Controls: Remote temperature sensor, flow meter, and water detector cable; microprocessor controller.

G. Filter: Easily removed 2-inch thick pleated glass fiber throw-away type, located to filter air before coil; filter rated MERV 8.

H. Control valve: 3-way modulating valve with actuator.

I. Capacity: As indicated on Drawings, based on 65 degrees F entering air temperature.

J. Electrical Characteristics:
   1. As indicated on Drawings.
   2. Refer to Section 26 05 03.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examination: Refer to Contact Documents.

B. For recessed units, verify recess dimensions are correct size.

C. Verify wall construction is ready for installation.

D. Verify ductwork is ready for installation.

E. Verify concealed blocking and supports are in place and connections are correctly located.

3.2 INSTALLATION

A. Install air coils in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible. Refer to Section 23 31 00.

B. Support air coil sections independent of piping on steel channel or double angle frames and secure to casings. Furnish frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Install with airtight seal between coil and duct or casing.

C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

D. Install coils level.

E. Make connections to coils with unions and flanges.

F. On water coils, install shut-off valve on supply piping and lockshield balancing valve on return piping. Locate water supply at bottom of supply header and return water connection at top. Install manual air vents at high points complete with stop valve. Install water coils to be drainable and install drain connection at low points. Refer to Section 23 21 13.

G. On water heating coils, and chilled water cooling coils, connect water supply piping to leaving airside of coil (counter flow arrangement). Refer to Section 23 21 13.

H. Install drain pan and drain piping connection for cooling coils. Fabricate drain pan from 20 gage galvanized steel. Extend 3 inches from face of coil entering air side, 6 inches from face of coil leaving air side. Pipe drain pans individually to floor drain with water seal trap. Refer to Section 23 21 13.

I. On refrigerant coils, install sight glass in liquid piping within 12 inches of coil. Refer to Section 23 23 00.

J. Insulate headers located outside airflow, insulate as specified for piping. Refer to Section 23 07 00.

K. Wire electric duct coils. Refer to Section 26 05 03.

L. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.

M. Protection: Install finished cabinet units with protective covers during remainder of construction.

N. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.

O. Units with Cooling Coils: Install drain piping to condensate drain. Refer to Section 23 21 13.

P. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's submittals and Section 26 05 03.

Q. Coordinate installation of in-row coolers with IT rack system; provide connections to chilled water coils, condensate drains and control wiring.

3.3 CLEANING

A. Cleaning Requirements: Refer to Contact Documents.

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

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

B. Related Sections:
   1. Refer to Procurement Documents
   2. Section 02 41 19.19 Selective Electrical Demolition
   3. Section 09 90 00 Painting and Coating
   4. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables
   5. Section 26 05 26 Grounding and Bonding for Electrical Systems
   6. Section 26 05 28 Hangars and Supports for Electrical Systems
   7. Section 26 05 33.13 Conduit for Electrical Systems
   8. Section 26 05 33.19 Wireways for Electrical Systems
   9. Section 26 05 33.23 Boxes for Electrical Systems
   10. Section 26 05 53 Identification for Electrical Systems
   11. Section 26 05 63 Acceptance of Electrical Systems
   12. Section 26 22 00 Low-Voltage Transformers
   13. Section 26 24 13 Switchboards
   14. Section 26 24 16 Panelboards
   15. Section 26 27 26 Wiring Devices
   16. Section 26 28 16.13 Low-Voltage Enclosed Switches
   17. Section 26 28 16.19 Low-Voltage Enclosed Circuit Breakers
   18. Section 26 29 13 Enclosed Controllers
   19. Section 26 32 13.13 Diesel Engine Driven Generator Sets
   20. Section 26 36 00 Transfer Switches
   21. Section 26 41 00 Lightning Protection
   22. Section 26 43 13 Surge Protective Devices for Low-Voltage Electric Power Circuits
   23. Section 26 50 00 Lighting
   24. Section 28 31 00 Fire Alarm System
   25. Section 33 71 73 Electrical Utility Services

1.02 REFERENCES

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. America National Standards Institute (ANSI):

1. ANSI Z535.4, Product Safety Signs and Labels.

C. American Society of Mechanical Engineers (ASME):
   1. ANSI/ASME Y14.2M, Line Conventions and Lettering.
   2. ANSI/ASME Y14.24M, Types and Applications of Engineering Drawings.
   3. ANSI/ASME Y14.34M, Associated Lists.
   4. ANSI/ASME Y14.35M, Revision of Engineering Drawings and Associated Documents.
   5. ANSI/ASME Y14.100, Engineering Drawing Practices.

D. Institute of Electrical and Electronic Engineers (IEEE):
   1. ANSI/IEEE 18, Standard for Shunt Power Capacitors.
   2. ANSI/IEEE 141, Recommended Practice for Electric Power Distribution for Industrial Plants - Red Book.
   3. ANSI/IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - IEEE Buff Book.
   4. ANSI/IEEE 399, Recommended Practice for Power Systems Analysis - Brown Book.
   5. ANSI/IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   6. IEEE 1036, Guide for Application of Shunt Power Capacitors.
   7. ANSI/IEEE 1584, Guide for Arc-Flash Hazard Calculations.
   8. ANSI/IEEE C37.10, Guide for Diagnostics and Failure Investigation of Power Circuit Breakers.
   9. ANSI/IEEE C37.13, Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   10. ANSI/IEEE C57.12.00, General Requirements doe Liquid-Immersed Distribution, Power and Regulating Transformers.
   11. ANSI/IEEE C57.12.59, Standard for Dry-Type Transformer Through-Fault Current Duration

E. InterNational Electrical Testing Association, Inc. (NETA):
   1. ANSI/NETA ETT Standard for Certification of Electrical Testing Technicians.

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

G. National Electrical Contractors Association (NECA)
   1. ANSI/NECA 100 Symbols for Electrical Construction Drawings.

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

I. The Society for Protective Coatings (SSPC):
   1. SSPC-SP 2, Hand Tool Cleaning.

J. Other Published References:

1. Electrical Safety Handbook, by John Cadick, McGraw Hill, Inc., Article on Safety Electrical One-Line Diagrams.

1.03 DESIGN REQUIREMENTS

A. Prepare and submit a Short Circuit, Arc-Flash, and Protective Device Coordination Study as specified in this Article.
   1. Immediately after award of the Contract, collect all data needed to perform calculations for the studies.
      a. Obtain, in writing, electrical utility source information and any other information required from the utility to perform the necessary studies directly from the serving utility.
      b. The Authority and Engineer will provide, as available, information about the portions of the facility's existing electrical system affected by the work performed under this Contract.
         1) The Authority will provide two copies of the latest revision of the existing facility record drawings and the facility equipment list to the Contractor for use in defining existing equipment load requirements.
         2) Base the contribution of motors on actual motor loads as indicated on the equipment list, system one-line diagrams, and panel schedules.
         3) If the information provided is insufficient to perform the studies or represents unknown ratings of existing equipment, investigate and obtain the information required.
            a) Employ qualified technicians to obtain the necessary data.
      c. Obtain data for new equipment directly from suppliers and other contractors working on the project.
   2. Once the data needed is obtained, perform a preliminary computerized Short Circuit, Arc-Flash, and Protective Device Coordination Study complete with calculations.
      a. At least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.
      b. After the Engineer provides his comments, submit four copies of the revised and corrected preliminary studies.
   3. Include the following types of information common to each study:
      a. Calculations and tabulations.
         1) Ensure that the calculations in the Short Circuit, Arc-Flash, and Protective Device Coordination Study are sufficient to ascertain interrupting and/or withstand ratings of the equipment.
            a) Identify items of distribution system equipment that are not rated for the available fault current, and provide corrective recommendations for consideration.
      b. Data on the computer programs used to perform calculations and tabulations.
      c. An appendix to each report that includes the information obtained from outside entities, agencies, electrical manufacturers, the serving utility company, field inspections, and other field sources such as the following:
         1) Copies of letters.
         2) Photographic records.

3) Nameplate tracings.
4) Actual data sources from which the data and information was obtained.

B. Final Project Report:
1. After the Engineer accepts the revised and corrected preliminary studies, prepare a report summarizing the results of the individual studies; and submit this Final Project Report to the Engineer for acceptance and approval.
a. Include the following sections in the Final Project Report:
1) Description.
2) Purpose.
3) Basis and scope of the study.
4) A single line diagram of that portion of the power system that is included within the scope of the study.
5) Computerized time versus current coordination graphs and corresponding printouts for protective devices.
a) Include the feeder cable damage curves associated with the items being coordinated in these graphs.
b) Include the ANSI/NEMA MG 1 damage points for the motors in the system and the ANSI/IEEE C57.12.00 mechanical and electrical damage points on the curves.
6) Tabulations of the relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
b. Submit ten bound copies of the Final Project Report for review and approval and two copies of record drawings showing the existing facility as it was before the work of this Contract was performed.
c. Once the Final Project Report has been approved, forward one additional bound final copy of the report to the Authority.

C. Short Circuit, Arc-Flash, and Protective Device Coordination Study:
1. Prepare the Short Circuit, Arc-Flash, and Protective Device Coordination Study under the supervision of a Professional Engineer licensed in the state of Pennsylvania, or have a NETA certified electrical testing laboratory employing technicians certified according to ANSI/NETA ETT prepare it.
a. Perform the short circuit portion of the Study in accordance with ANSI/IEEE C37.10, ANSI/IEEE C37.13, ANSI/IEEE 141, ANSI/IEEE 242, and ANSI/IEEE 399.
1) Calculate short circuit momentary duty values and interrupting duty values on the basis of the following short circuit conditions at every distribution transformer, secondary and primary terminal at every bus in every switchboard, distribution panelboard, and branch circuit panelboard.
2) Include:
a) Single line to ground fault.
b) Bolted three-phase line to ground fault.
c) Double line (line to line) to ground fault.
b. Perform the arc flash portion of the Study for the electrical distribution equipment in accordance with NFPA 70E and ANSI/IEEE 1584.
1) Perform the analysis under worst-case arc-flash conditions; and if applicable, describe in the final report how these conditions differ from worst-case bolted fault conditions.

2) Perform separate analysis for operation from the normal utility source(s) and operation from the stand-by generator(s). Present results for both operating conditions in the reports.
3) Provide the following items for each circuit and arc location analyzed:
   a) Printed hardcopy of calculations performed.
   b) Arcing fault magnitude.
   c) Device clearing time.
   d) Duration of arc.
   e) Arc flash boundary distances.
   f) Working distance.
   g) Arc flash incident energy.
   h) Hazard risk category.
   i) Personal-protective equipment classes.
   j) Arc flash warning labels as specified in Section 26 05 53.
   k) Provide separate labels for operation from the normal utility source(s) and operation from the stand-by generator(s).
   l) Recommendations and potential options for arc flash energy reduction to reduce the Incident Energy levels where they are calculated to be over the 40 cal/cm2.
   m) Maintenance procedures/guidelines in accordance with the requirements of NFPA 70E for the Authority.

c. Coordinate protective devices with systems and equipment by providing the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, ratios and characteristics of associated current transformers, and breaker trip characteristics and settings and distribution system fuses.
   1) Provide coordination plots for phase and ground protective devices on a system basis.
      a) Adhere to National Electrical Code restrictions, and maintain proper coordination.
      b) Provide a sufficient number of separate curves to clearly indicate the coordination achieved.
   2) Either computer-generate or hand-draw time-current characteristics of the specified protective devices on log-log scale plots.
      a) Include complete titles, the respective one-line diagram and identifying legends, associated relays or fuse characteristics, significant motor starting characteristics, complete operating bands of low voltage circuit breaker trip curves and fuses.
      b) Indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush, through-fault current duration per ANSI/IEEE C57.12.59, dry-type transformers withstand, cable thermal overcurrent withstand limits, symmetrical fault currents and motor full load current, locked-rotor current, and magnetizing inrush in the coordination plots.
   3) Provide the selection and settings of the protective devices separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment, and recommended settings.

a) Use the information from the Study to obtain optimum device protective and coordination performance.

2. In addition to the information common to the studies as listed in Subparagraph 1.04.A.3, include the following information specific to short circuit, arc-flash, and protective device coordination distortion only in the Short Circuit, Arc-Flash, and Protective Device Coordination Study:
   a. Complete short circuit and protective device coordination studies, including coordination plots, for the following electrical distribution systems serving the entire facility:
      1) Utility low voltage service system.
      2) Standby low voltage generator system.
      3) Low voltage distribution systems.
      4) Downstream systems devices connected through isolation transformers.
   b. Power company supply and network characteristics, including the following:
      1) The base quantities selected.
      2) Source impedance data and impedance diagrams.
      3) One-line diagrams.
      4) Calculation methods and tabulations.
         a) Include short circuit tabulations of the fault impedance, X to R ratios, asymmetry factors, KVA, symmetrical and asymmetrical fault currents, and all multiplying factors.
      5) Conclusions and recommendations.
   c. Provide sufficient information in the study to ensure adequate protection of the cables, transformers, and other equipment; to indicate proper coordination between fuses and circuit breakers; and to determine areas of the system in which additional coordination may be required.
3. Submit Short Circuit, Arc-Flash, and Protective Device Coordination Study information with the equipment submittals for review by the Engineer.

D. Electrical Safety Operating Diagrams:
   1. Prepare and submit one-line Electrical Safety Operating Diagrams for the electrical system.
      a. Make the diagrams similar to the diagrams shown in the article on Safety Electrical One-Line Diagrams in the Electrical Safety Handbook, or in any other nationally recognized style.
         1) Show outlines of equipment using a line weight that contrasts with the line weight of wiring.
         2) Use heavier of line weights for buses; and use different line weights for each voltage level, increasing the line weight for increasing voltage.
         3) Omit ratings, but include the voltage levels of all buses; and include equipment designations and their common names.
         4) Use symbolism similar to that on the Contract Drawings or conforming to ANSI standards, such as ANSI/NECA 100, ASME Y14.2M, ASME Y14.24M, ASME Y14.34M, ASME Y14.35M, and ASME Y14.100.
         5) Provide a legend on each sheet.
   2. Create a diagram showing the following items:
      a. The electrical system for the building or structure, complete and showing all sources supplying power to the building or structure from the first disconnecting device upstream of the building or structure.

b. Overcurrent protective devices, disconnecting devices, and all wiring between them and equipment buses for the following:
    1) Devices and buses within motor control centers.
    2) Devices and buses within switchboards.
    3) Main devices and devices disconnecting external power from each motor starter.
    4) Main devices and buses in each panelboard.
    5) Main devices on engine generator sets.
    6) Feeder overcurrent protective devices on engine generator sets.
c. Include branch circuit overcurrent protective devices within panelboards that supply the following items:
    1) Feeders to other panelboards and to transformers.
    2) Motor starters.
    3) Control panels.
    4) Motor control centers.
    5) Transient voltage surge suppressors.
    6) Loads larger than 5 kVA or 5 horsepower, or rated over 300 Volts.
d. Equipment:
    1) Transformers external to equipment.
    2) Motor starters for motors over 1 horsepower and their disconnecting devices.
    3) Utilization equipment that is rated larger than 5 kVA or 5 horsepower, or is rated over 300 Volts, and its disconnecting devices.
    4) Motors rated over 1 horsepower and their disconnecting devices.
e. Interconnecting wiring between equipment.
f. Sources of all power upstream of the building or structure, and devices that disconnect this power without ratings.

3. For each device in the building or structure show the first item downstream of that device whether or not the downstream item is in the same building or structure.
4. Submit the Electrical Safety Operating Diagrams for approval.
    a. After approval by Engineer, provide an electronic copy of all Electrical Safety Operating Diagrams on a CD ROM disc in AutoCAD (dwg) or Adobe (pdf) format.

1.04 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of the Procurement Documents:
    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. Design Data:
            1) Short Circuit, Arc Flash and Protective Device Coordination Study Reports:

a) Preliminary Short Circuit, Arc Flash and Protective Device Coordination Study.
b) Final Short Circuit, Arc Flash and Protective Device Coordination Study.
c) CD ROM disc containing:
(1) The complete computer program model(s) used in performing the Short Circuit, Arc Flash, and Protective Device Coordination Study. Provide with both the Preliminary and Final Study Reports.
(2) Spreadsheet in MS Excel format that tabulates all analyzed scenarios with accompanying results. Provide with both the Preliminary and Final Study Reports.

2) Final Project Report, with final Short Circuit, Arc Flash and Protective Device Coordination Study Report.
3) Motor Overload Relay and Branch Circuit Overcurrent Protective Device Schedule.
4) Electrical Safety Operating Diagrams:
a) Hard copies for approval.
b) CD ROM disc in AutoCAD (dwg) or Adobe (pdf) format.

b. Certificates:
1) Testing agency quality verification that all products meet requirements or manufacturer disclaimer statements.

c. Qualification Statements:
1) Testing agency qualifications.

4. Closeout Submittals:
a. Operation and Maintenance Manuals.
b. CD ROM disc containing the complete computer program model(s) used in performing the Circuit, Arc Flash, Protective Device Coordination Studies, updated to reflect the final as-built condition.

1.05 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. Qualifications:
1. Testing Agency Qualifications:
a. Use a NETA accredited testing agency, or approved equal, that is accredited for the region in which the Contract work is performed.
b. Submit the testing agency's qualifications to the Engineer for approval.

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

D. 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 Authority and the Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and equipment to the work site in accordance with the requirements of the Procurement Documents.
    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 The Procurement Documents.
    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 The Procurement Documents 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.

1.07 MAINTENANCE

A. Operation and Maintenance Manuals:
    1. Prepare Operation and Maintenance Manuals in conformance with the requirements of The Procurement Documents, other Contract requirements, and as follows:
        a. Organize Operation and Maintenance Manuals by Specification Section and equipment number as designated on the Contract Drawings.

b. Include suppliers, supplier addresses, and supplier telephone numbers for the equipment and products furnished.

2. 60 days prior to the request for final payment, prepare and submit two copies of the proposed Operation and Maintenance Manuals to the Engineer for approval.
3. Upon approval of the proposed Operation and Maintenance Manuals, submit six corrected copies as follows:
   a. Submit one set to the Engineer.
   b. Place one set in the spare parts and fuse cabinet in the new electrical service building
   c. Deliver the remaining four copies to the Authority.
4. Insert final record drawings in each set of Operation and Maintenance Manuals at Project Closeout.

PART 2 PRODUCTS

2.01 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. Electrical Identification Materials:
   1. Provide electrical identification materials in accordance with the requirements of Section 26 05 53.

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

E. 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.
      b. Wireway and Fittings: Provide electrical wireway and fittings in accordance with the requirements of Section 26 05 33.19.

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

2.02 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

3.01 POSTING OF ELECTRICAL SAFETY OPERATING DIAGRAMS

A. Post a 24” x 36” hard paper copy of the Electrical Safety Operating Diagram in each building or structure. Diagrams shall be posted on a wall in metal frame under 1/8” Lexan in clear view of the devices disconnecting all power from the building or structure.

3.02 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 Authority.
   2. Coordinate the painting of large areas with the Engineer to minimize the duration of exposure of other workers to toxic paint fumes.

3.03 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.

3.04 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.

3.05 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.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY

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

B. Related Sections:
   1. Procurement Documents
   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 33.13 Conduit for Electrical Systems
   5. Section 26 05 33.19 Wireways for Electrical Systems
   6. Section 26 05 33.23 Boxes for Electrical Systems
   7. Section 26 05 53 Identification for Electrical Systems
   8. Section 26 05 63 Acceptance of Electrical Systems

1.02 REFERENCES

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

B. American Society for Testing Materials (ASTM):
   1. ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 383 - Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations.
   2. IEEE 1202 - Standard for Flame-Propagation Testing of Wire and Cables.

D. National Electrical Manufacturer's Association (NEMA):
   1. NEMA WC 26/EEMAC 201 - Binational Wire and Cable Packaging Standard.
   2. ANSI/NEMA WC 57 - Standard for Control, Thermocouple Extension, and Instrumentation Cables.

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

F. Underwriter's Laboratories, Inc. (UL):
   1. UL 13 - Standard for Power-Limited Circuit Cables.

2. UL 1277 - Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
3. UL 1569 - Standard for Metal-Clad Cables.
4. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords.
5. UL 1685 - Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.
6. UL 2250 - Standard for Instrumentation Tray Cable.

G. Insulated Cable Engineers Association (ICEA):
1. ICEA T-29-520 - Vertical Cable Tray Flame Test @ 210,000 BTU.

1.03 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 conductors in each raceway or conduit does not exceed 4, including three phase conductors and one neutral, plus a ground.

B. Cable Tension Design Requirements:
1. Design conduit runs so that the tension limits set by the wire and cable manufacturers will not be exceeded.
   a. Provide additional pulling points as required to limit the tension to acceptable levels.
2. Generate and submit tension cable pulling calculations for all underground power runs.
   a. Include pull loads, tension, and safety factors for all cables with the calculations.

C. 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.
   f. Tools used to crimp connectors.

D. 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.

1.04 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of the :
   1. Product Data:
      a. Wires and cables.
      b. Lugs
      c. Connectors.
      d. Tape.
      e. Pulling lubricant.
      f. Crimping tools.
   2. Samples:
      a. Wire samples.
   3. Quality Assurance/Control Submittals:
      a. Design Data.
         1) Tension cable pulling calculations for all underground power runs.
      b. Certificates.
         1) Testing agency/quality verification.
      c. Manufacturers Instructions.
         1) Cable manufacturer's recommendations.
      d. Qualification Statements.
         1) Documented experience of the installing firm.
         2) Qualifications of the licensed electricians supervising the Work.

1.05 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. 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.

C. 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.

D. 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.
    a. For items without such evidence, submit a written statement from the product manufacturer that indicates why it does not have quality assurance verification.

E. Field Samples:
1. Submit one 36-inch long sample of each type of wire to be used.

1.06 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.

1.07 PROJECT ENVIRONMENTAL REQUIREMENTS

A. Install armored instrumentation cable only when the temperature is above -40 degrees Celsius.

1.08 MAINTENANCE

A. Operation and Maintenance Manuals:
1. Include product data for the products provided as the Work of this Section in the Operation and Maintenance Manuals submitted with the record drawings at project closeout in accordance with the Procurement Documents.

PART 2 PRODUCTS

2.01 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 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.
         3) For alarm and status circuits: 14 AWG.
         4) For single conductor instrument wiring: 14 AWG.
         5) For multiple conductor instrument wiring: 16 AWG.

B. Insulation Design Requirements:
   1. Provide low voltage ground, power, and control wiring having the proper insulation types as follows, unless noted otherwise on the plans:
      a. Above Ground
         1) Feeders
            a) All locations: Type XHHW-2
         2) Branch Circuits
            a) Exterior locations: Type XHHW-2
            b) Interior wet and damp locations: Type XHHW-2
            c) Interior dry locations: dual-rated THHN/THWN
      b. Below Ground (Interior and Exterior)
         1) Feeders and Branch Circuits: Type XHHW-2

C. Manufacturers
   1. Acceptable Manufacturers:
      a. Cablec Continental Co.
      b. SouthWire.
      c. Okonite Co.
      d. Rome Cable Corp
      e. Or Approved Equal

2.02 MATERIALS

A. 600 Volt Rated Multi-Conductor Cable:
   1. Provide multi-conductor cable that is suitable for use indoors or outdoors; exposed or concealed; as open wiring; in any raceway, underground duct, or cable tray; direct buried; or embedded in concrete.
      a. Provide cable that is UL listed as Type MC in compliance with the requirements of UL 1569, and is UL listed for 90 degrees Celsius dry or wet, for direct burial, for cable tray use, and as sunlight resistant.
   2. Assemble the cable with non-hygroscopic fillers and binder tape.

a. Insulated Conductors:
    1) Provide uncoated stranded copper conductors, complying with the requirements of ASTM B 8 for Class B conductors.
    2) Provide cross-linked polyethylene type XHHW-2 insulation rated for 600 volts.
b. Grounding Conductors:
    1) Provide uninsulated copper conductors.
c. Cover the overall assembly with a single strip of interlocked aluminum tape, and then apply an outer final jacket of black flame-retardant PVC.

3. Manufacturers:
    a. General Cable Technologies Corporation, www.generalcable.com/GeneralCable/en-US/Catalogs/IndustrialCables.
    b. The Okonite Company, www.okonite.com.
    c. Or Approved Equal.

B. Tray Cable:
1. Provide tray cable that is suitable for use indoors or outdoors; in any raceway, underground duct, or cable tray; or direct buried.
    a. Provide cable that is UL listed as Type TC in compliance with the requirements of UL 1277, and is UL listed for 90 degrees Celsius dry or wet, for direct burial, for cable tray use, and as sunlight resistant.
2. Assemble the cable with non-hygroscopic fillers and binder tape.
    a. Conductors:
        1) Provide uncoated stranded copper conductors, complying with the requirements of ASTM B 8 for Class B conductors.
        2) Provide the following number and size of conductors where indicated in the Contract Documents:
            a) For power cables:
                (1) 3-conductor, Number 12 AWG.
                (2) 4-conductor, Number 12 AWG.
                (3) 3-conductor, Number 10 AWG.
                (4) 4-conductor, Number 10 AWG.
            b) For status/control cables:
                (1) 4-conductor, Number 16 AWG.
                (2) 4-conductor, Number 14 AWG.
    b. Insulation:
        1) Provide type XHHW-2 insulation rated for 600 volts that is color coded according to ANSI/NEMA WC 57 Method 1.
    c. Cover the overall assembly with a cable jacket constructed of flame-retardant chlorinated polyethylene (CPE).
3. Manufacturers:
    a. General Cable Technologies Corporation, Flame-Retardant Ethylene Propylene (FREP®) XHHW-2 VW-1, http://www.generalcable.com/GeneralCable/en-US/Catalogs/IndustrialCables.
    b. Or Approved Equal.

C. Metal Clad Cable:

1. Bare soft annealed copper conductors, solid or Class B stranded per ASTM B8. Conductors shall be solid copper in sizes up to and including No. 10 AWG. For sizes No. 8 AWG and larger, conductors to be stranded copper.
2. Type THHN insulation, 600 volts, color coded.
3. Insulated green copper grounding conductor. Meets or exceeds requirements of NEC Table 250-95.
4. Assembled per UL 1569 with non-hygroscopic fillers and binder tape.
5. Close fitting interlocked galvanized steel armor per UL 1569.
6. UL listed as type MC cable.
7. UL listed for cable tray use.
8. Cable shall be suitable for environmental air handling space installation.
9. Imprint insulated conductors with the date of manufacture, wire type, and manufacturer. Wire and cable manufactured more than 12 months before delivery to the job site shall not be used.
10. The only permitted use of Metal Clad cable is as follows:
    a. For final whip-connections to lighting fixtures above suspended ceilings.
    b. For branch circuits in existing finished areas where concealed above suspended ceilings or inside walls.
11. Acceptable Manufacturers:
    a. AFC Cable Systems.
    b. Or Approved Equal.

D. Cable Lubricant:
1. Provide cable lubricant specifically recommended by the cable manufacturer for cable pulling operations.
    a. For rubber of plastic jacketed cables, provide soapstone, graphite, or talc cable lubricant.

E. Grounding Braid:
1. Provide conformable, all-metal (tinned copper wires), corrosion resistant, woven grounding braid having a high current-carrying capacity approximately that of 6 AWG wire.
2. Manufacturers:
    a. 3M, Scotch, Scotch® 25 Electrical Grounding Braid, http://solutions.3m.com/portal/3M/en_US.
    b. Plymouth, www.plymouthrubber.com.
    c. Permacel, www.permacel.com.
    d. Or Approved Equal.

F. Tapes:
1. Arc Proofing Tape:
    a. Provide fire retardant arc proofing tape, such as Scotch® 77 Fire Retardant Electric Arc Proofing Tape, that is capable of protecting cables from fault arc generated heat and flames and of protecting adjacent wrapped cables and accessories exposed to fault arcs until limiting devices can interrupt the faulted circuit.
2. 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.

3. Rubber Splicing Tape:
   a. Provide highly conformable, linerless, self-bonding, ethylene rubber (EPR), high-voltage (through 69 kV) insulating tape formulated to provide excellent thermal dissipation of splice heat, and designed to insulate splices and terminate cables whose overload temperatures can reach 130 degrees Celsius, such as Scotch® 130C Linerless Rubber Splicing Tape.
4. Manufacturers:
   a. 3M, Scotch, http://solutions.3m.com/portal/3M/en_US.
   b. Plymouth, www.plymouthrubber.com.
   c. Permacel, www.permacel.com.
   d. Or Approved Equal.

G. Tubing:
1. Heat Shrinkable Tubing:
   a. Provide flexible, flame retardant, polyolefin heat shrinkable thin wall tubing that has good resistance to common fluids and solvents, and has a high dielectric strength.
2. Waterproof Splice Kits:
   a. Provide heat shrinkable thin wall polyolefin electrical cable splice kits.
3. Manufacturers:
   a. Tyco Electronics, CGPT, http://catalog.tycoelectronics.com.
   b. Thomas & Betts Corp., www.tnb.com.
   c. Or Approved Equal.

H. Wire and Cable Connections:
1. Grounding Connectors:
   a. Provide grounding connectors conforming to the requirements of Section 16060, Grounding and Bonding.
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.
   c. Crimped Compression Connectors:

1) Provide two-hole crimped compression type connectors fabricated from high conductivity, seamless, electrolytic wrought copper, electrolytically tin-plated, and color coded to match the dies.
2) Provide crimped compression type connectors with adequate area to conduct the electrical current.
3) To crimp connectors, provide crimping tools from the same manufacturer that manufactured the connectors.

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. Instrumentation Cable Connectors:
   a. For connecting instrumentation cable and the equipment being furnished under this Contract, provide companion type connectors.
      1) For equipment controllers/enclosures that are furnished under other Sections of this Contract, furnish the connectors for connecting cable to the equipment with the equipment.
      2) Terminate the wiring as required for proper operation.
   b. Manufacturers:
      1) Thomas & Betts Corp., www-public.tnb.com/ps/pubint.
      2) AMP Inc., www.amp.com.
      3) Ilsco Corp., http://ilsco.com.
      4) Ideal Industries, Inc., www.idealindustries.com/products/index.htm.
      5) Or Approved Equal
5. 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., www-public.tnb.com/ps/pubint.
      2) Tyco Electronics, AMP Inc., www.amp.com.
      3) Ilsco Corp., http://ilsco.com.
      4) FCI-Burndy® Products, https://portal.fciconnect.com.
      5) Or Approved Equal.

2.03 SOURCE QUALITY CONTROL

A. Tests:
   1. 600 Volt Rated Multi-Conductor Cable:
      a. 70,000 BTU/hr Vertical Tray Flame Test:
         1) 600 Volt rated multi-conductor cable must pass the vertical tray flame test requirements of UL 1569, IEEE 383, and IEEE 1202.
      b. 210,000 BTU/hr Vertical Tray Flame Test:
         1) 600 Volt rated multi-conductor cable must pass the vertical tray flame test requirements of ICEA T-29-520.
   2. Tray Cable:
      a. 70,000 BTU/hr Vertical Tray Flame Test:
         1) Tray cable must pass the vertical tray flame test requirements of UL 1277, IEEE 383, and IEEE 1202.
      b. 210,000 BTU/hr Vertical Tray Flame Test:
         1) Tray cable must pass the vertical tray flame test requirements of ICEA T-29-520.
      c. VW-1 test:
         1) Tray cable insulated conductors must pass the VW-1 test requirements of UL 1581.
   3. Shielded Instrumentation Tray Cable (2/C Cable):
      a. Vertical Tray Flame Test:
         1) Shielded instrumentation tray cable must pass the vertical tray flame test requirements of UL 1581 to obtain a VW-1 rating.
   4. Shielded Instrumentation Cable (2/C Cable):
      a. Vertical Tray Flame Test:
         1) Shielded instrumentation cable must pass the vertical tray flame test requirements of UL 1685 with UL loading.
   5. Armored Instrumentation Cable:
      a. 70,000 BTU/hr Vertical Tray Flame Test:
         1) Armored instrumentation cable must pass the vertical tray flame test requirements of UL 1581, IEEE 383, and IEEE 1202.
      b. 210,000 BTU/hr Vertical Tray Flame Test:
         1) Armored instrumentation cable must pass the vertical tray flame test utilizing the corner configuration.
         2) Armored instrumentation cable must pass the vertical tray flame test requirements of ICEA T-29-520.
         3) Such statements are subject to the approval of the Engineer before the product may be used for this Contract.

PART 3 EXECUTION

3.01 INSTALLERS

A. Install the work of this Section only under the supervision of licensed electricians.

3.02 EXAMINATION

A. Inspect all conduits, junction boxes, electrical vaults, and handholes 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 for Electrical Systems.
   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).

3.03 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, electrical vaults, and handholes 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.
   2. Pre-lubricate the conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.

D. Verify that a means of controlling the pulling tension on the wire or cable is installed on the mechanical assist devices furnished for pulling cable.

E. Take the necessary precautions to prevent water, dirt, or other foreign material from accumulating in the conduits during the execution of wiring work.

3.04 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-phyase 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 16060, Grounding and Bonding.

B. Pulling Cable:
   1. Establish a feed-in point at the manhole, handhole, or building located at the highest elevation of the run, and pull cables down grade using flexible cable feeds to convey the cables into the duct runs through the feed-in point opening.
      a. Furnish quadrant blocks located properly along the cable run.
      b. Limit cable pulling tensions to the maximum pulling tensions recommended by the cable manufacturer.
         1) Measure the cable pulling tension on all runs pulled with mechanical assistance and for all cable runs where calculations are required to be submitted by using a dynameter.
         2) Remove cables subjected to excessive bending and tension and that are cracked or have damaged or nicked outer jackets from the Site, and replace these cables with new undamaged cables.
            a) If pulling tension is exceeding during pulling, remove the affected cables and mark them as not to be reused.
      c. Lubricate cables with lubricants during pulling.

C. Installing Cables in Manholes:
   1. Install cable along the manhole wall that provides the longest route and the maximum spare cable length.
   2. Form cables so they closely parallel the walls, and do not interfere with duct entrances.
   3. Support cable on brackets and insulators spaced at a maximum of 2 feet apart.
   4. Use pulling lubricants approved by the cable manufacturer.

D. 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.

E. Splicing Wire and Cable:
   1. Install all service and feeder conductors from end to end without splices.
   2. Install all motor conductors from the starter to the motor without splices.
   3. Only splice cables in accessible locations.
   4. Below-Grade Splices:
      a. In underground systems, locate splices above the 100 year flood level.
      b. Make below-grade splices using a compression connector on the conductor.
      c. Insulate and waterproof below-grade splices by methods suitable for continuous submersion in water using either of the methods that follow:
         1) Gravity Pour Method:
            a) Provide an approved commercial waterproof splice kit with the necessary materials and equipment, including a mold suitable for the cables to be spliced.
               (1) When the mold is in place around the joined conductors, prepare and pour the resin mix into the mold.
         2) Cast-Type Splice Insulation:
            a) Provide an approved commercial waterproof splice kit with the necessary materials and equipment, including a thermosetting epoxy resin insulating material applied by a gravity pour method or by a pressure injection method.
            b) Fix cables in place until the splicing materials have completely set.
   5. 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.

F. Wiring Identification:
   1. Color code all feeder wires and cables as indicated in Table 26 05 19 - 1.

Table 26 05 19 - 1 Feeder Wire and Cable Color Coding

Phase	208/120 Volts
A	Black
B	Red
C	Blue
Neutral	White
Electrical Ground Conductor	Green

   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.

3.05 FIELD QUALITY CONTROL

A. Site Tests:

1. Prior to energizing wire and cable, field test the wire and cable as specified in Section 26 05 63, Acceptance of Electrical Systems.

B. Inspection:
   1. Record the actual installed elevations and locations of grounding cables and rods, both concealed and exposed, on the record drawings.
      a. Verify that the control wiring wire numbers correspond to the numbers indicated in the record drawings.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for connecting, energizing, testing, cleaning, and protecting grounding and bonding systems.

B. Related Sections:
   1. Refer to Procurement Documents
   2. Division 31 Earthwork
   3. Section 26 05 00 Common Work Results for Electrical
   4. Section 26 05 63 Acceptance of Electrical Systems
   5. Section 26 05 33.13 Conduits for Electrical Systems

1.02 REFERENCES

A. Reference Standards:
   1. U. S. Government:
      a. Federal Transit Administration (FTA):
   2. 49 CFR 661 Buy America Requirements

B. American Public Works Association (APWA):
   1. APWA Public Works Management Practices Manual.

C. American Society for Testing Materials (ASTM):
   1. ASTM B 1; Standard Specification for Hard-Drawn Copper Wire.
   2. ASTM B 8; Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   3. ASTM C 653; Standard Guide for Determination of the Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation.
   4. ASTM D 5; Standard Test Method for Penetration of Bituminous Materials.
   5. ASTM D 149; Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
   6. ASTM D 257; Standard Test Methods for D-C Resistance or Conductance of Insulating Materials.
   7. ASTM D 570; Standard Test Method for Water Absorption of Plastics.

D. InterNational Electrical Testing Association, Inc. (NETA):
   1. ANSI/NETA ETT Standard for Certification of Electrical Testing Technicians.

E. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).

F. National Electrical Manufacturing Association (NEMA):
   1. NEMA TC-2; Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
   2. NEMA TC-3; Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   3. NEMA TC-14; Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   4. NEMA WC-7; Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

G. Underwriter's Laboratories, Inc. (UL):
   1. UL 467, Standard for Grounding and Bonding Equipment.
   2. UL 486A-486B,Wire Connectors.
   3. UL 486C, Standard for Splicing Wire Connections.
   4. UL 486D, Standard for Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations.
   5. UL 486E, Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors.

H. Motorola, Inc.:
   1. R56, Standards and Guidelines for Communications Sites. (Building B only)

1.03 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.
      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, Type XHHW 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. Bond building ground electrode systems to the building lightning protection cable(s) as indicated on the Contract Drawings and as specified in Section 26 41 13.

D. 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.

E. 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 #12 AWG, minimum.
         2) Control power circuits, Provide #14 AWG, minimum.
      b. Over 600 volts:
         1) For transformers, provide #2 AWG ground wire, minimum.
         2) For motors, provide #4 AWG ground wire, 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.

F. 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.
   2. Shop Drawings for the ground well grid installation in unpaved areas.
   3. Shop Drawings for the ground well grid installation in paved areas.
   4. Shop Drawings for the ground bus installation.

G. Project Record Documents:
   1. Prepare and submit record drawings showing the actual installed elevations and locations of grounding cables and rods for both concealed and exposed work provided under this Contract.

H. Project Closeout:
   1. Submit Operation and Maintenance Manuals that include the record drawings and all Product Data in accordance with the Procurement Document.

1.04 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of the Procurement Document:
   1. Product Data:
      a. Manufacturer’s product data

2. Shop Drawings:
    a. Ground well grid installation in unpaved areas.
    b. Ground well grid installation in paved areas.
    c. Ground bus installation.
3. Quality Assurance/Quality Control Submittals:
    a. Certificates:
        1) Testing agency product certification
    b. Qualification Statements:
        1) System installers' qualifications
        2) Installation supervisors' resumes
4. Closeout Submittals:
    a. Operation and Maintenance Manuals

1.05 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. 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),

C. Regulatory Requirements:
    1. All grounding and bonding Work must comply with the requirements of NFPA 70, the National Electrical Code.

D. 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) If an item does not have this quality assurance verification, provide a written statement from the product manufacturer indicating why not; such manufacturer's statements are subject to the approval of the Authority and the Engineer.

1.06 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

2.01 MATERIALS

A. Conduit and Conduit Fittings:
   1. For conduit and conduit fittings that enclose single ground wires without accompanying circuit conductors provide one of the following:
      a. Schedule 80, non-metallic conduit and fittings conforming to the requirements of Section 26 05 33.13 and the conduit additionally conforming to the requirements of NEMA TC-2, and the fittings additionally conforming to the requirements of NEMA TC-3.
      b. Fiberglass reinforced plastic (FRP) conduit and fittings conforming to the requirements of NEMA TC-14 and Section 26 05 33.13.
   2. For other conduit and conduit fittings, provide conduit of the types specified or indicated and that conform to the requirements of Section 26 05 33.13.

B. Wire:
   1. Bare Ground Wire:
      a. Soft drawn copper, Class A or Class B stranded, meeting the requirements of ASTM B8 for sizes #6 or larger.
      b. Soft drawn solid copper, meeting the requirements of ASTM B1 for sizes #8 or smaller.
   2. Insulated Ground Wire:
      a. Provide type XHHW insulated Class B copper stranded wire rated for 600 volts that conforms to the requirements of NEMA WC-7, and is green in color.
   3. Acceptable Manufacturers:
      a. Cablec Continental Co.
      b. SouthWire
      c. Okonite
      d. Rome Cable
      e. Or Approved Equal

C. Clamps and Non-Welded Connectors:
   1. Provide bronze or brass clamps and connectors that are UL listed for use below grade.
      a. All bolts and other material must be bronze or brass, plated steel screws are unacceptable.

b. Fabricate multi-bolt, solderless compression clamps from high strength electrical bronze, and provide silicon bronze clamping bolts and hardware.
2. Provide bolts, nuts, lock-washers, and similar hardware designed not to damage ground wire.
3. Acceptable manufacturers:
   a. Ilsco.
   b. Framatone Connectors Inc. (FCI), Burndy.
   c. Or Approved Equal.

D. Exothermic Welding Kits:
1. Provide molds, thermite packages, and other material for exothermic welds that are rated to carry 100 percent of the cable ratings, and which are letter-coded exothermic welded type.
2. Provide all items such as tees, crosses, splices, and cable connections necessary for connecting ground and bonding cables to the following items:
   a. Ground rods.
   b. Reinforcing steel bars.
   c. Ground-bus.
   d. Structural steel.
   e. Water pipe.
   f. Bonding to the main-ground-grid.
   g. Bonding to Copper Grounding Bus Bar
3. Provide all exothermic welding molds, thermite packages, and other material used throughout the Work from a single manufacturer.
4. Acceptable Manufacturers:
   a. Erico, Cadweld®.
   b. Continental Industries, Inc., Thermoweld®.
   c. Or Approved Equal.

E. Ground Rods:
1. Provide UL listed, sectional ground rods fabricated using a electrolytic plating process to copper clad a medium carbon steel core
2. Diameter: 3/4 inch.
3. Length: 10 feet.
   a. To obtain longer length rods, join rod sections using copper clad rod couplers.
4. Acceptable Manufacturers:
   a. Erico International Corp.
   b. Galvan Industries, Inc.
   c. South Atlantic, LLC
   d. A.B. Chance Co.
   e. Or Approved Equal

F. Concrete Protective Boxes (Ground Wells):
1. Provide precast concrete boxes with flush cast iron covers rated for heavy traffic H20 areas and having slots for conduit entrances.
   a. Minimum size: 10” diameter by 12” high with maximum depth up to 36”.
   b. Cover legend: Provide the cast-in legend “GROUND TEST WELL” in the cast iron covers provided.

2. Acceptable Manufacturers:
    a. National Lightning Protection Corporation
    b. East Coast Lightning Equipment
    c. Or Approved Equal

G. Coating Compound:
1. Provide permanently pliable, moldable, un-backed, black rubber based coating materials for covering or coating grounding clamps and connectors.
2. Coating Physical Properties:
    a. Solids/Density: 100 percent; 12 pounds per gallon.
    b. Penetration: Within 90 to130 when tested in accordance with ASTM D 5.
    c. Water Absorption: 0.10 percent, maximum, when tested in accordance with ASTM D 570.
    d. Dielectric Strength: 500 volts/mil when tested in accordance with ASTM D 149.
    e. Volume Resistivity: 2,000 megohm-inches, or 5,000 megohms-cm, when tested in accordance with ASTM D 257.
    f. Service Temperature: Minus 40 degrees to 160 degrees Fahrenheit; and having no melting point; flammability, or slow burning when tested in accordance with ASTM C 653.
    g. Chemical Resistance:
        1) Resistant to alcohol, water, aqueous hydrochloride, and sodium hydroxide.
        2) Dissolved by carbon tetrachloride, naphtha gasoline, mineral spirits, and benzene.
    h. Cohesive/Adhesive: Adheres to metals, concrete, and itself.

PART 3 EXECUTION

3.01 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.
    b. Locate all on-site utilities and other obstructions in the area of construction, and verify that interferences will not occur.

3.02 PREPARATION

A. Layout electrical work to suit actual field conditions and in accordance with accepted standard practice.

3.03 INSTALLATION

A. Perform required earthwork including excavation, backfill, and compaction, as specified in Division 31.

B. 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.

C. Ground Grids:
   1. Installing Ground Rods:
      a. Drive ground rods head to 6 inches below grade by using a ground rod cap to protect the head of the rod.
         1) If the top of the rod is damaged during driving operations, cut it off.
   2. Installing Ground Wells:
      a. Install a concrete protective box for the ground well flush with the grade and 4 inches above the top of the ground rod designated on the Contract Drawings.
   3. Installing Ground Wires:
      a. Excavate the trenches for the ground grid cables, and lay the ground cable in the trenches from ground rod to ground rod without splice, and from one side of the grid to the other as shown on the Contract Drawings.
         1) Lay the ground grid cables cable allowing 10 percent slack.
         2) Form 12-inch minimum radius bends at changes in direction.
         3) At intersections, place cables so they diverge 60 degrees or more from other cables at the intersection.
         4) Connect service entrance grounds directly to the ground grids without splices in the cable.
      b. Route connecting cables from the ground grid in the trenches to the building structure.
         1) Route exposed cables parallel to the building lines, except for bends; form all bends with a 12-inch minimum radius.
         2) Wherever the cable breaks grade, provide schedule 80 conduit from 2-feet below finished grade to 3-feet above finished grade for protection; and provide conduit at other points where the cable may be subject to damage.
      c. Clamp the conduit to the building structure's wall at the ends and at intervals not to exceed 5 feet.
         1) Whenever cable exits from the conduit, clamp the cable to the wall at intervals not to exceed 5 feet and at each entrance to equipment.
         2) Allow a 1/4 inch space between ground cables, conduit, and the surface it is mounted on.
      d. Remove any damaged or kinked cable.
   4. Welding ground wires to the ground rods and equipment connections.
      a. Follow the procedures of the exothermic welding kits manufacturer.
      b. Prior to welding ground wires to the ground rods and equipment connections perform the following:

1) Clean the proposed welding area of combustible and flammable materials; and block access to personnel to protect them from harm; and provide a shield to prevent damage to other materials.
2) Clean insulation from ground wire for a distance of 12 inches, and clean the exposed wire to a bright finish.
3) Clean paint, grease, and other similar insulating materials from contact points.
4) Inspect the molds for damage; and discard any faulty mold or any molds used over 40 times.

c. Exothermically weld the ground wires to the ground rods as shown on the Contract Drawings, including to ground rods at grid crossings, to ground rods at grid intersections on the sides of the ground grid, and at all equipment connections.
d. After completing the welding, replace the insulation removed from insulated wires, and coat connections and the area around connections with coating compound.
1) Coating Thickness: 1/8-inch, minimum.
2) Make sure the coating is free from pin-holes and holidays.

5. Make all connections to electrical equipment and ground buses with compression, two-hole lugs and studs.
a. Clean paint, grease, and other similar insulating materials from the contact points for the ground lugs and studs.
b. Clean all wires to a bright finish prior to construction the connections.

D. Equipment Ground Buses:
1. Whenever several pieces of equipment, other than service grounds, require external bond wires in an area, provide an equipment ground bus.
2. Wherever 5 or more conduits enter a box or enclosure, provide an equipment ground bus.
a. Connect all equipment ground wires and conduit bond wires within the box or enclosure to a single ground stud or single common ground bus.
3. Size ground buses to carry 100 percent of the rating or setting of the largest over current device in the circuit(s) ahead of the equipment, conduit, or other item, and as indicated on the Contract Drawings.

E. 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. Unless using multi-conductor cable, run equipment grounding conductors inside the same conduit or wiring channel enclosing the power conductors.

b. In multi-conductor cable, locate grounding conductor inside the sheath or cable.
c. 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.

5. Grounding Motors:
a. Install equipment grounding wire within conduit supplying power to motor.
b. Install bonding connectors across the liquid tight flexible conduit supplying motors.

6. Grounding and Bonding Pumps:
a. Provide a bond from each pump to its motor using a conductor equal in size to the motor circuit equipment grounding conductors.

7. Grounding Transformers:
a. If a transformer is a separately derived system as defined in NFPA 70, provide a ground wire in both the primary and secondary conduits; and bond the ground wire and metallic conduits, if used, to the nearest effectively grounded metallic water pipe or nearest effectively grounded structural steel column.
b. Provide an additional bond between cold or hot water pipes and structural steel located near a transformer bond connection.

F. Perform grounding work in accordance with the requirements of Motorola R56, Standards and Guidelines for Communications Sites. (Building B only)

3.04 REPAIR/RESTORATION

A. Replace any finished exothermic welded splice connections that inspections find to be defective.

B. After inspection by Engineer and Authorities's representative, backfill the direct buried cables and around ground rod protectors.
1. Begin backfilling with clean washed sand to 6 inches above the ground rods or to the depth shown on the Contract Drawings, whichever is greater.
2. Backfill using select fill in accordance with the requirements of Division 31.
3. Slope the finish grade away from ground rods at a slope of 1 inch in 18 inches for a distance of 27 inches from the rods in all directions.

C. Install underground warning tape above all buried cables/conduits at a depth of 12" below finished grade.

3.05 FIELD QUALITY CONTROL

A. Site Testing:
   1. Prior to energizing any system, test the resistance to ground for the system in accordance with Section 26 05 63.
      a. Perform a continuity test from all utilization and distribution equipment to the ground grid on a run-by-run basis.

B. 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.
   2. Inspect finished exothermic welded connections for the following defects:
      a. Conductors appear within the splice area.
      b. Top of splice risers are below conductors.
      c. Surfaces exhibiting more than 20 percent slag material.
      d. Surfaces with over slag material that has flowed into conductors.
      e. Mold blowouts.
      f. Excessive porosity.
         1) Small pores less than 1/32 inch are permitted.

3.06 PROTECTION

A. Protect finished insulated wires from being painted.

B. Protect all ground grid wells from damage during paving and landscaping.

C. Protect all ground grid installations and ground wires from damage during the work of other Sections.

END OF SECTION

SECTION 26 05 28

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, cleaning, and protecting hanger and support systems for electrical wiring, conduit boxes, and equipment.

B. Related Section:
   1. Refer to Procurement Documents
   2. Section 26 05 00 Common Work Results for Electrical

1.02 REFERENCES

A. Reference Standards:
   1. U. S. Government:
      a. Federal Transit Administration (FTA):
   2. 49 CFR 661 Buy America Requirements

B. American Iron and Steel Institute (AISI):
   1. AISI Standard Steels (Handbook).

C. American Society for Testing Materials (ASTM):
   1. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.
   2. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated - Welded and Seamless.
   3. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   6. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi, Minimum Tensile Strength.
   7. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   8. ASTM A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
   9. ASTM A 575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
   10. ASTM A 576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   11. ASTM A 635/A 635M - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled.

12. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
13. ASTM B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
14. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

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

E. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts maximum).

F. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code (NEC).
2. NFPA 258 - Standard Research Test Method for Determining Smoke Generation of Solid Materials.

G. Society of Automotive Engineers International (SAE):
1. SAE J 429 - Mechanical and Material Requirements for Externally Threaded Fasterners.

H. 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, “Inorganic,” and type II, “Organic”).

I. Underwriters Laboratory, Inc. (UL):
1. UL 568 - Nonmetallic Cable Tray Systems.
2. UL 635 - Standard for Insulating Bushings.
3. UL 870 - Standard for Wireways, Auxilliary Gutters, and Associated Fittings.
4. UL 884 - Standard for Underfloor Raceways and Fittings.
5. UL 1479 - Standard for Fire Tests of Through-Penetration Firestops.
6. UL 2239 - Hardware for the Support of Conduit, Tubing, and Cable.

J. U. S. General Services Administration (GSA)
1. Federal Specifications:
   a. A-A-1922A - Shield, Expansion (Caulking Anchors, Single Lead).
   b. FF-S-107C(2) - Screws, Tapping and Drive.

1.03 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of the Procurement Documents, 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. Design Data:
      1) Provide structural calculations for the following items:
         a) Equipment backboards and support structures not directly fastened to the walls.
         b) Hanging supports for conduit.
      2) Detailed drawings of proposed departures from the original design.
   b. 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.
         b) If an item does not have ETA quality assurance verification, provide a written quality assurance verification statement from the product manufacturer indicating why the item does not have the specified quality assurance verification.
            (1) Such quality assurance verification statements are subject to approval by the Authority and the Engineer.
      2) Manufacturers' Certificate of Compliance.
   c. Qualification Statements:
      1) Manufacturers' qualifications.

1.04 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. Qualifications;
   1. Electrical Testing Agency (ETA) Qualifications:
      a. Use the Electrical Testing Agency (ETA) qualified as specified in Section 26 05 00, Common Work Results for Electrical.
   2. 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.

C. Certifications:
   1. Electrical Testing Laboratory (ETL) Certification:

a. Provide products that are listed and labeled by Underwriters Laboratory, Inc. (UL) or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.

2. 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.

1.05 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

2.01 MATERIALS

A. Carbon Steel Shapes:
   1. Provide shapes of the sizes specified and as indicated on the Contract Drawings:
   2. Provide steel shapes complying with the following material specifications for the type of steel shape listed:
      a. Steel Sections: ASTM A36/A 36M.
      b. Steel Tubing: ASTM A 500, Grade B.
      c. Plates: ASTM A 283/A 283M.
      d. Sheets: ASTM A 1011/A 1011M.
      e. Pipe: ASTM A 53/A 53M, Grade B, Schedule 40, hot-dipped, zinc-coated.

B. Welding materials:
   1. Provide welding materials complying with the requirements of AWS D1.1/D1.1M for the type of material being welded.

2.02 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 1-5/8-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:

1) Unistrut Corporation, Unistrut® Metal Framing System, www.unistrut.com.

2) Thomas & Betts, Kindorf®, http://elec-cat.tnb.com.

3) Cooper B-Line®, Inc., www.b-line.com.

4) Or Approved Equal

2. Stainless Steel U-Channel Support Framing Systems:

a. Provide U-channel supports, fittings, threaded rod, and hardware fabricated from Type 316 stainless steel.

B. Nonmetallic Electrical Support Framing Systems and Fittings:

1. Fiberglass Reinforced Polyester Angles, Channels, and Bars:

a. Provide non-metallic angles, channels, and bars fabricated from a high impact strength, fiberglass reinforced polyester formulation having a glass to resin ratio of 45 to 55 percent by weight.

b. Provide angles, channels, and bars that meet or exceed a Class 1 flame spread rating of less than 25 determined according to the requirements of ASTM E 84, and a smoke rating of 5 determined according to the requirements of the Smoke Chamber Test specified in NFPA 258.

c. Manufacturers:

1) Enduro Systems, Inc., www.endurocomposites.com.

2) Robroy Industries, www.robroy.com.

3) Or Approved Equal.

2. Pre-Engineered Glass-Fiber-Reinforced Supporting Systems:

a. Pre-engineered, UL-listed supporting systems fabricated from glass-fiber-reinforced composites may be used in lieu of field-fabricated support systems.

b. Manufacturers:

1) Unistrut, www.unistrut.com.

2) Allied Electrical Group, Aickinstrut Fiberglass Framing System, www.alliedtube.com.

3) Enduro Systems, Inc., www.endurocomposites.com.

4) Or Approved Equal

C. 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. Stamped Steel Conduit Supports:

a. Provide one-hole style galvanized stamped steel 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.

3. Special Finishes:
   a. Where PVC-coated RGS conduits are to be installed, provide 40-mil PVC coated conduit supports including the threaded rods, channel supports, and conduit straps/fasteners.
4. Manufacturers:
   a. Thomas & Betts, http://www-public.tnb.com/contractor/docs/superstrut.pdf.
   b. Or Approved Equal.

D. Cable Supports:
1. Provide voltage rated cable supports fabricated from hot-dip galvanized malleable iron with a threaded collar.
2. Provide tapered wedging cable plugs fabricated from hard fiber, impregnated hardwood, or canvas bakelite for the cable supports.
3. Manufacturers:
   a. EGS Electrical Group, O-Z/Gedney, Inc., Type "M", http://www.o-zgedney.com/PDF/QA%201thru16.pdf.
   b. Or Approved Equal.

E. 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.
2. For fastening galvanized components, provide galvanized bolts, nuts, and washers galvanized in accordance with the requirements of ASTM A 153/A 153M.

F. 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:
a) U.S.E. Diamond, Inc., FORWAY System, , www.mktfastening.com.
b) Or Approved Equal

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:
a) U.S.E. Diamond, Inc.; SUP-R-STUD, www.mktfastening.com.
b) Hilti Fastening Systems; KWIK-BOLT, hilti.com.
c) Molly Fastener Group; PARABOLT.
d) Phillips; RED HEAD Wedge-Anchor, www.phillipsfastener.com.
e) Or Approved Equal

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.

2.03 ACCESSORIES

A. Wall Seals:
1. For wall penetrations between conditioned and non-conditioned spaces, and for all penetrations through exterior walls, provide a hydrostatic seal to fill the annular space between conduit and through structure openings.
a. Manufacturer:
1) PSI-ThunderLine/Link-Seal Corp., Link-Seal®, www.linkseal.com.
2) Or Approved Equal
2. For wall penetrations other than those listed above, seal around conduits with non-shrink grout.

B. 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:
        1) Dow Corning Corporation, www.dowcorning.com.
        2) 3M, http://solutions.3m.com/en_US/.
        3) Or Approved Equal
    b. Mechanical Fire Seals:
        1) PSI-ThunderLine/Link-Seal Corp., www.linkseal.com.
        2) Or Approved Equal
    c. Through-Wall Barrier Fire Seals:
        1) Cooper Crouse-Hinds, http://crouse-hinds.com.
        2) Or Approved Equal

2.04 FABRICATION

A. Fit and shop assemble items in the largest sections practical for delivery to the Site.

2.05 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

3.01 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.

3.02 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.

3.03 INSTALLATION

A. Install electrical Work in conformance to the requirements of NFPA 70 for wiring methods general requirements (Refer to Procurement Documents), 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 26 05 28 - 1 U-Channel Support Framing Selection

Condition 1	Condition 2	Type
Aboveground	Outside vertical support within 6" of concrete	PVC Coated Steel
	Outside other locations	Stainless Steel or PVC Coated Steel
	Interior NEMA 1/12	Carbon steel
	Interior NEMA 4X	Stainless Steel, PVC Coated Steel or Glass-Fiber-Reinforced
Underground	Exposed/Embedded	PVC Coated Steel

D. Installing Conduit Supports:
1. For exterior locations provide malleable iron conduit supports.
2. For interior locations, provide stamped steel conduit supports.

E. Panelboard/Enclosure Feed Risers:
1. Furnish and install cable supports in feeder risers as required by the underwriters.

F. In areas designated as wet, NEMA 3, NEMA 3R, NEMA 4X, NEMA 12, or NEMA 13 as defined in NEMA 250; secure equipment and conduit to no fewer than two 7/8-inch minimum depth, non-metallic channels mounted vertically on the walls.

G. 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).

3.04 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.

3.05 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:

3.06 PROTECTION

A. Protect the items provided under this Section from damage during the work of other trades.

END OF SECTION

SECTION 26 05 33.13

CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, energizing, and testing conduit, tubing, and fittings for communication lines and electrical transmission, distribution, and service lines.

B. Related Section:
   1. Refer to Procurement Documents
   2. Division 2 Existing Conditions
   3. Division 3 Concrete
   4. Division 7 Thermal and Moisture Protection
   5. Section 26 05 00 Common Work Results for Electrical
   6. Section 26 05 26 Grounding and Bonding for Electrical Systems
   7. Section 26 05 28 Hangars and Supports for Electrical Systems
   8. Section 26 05 63 Acceptance of Electrical Systems
   9. Division 31 Earthwork

1.02 REFERENCES

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

B. 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 C80.3 - Electrical Metallic Tubing - Zinc Coated (EMT).
   4. ANSI C80.6 - Intermediate Metal Conduit - Zinc Coated (IMC).

C. American Society for Testing and Materials (ASTM):
   1. ASTM A 568/A 568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold Rolled, General Requirements (Refer to Procurement Documents).
   2. ASTM D 1784 - Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

D. National Electric Manufacturer's Association (NEMA):
   1. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   2. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.

E. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code (NEC).

F. Underwriters Laboratory, Inc. (UL):
   1. ANSI/UL 6 - Standard for Rigid Metal Conduit.
   2. ANSI/UL 360 - Standard for Liquid-Tight Flexible Steel Conduit.
   3. ANSI/UL 498 - Standard for Safety for Attachment Plugs and Receptacles.
   4. ANSI/UL 514A - Metallic Outlet Boxes.
   5. ANSI/UL 797 - Electric Metallic Tubing - Steel.
   6. ANSI/UL 886 - Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
   7. ANSI/UL 1242 - Standard for Electrical Intermediate Conduit - Steel

G. Institute of Electrical and Electronics Engineers (IEEE):
   1. IEEE C2 - National Electrical Safety Code.

1.03 DEFINITIONS

A. Definitions for all items are as stated in NFPA 70, IEEE C2, and in other reference documents unless otherwise stated, specified, or noted.

1.04 DESIGN REQUIREMENTS

A. Conduit Systems:
   1. Provide conduit of the type and material shown in Tables 26 05 33.13 - 1, - 2, - 3, - 4, -5, and - 6 below for the application indicated, or as indicated on the Contract Drawings.
      a. In a given location, provide only the type of conduit indicated or scheduled for that location.
      b. For conduits embedded in concrete, use rigid galvanized steel (RGS) conduit.
      c. Intermediate metal conduit (IMC) and fittings meeting the requirements specified below may be used wherever rigid galvanized steel is specified.
      d. For wall and floor penetrations, use only metallic raceways.
      e. Use PVC coated flexible metal conduit and fittings in exposed areas.
   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

Location	Condition 1	Condition 2	Conduit Type	Minimum Size
Under-Ground	Below Concrete Slab	Bends, over 10 degrees in length	PVC Coated Rigid Galvanized Steel	3/4 Inch
		Conduit Risers	PVC Coated Rigid Galvanized Steel	3/4 Inch
		Exposed conduit within 6-inches of exit from encasement	PVC Coated Rigid Galvanized Steel	3/4 Inch
		Straight Runs	PVC Schedule 40	3/4 Inch

Table 26 05 33.13 - 2 Conduit System Selection				
Location	**Condition 1**	**Condition 2**	**Conduit Type**	**Minimum Size**
Under-ground	Direct Burial	Bends, over 10 degrees in length	PVC Coated Rigid Galvanized Steel	1 Inch
		Conduit Risers	PVC Coated Rigid Galvanized Steel	1 Inch
		Exposed conduit within 6-inches of exit from encasement	PVC Coated Rigid Galvanized Steel	1 Inch
		Straight Runs	PVC Schedule 80	1 Inch

Table 26 05 33.13 - 3 Conduit System Selection				
Location	**Condition 1**	**Condition 2**	**Conduit Type**	**Minimum Size**
Above-Ground	Outside	All	PVC Coated Rigid Galvanized Steel	3/4 Inch

Table 26 05 33.13 - 4 Conduit System Selection				
Location	**Condition 1**	**Condition 2**	**Conduit Type**	**Minimum Size**
Above-Ground	Inside NEMA 1/12	Within 6-inches of floor when exposed	PVC Coated Rigid Galvanized Steel	3/4 Inch
		Within 6-inches of floor when within footprint of floor mounted equipment	PVC Schedule 40	3/4 Inch
		Concealed above ceilings	Electrical Metal Tubing	3/4 Inch
		Concealed in Masonry Block Wall	Electrical Metal Tubing or PVC Schedule 40	3/4 Inch
		Concealed in Cast-in-Place Concrete Wall or Floor	Rigid Galvanized Steel	3/4 Inch
		Concealed behind Gypsum Board Wall or Ceiling	Electrical Metal Tubing	3/4 Inch

Table 26 05 33.13 - 4 Conduit System Selection				
Location	**Condition 1**	**Condition 2**	**Conduit Type**	**Minimum Size**
		Recess Mounted Lighting Fixtures and Rotating or Vibrating Equipment	Flexible Metal Conduit	3/4 Inch
		Exposed (NEMA 1)	Electrical Metal Tubing	3/4 Inch
		Exposed (NEMA 12)	Rigid Galvanized Steel	3/4 Inch

Table 26 05 33.13 - 5 Conduit System Selection				
Location	**Condition 1**	**Condition 2**	**Conduit Type**	**Minimum Size**
Above-Ground	Inside NEMA 3R/4/4X	Within 6-inches of floor	PVC Coated Rigid Galvanized Steel	3/4 Inch
		Concealed in Masonry Block Wall	Rigid Galvanized Steel or PVC Schedule 40	
		Concealed in Cast-in-Place Concrete Wall or Floor	Rigid Galvanized Steel	3/4 Inch
		Recess Mounted Lighting Fixtures and Rotating or Vibrating Equipment	Liquid-Tight Flexible Metal Conduit	3/4 Inch
		Exposed	PVC Coated Rigid Galvanized Steel	3/4 Inch
		Recess Mounted Lighting Fixtures and Rotating or Vibrating Equipment	Liquid-Tight Flexible Metal Conduit	3/4 Inch

Table 26 05 33.13 - 6 Conduit System Selection				
Location	**Condition 1**	**Condition 2**	**Conduit Type**	**Minimum Size**
Above-Ground	Inside NEMA 7/9	Within 6-inches of floor	PVC Coated Rigid Galvanized Steel	3/4 Inch
		Concealed in Masonry Block Wall, Cast-in-Place Masonry or Floor above grade	Rigid Galvanized Steel	3/4 Inch

Table 26 05 33.13 - 6 Conduit System Selection				
Location	**Condition 1**	**Condition 2**	**Conduit Type**	**Minimum Size**
		Exposed	PVC Coated Rigid Galvanized Steel	3/4 Inch

1.05 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of the Procurement Document:
   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 the Procurement Document.
      b. Rigid Polyvinyl Chloride (PVC) Conduit.
      c. Non-metallic conduit solvent.
      d. Electrical Metallic Tubing (EMT).
      e. Intermediate Metal Conduit (IMC).
      f. Plastic coated rigid galvanized steel conduit.
      g. Liquidtite flexible metal conduit.
      h. Rigid galvanized steel conduit (RGS).
      i. Fittings for non-metallic conduit systems.
      j. Fittings for metallic conduit systems.
      k. Conduit spacers.
      l. Heat shrink tubing.
      m. Wall and floor penetration seals.
      n. Cold galvanize coating.
   2. Shop Drawings:
      a. Proposed departures from the original design.
   3. Quality Assurance/Control Submittals:
      a. Qualification Statements:
         1) Qualifications of the installer.
         2) Qualifications of the Electrical Testing Laboratory (ETL).
      b. Certificates:
         1) Testing agency/quality verification, listing, and labeling.

1.06 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. 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.

2. Electrical Testing Laboratory (ETL) Qualifications:
   a. Employ an independent testing agency, qualified as specified in the Procurement Document, and Section 26 05 63 Acceptance of Electrical Systems, to perform the testing required by this Section.
   b. Submit information verifying the ETL's qualifications.

C. 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.

D. 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.
   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 a quality assurance verification.
      1) Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Authority and the Engineer.

1.07 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

2.01 NON-METALLIC CONDUIT

A. Electrical Plastic Tubing and Conduit:
   1. Rigid Polyvinyl Chloride (PVC) Conduit:
      a. Provide high impact PVC conduit conforming to the requirements of NEMA TC 2 at 90 degrees Celsius, and made from compounds conforming to the requirements of ASTM D 1784.
         1) Use material that at 78 degrees Fahrenheit has a tensile strength exceeding 5500 psi, a flexural strength exceeding 11,000 psi, and a compressive strength exceeding 800 psi,
      b. Provide PVC conduits that are UL listed, labeled, or approved for both underground and above ground use.
   2. Manufacturers:
      a. Lamson & Sessions, Carlon®, www.carlon.com.
      b. Queen City Plastics, Inc., www.queencityplastics.com.
      c. Or Approved Equal.

B. Non-Metallic Conduit Solvent:
   1. Provide solvent for non-metallic conduit joints from the same manufacturer as the conduit and conforming to the requirements of ASTM D 2564.

2.02 METALLIC CONDUIT

A. Electrical Metallic Tubing (EMT):
   1. Provide electrical metallic tubing (EMT) conforming to the requirements of Article 358 in NFPA 70 (NEC) for materials and uses, ANSI C80.3 and UL 797.
   2. Provide galvanized steel tubing conduit lengths bearing the manufacturer's trademark.
   3. Manufacturers:
      a. Tyco/Allied Tube and Conduit, www.alliedtube.com
      b. Wheatland Tube Company, Division of John Maneely Company, www.wheatland.com.
      c. Or Approved Equal.

B. Intermediate Metal Conduit (IMC):
   1. Provide intermediate metal conduit (IMC) conforming to the requirements of Article 342 in NFPA 70 (NEC) for materials and uses, ANSI C80.6 and UL 1242.
   2. Fabricate intermediate metal conduit (IMC) from high strength low alloy sheet steel meeting the requirements for ASTM A 568 piping, galvanized inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating.
   3. Provide conduit furnished in 10-foot minimum lengths with both ends threaded and one end fitted with a coupling.
   4. Manufacturers:
      a. Tyco/Allied Tube and Conduit, www.alliedtube.com.
      b. Wheatland Tube Company, Division of John Maneely Company, www.wheatland.com.
      c. Or Approved Equal.

C. Plastic Coated Rigid Galvanized Steel Conduit:
   1. Provide plastic coated rigid galvanized steel conduit bearing the UL label.
   2. Provide base conduit of rigid hot-dip galvanized steel conduit as specified in Paragraph 2.02E, and of the type indicated, specified, or scheduled to be coated.
   3. Apply plastic coating in accordance with the following:
      a. Apply a 40-mil thick PVC coating on the outside and a 2-mil thick fusion-bonded blue, red, or green urethane coating on the inside, both coatings conforming to the requirements of NEMA RN 1.
      b. Have the same manufacturer who produces the hot dip galvanized base conduit factory-apply the plastic coating.
      c. Provide plastic coating of one uniform color on all plastic coated rigid galvanized steel conduit provided for the Contract.
   4. Provide 40-mil thick plastic sleeves to protect internally threaded conduit openings.
      a. Provide sleeves with an inside diameter equal to the outside diameter of the conduit/pipe protected by it; and extending either one pipe diameter or 2-inches, whichever is less, beyond the opening.
   5. Manufacturers:
      a. OCAL, http://www.tnb.com/contractor/docs/ocal.pdf.
      b. Robroy Industries/Perma-Cote, www.permacote.com.
      c. Or Approved Equal

D. Liquidtite 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
      a. Electri-Flex Company, Liquatite®, Type LA, www.electriflex.com.
      b. ANAMET Electrical, Inc., Anaconda Sealtite®, www.anacondasealtite.com.
      c. Or Approved Equal.

E. 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.

a. Provide tapered NTP 3/4 inch per foot threads complying with ANSI/ASME B1.20.1.

4. Acceptable Manufacturers:
   a. Tyco/Allied Tube and Conduit, www.alliedtube.com.
   b. Wheatland Tube Company, Division of John Maneely Company, www.wheatland.com.
   c. Or Approved Equal.

2.03 CONDUIT FITTINGS

A. Fittings for Non-Metallic Conduit Systems:
   1. Provide high impact non-metallic fittings conforming to same requirements as for the non-metallic conduit as specified in Article 2.01.
   2. Non-Metallic Conduit Expansion Fittings:
      a. Provide a two-piece nonmetallic, noncorrosive, nonconductive, UL listed expansion fitting.
   3. Acceptable Manufacturers:
      a. Lamson & Sessions, Carlon®, www.carlon.com.
      b. Queen City Plastics, Inc., www.queencityplastics.com.
      c. Or Approved Equal.

B. Fittings for Metallic Conduit Systems:
   1. Construct conduit bodies/fittings from cast malleable iron or cast steel.
   2. For PVC coated raceway systems, provide PVC coated fittings of cast malleable iron or cast steel from the same manufacturer that provides the uncoated conduit bodies/fittings.
   3. Conduit Outlet Bodies:
      a. Provide malleable iron threaded entry type conduit outlet bodies with neoprene gaskets and cast steel conduit.
      b. Acceptable Manufacturers:
         1) EGS/Appleton Electric, www.appletonelec.com.
         2) EGS/O-Z/Gedney, www.o-zgedney.com.
         3) Or Approved Equal.
   4. 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:
         1) EGS/Appleton Electric, www.appletonelec.com.
         2) EGS/O-Z/Gedney, www.o-zgedney.com.
         3) Or Approved Equal.
   5. Conduit Unions:
      a. Provide conduit unions capable of completing a conduit run when neither conduit end can be turned.
      b. Acceptable Manufacturers:
         1) EGS/Appleton Electric, UNF and UNY Unions, www.appletonelec.com..
         2) Thomas and Betts Company, Erickson® Coupling., www.tnb.contractor/docs/tnbhazardous.pdf.
         3) Or Approved Equal.
   6. 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:
1) EGS/Appleton Electric, GRF outlets and covers, www.appletonelec.com.
2) EGS/O-Z Gedney, www.o-zgedney.com.
3) Or Approved Equal.

7. 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:
1) EGS/Appleton Electric, FD device boxes, www.appletonelec.com.
2) EGS/O-Z Gedney, www.o-zgedney.com.
3) Or Approved Equal.

8. Conduit Sealing Fittings:
a. Provide, triple coated, malleable iron conduit sealing fittings.
1) Coat the conduit sealing fittings with zinc electroplate, dichromate, and an epoxy powder coat.
b. Provide drain fittings in conduit sealing fittings where required.
c. Provide sealing covers for junction boxes where required.
d. Acceptable Manufacturers:
1) EGS/Appleton Electric, www.appletonelec.com.
a) Sealing hubs: ES.
b) Sealing fittings: EYSEF, EYSDEF, and EYD.
2) EGS/O-Z Gedney, www.o-zgedney.com.
3) Or Approved Equal.

2.04 CONDUIT SPACERS

A. Provide non-metallic, interlocking type conduit spacers which snap together to join any combination of intermediate and base units together, both vertically and horizontally.

B. Manufacturers:
1. Underground Devices Inc., www.udevices.com.
2. The George-Ingraham Corp.
3. Or Approved Equal.

2.05 HEAT SHRINK TUBING

A. Provide all-weather corrosion resistant vinyl plastic heat shrink tubing designed for application on the exterior of metallic conduit to protect against galvanic action, moisture or other deteriorating contaminants.

B. Manufacturers:
1. Tyco Electronics, Raychem, www.raychem.com.
2. Thomas & Betts
3. Or Approved Equal.

2.06 CONDUIT PENETRATION SEALS

A. Fire Rated Walls, Floors, and Ceilings
   1. Through penetration firestop system. Materials and installation in accordance with Division 7.
   2. Seals for exterior walls, floors, and ceilings shall be weatherproof and watertight.

B. Non-Fire Rated Walls, Floors, and Ceilings
   1. Caulk all around; with sleeve and backer / packing material where required. Materials and installation in accordance with Division 7.
   2. Seals for exterior walls, floors, and ceilings shall be weatherproof and watertight.

C. Below Grade Walls
   1. Provide watertight mechanical seals capable of holding up to 20 psig, and sealing against water, soil, and backfill material.
   2. Acceptable Manufacturers:
      a. Pipeline Seal & Insulator, Inc., Thunderline/Link-Seal, www.linkseal.com.
      b. Flexicraft Industries, PipeSeal, http://flexicraft.com.
      c. Or Approved Equal.

2.07 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:
      a. ZRC. Worldwide, www.zrcworldwide.com.
      b. Clearco
      c. Krylon
      d. Rustoleum
      e. Or Approved Equal

PART 3 EXECUTION

3.01 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.

3.02 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.
   2. Include Product Data for the conduit and tubing provided under this Section with the Operation and Maintenance Manuals submitted in accordance with the requirements of the Procurement Documentat Project Closeout.

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.

3.03 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.
      a. 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 the Procurement Document and submit the record drawings.
   2. Install the electrical Work of this Section in conformance to the wiring methods general requirements (Refer to Procurement Documents) of Article 300 in NFPA 70 (NEC), and to all other applicable Articles of NFPA 70 governing wiring methods.
   3. 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.
   4. 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.
   5. Do not install crushed or deformed conduit, and remove crushed or deformed conduit from the Site.

6. On conduit that is installed outside, provide a second equipment ground conductor and use fittings with a built-in ground lug for bonding.
7. 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, 36 inches in length for equipment connections or 72-inches for lighting fixture connections.
8. 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.
    d. Provide sealing fittings with drain fittings in all lower runs and vertical runs.
    e. Provide sealing covers for junction boxes where required.
    f. Provide weatherproof conduit hubs on all conduit connections exterior to the building, and on instruments, process equipment, and pump motors.
9. Installing RGS and PVC Coated Conduit:
    a. Install RGS and PVC coated conduit using methods and techniques recommended by the conduit manufacturer.
    b. Threading Conduit:
        1) Field thread the conduits per the manufacturers instructions.
            a) For PVC coated conduit, first use a cylindrical guide, oversized to fit over the plastic coating, to neatly cut the coating off at the proposed end of the threads.
            b) Do not damage or remove the coating beyond the proposed end of the threads.
        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 and PVC Coated Conduit Fittings:
        1) Use PVC coated conduit bodies, clamps, supports, accessories, and fittings with coated conduit systems.

2) 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.
3) Use cloth or other material over strap type wrenches to protect the coating while tightening conduits.

10. Breathers and drains shall be provided at the low point(s) of all conduit runs in NEMA 3R, 4, 4X and 7 areas, and where otherwise subject to the accumulation of condensation. Conduits shall be arranged to drain away from dry areas toward damp or wet areas, and away from equipment and enclosures.

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. Concealed Work:
1. When performing electrical work in concealed spaces, provide the same quality workmanship as in exposed work.
2. Conceal conduits and raceways in the structure’s construction where practicable unless otherwise indicated on the Contract Drawings or required by the Engineer.
a. Group conduit and raceway runs in concealed work as much as practical to avoid congesting the concealed spaces.
b. Do not weaken the structure by excessive or unnecessary cutting.
1) Only make cuts into the structure’s construction in conformance to the applicable building codes.
3. Except for vertical transitions from below to above slab, conduits shall not be installed within floor slabs. Vertical transitions shall be made perpendicular to the slab.
4. Below Slab and Below Grade Conduits
a. Comply with the minimum cover requirements of NEC Article 300.
b. For conduits installed below building floor slabs, minimum cover below the bottom of the slab shall be 4 inches.
c. Excavation and backfill shall comply with the requirements of Division 31. Any excavation involving potentially contaminated and/or hazardous soils shall comply with the requirements of Division 2.
d. For conduits that pass under building support walls, provide a minimum of 3 inches of concrete encasement all around. Concrete work shall comply with the requirements of Division 3.
e. For underground and concrete encased duct banks, provide non-metallic conduit spacers.
1) Provide sufficient space to allow pouring the concrete envelope without displacing or shifting the individual conduits.
2) Install conduit spacers at intervals not exceeding five feet.

E. Hangers and Supports:
   1. Install auxiliary support structures, anchors, and fasteners as specified in Section 26 05 28 Hangars 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.

F. Structure Penetrations:
   1. Make penetrations in existing concrete structures by core-drilling.
      a. Drill the penetrations true, clean, and free from spalling.
      b. Maintain spacing between adjacent cores of not less than 3 times the diameter of the largest core.
   2. At penetrations through fire rated floors, walls, and similar assemblies, provide firestopping as specified in Section 07 84 00.
   3. Make floor penetrations as detailed on the Contract Drawings.
      a. Seal all conduit penetrations through floor slabs on grade in buildings with a floor penetration seal.
   4. 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.
   5. For conduits that enter rooms from concrete floors or masonry, provide corrosion protection by using an RGS or PVC coated conduit that extends from 12 inches inside the concrete or masonry to at least 6 inches into the room.

G. Hazardous Locations
   1. Within the areas labeled as “hazardous” on the Contract Drawings, only provide equipment, fittings, and wiring as indicated which are approved for Class 1, Division 1, Group D or Class II, Division 1, Group F locations as required by NFPA 70 (NEC) for the type of area in question and as specifically designed for this type of hazardous use.
   2. In hazardous locations, engage at least five full threads on conduit connections to couplings and fitting hubs.
      a. Coat the threads with a sealing compound that makes the connections gas tight
   3. Properly install sealing fittings at all required locations in accordance with code regulations.

H. 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 for 1-1/2-inch through 4-inch PVC coated flexible metal conduit.

3.04 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 the Procurement Document.

END OF SECTION

SECTION 26 05 33.19

WIREWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of constructing the metallic raceway systems for the project.

B. Related Sections:
1. Section 07 84 00 Penetration Firestop Systems
2. Section 26 05 00 Common Work Results for Electrical
3. Section 26 05 28 Hangers and Supports for Electrical Systems

1.02 REFERENCES

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

B. Federal Specifications:
1. Fed. Spec W-C-582, Conduit, Raceway, Metal, and Fittings, Surface.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's catalog cuts for the following materials:
1. Wireway and Fittings.

1.04 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. Product Quality Control:
1. Manufacturers shall fabricate their products in such a manner that all criteria for appearance, fit and tolerances shall be complied with.
2. Each manufacturer shall carefully control his operations to ensure that the engineering, quality, safety and reliability of product are achieved.

PART 2 PRODUCTS

2.01 WIREWAY SYSTEM MATERIALS

A. Wireway (General Purpose, NEMA Type 1): Lengths, connectors and fittings UL Listed and constructed in accordance with Underwriters Laboratories Standard UL 870 for Wireways, Auxiliary Gutters and Associated Fittings.
   1. Screw cover design. Covers held firmly in place with captivated screw fasteners.
   2. Wireway constructed without knockouts.
   3. 16 gauge galvanneal sheet metal parts provided with corrosion resistant phosphate primer and ASA-49 gray enamel finish.
   4. Acceptable Manufacturers:
      a. Hoffman Engineering Company.
      b. Wiegmann.
      c. Or Approved Equal.

B. Wireway (Raintight, NEMA Type 3R): Lengths, connectors and fittings UL listed and constructed in accordance with Underwriters Laboratories Standard UL 870 for Raintight Wireways, Auxiliary Gutters and Associated Fittings.
   1. Wireway constructed without knockouts.
   2. Provide gasketing that cannot rip or tear during installation and maintain its raintight capability during the life of the wireway.
   3. 16 gauge galvanneal sheet metal parts provided with corrosion resistant phosphate primer and ASA-49 gray enamel finish.
   4. Acceptable Manufacturers:
      a. Hoffman Engineering Company.
      b. Wiegmann.
      c. Or Approved Equal.

C. Fiberglass Wireway Systems:
   1. Provide UL listed wireway for use in areas designated NEMA 4X or as indicated on the Drawings.
   2. Provide lay in type wireway to support and protect power, control and instrumentation cables.
   3. Supply solid bottom type wireway with a minimum wall thickness of 3/16 inches.
   4. Provide with covers and cover splice plates of snap-on type construction, requiring no installation fasteners.
   5. Manufacture wireway, covers and splice plates fabricated by the pultrusion process utilizing polyester fiberglass reinforced resin formulation with UV light inhibiting additives and exterior nexus veil coverage.
   6. Provide wireway systems conforming to the applicable sections of the National Electrical Code Article 362, and supported at intervals not exceeding 5 feet.
   7. Test wireway to exceed standards for UL94-V0 flammability classifications and ASTM E84 Temperature Index of 130□C.
   8. Provide gray color wireway.
   9. Refer to the Drawings for sizes and installation requirements of the various wireway systems.
   10. Acceptable Manufacturers:
      a. Enduro Fiberglass Systems.

b. Robroy Industries
c. Or approved Equal.

PART 3 EXECUTION

3.01 INSPECTION

A. Carefully investigate the structural and finish condition, as well as other construction work, which may affect the work of this Section. 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, etc.

B. Prior to performance of work described above, make detailed drawings of proposed departures from original design due to field conditions or other cause, and submit for Engineer's approval.

C. Inspect installed wireways and remove obstructions, dirt and debris if present.

3.02 PREPARATION

A. Field Measurement: The Drawings are generally indicative of the work, but due to their small scale, it is not possible to indicate all offsets, fittings, and apparatus required nor the minor structural obstructions that may be encountered.

B. Obtain roughing-in dimensions of electrically operated equipment being installed in other construction work. Set wireways only after receiving approved dimensions and checking such equipment locations.

C. Layout electrical work to suit actual field measurements and according to accepted Trade standard practice. However, electrical installations shall conform to NEC 300 for wiring methods general requirements (refer to Procurement Documents), and to all other applicable Articles of the NEC governing methods of wiring.

3.03 INSTALLATION

A. Methods of Wiring: In general fabricate raceway systems in accordance with accepted Trade standard practice. The following installation requirements are in addition to requirements set forth in Article 300 of the NEC and are included to complement the same.
   1. Do not attach raceway systems to suspended ceiling members or to the suspending mediums.
   2. Cut raceways square and deburr cuts to the same degree as cuts made by the material manufacturer. Ream cuts of conduits per NEC requirements with openings not restricted more than cuts made by the material manufacturer.
   3. Mount or suspend raceway systems directly on structural members of the structures, except where indicated as being wall mounted. Space supports in accordance with NEC requirements.
   4. Attach wall mounted raceway runs tight to walls, following contour of walls and securely attach anchors into walls.
   5. Do not weaken the structure by excessive or unnecessary cutting.

6. Make provisions for expansion in raceway runs where same cross building expansion joints.

B. Firestopping of penetrations through fire rated assemblies is provided by the General Contractor as specified in Section 07 84 00 of the Contract documents.

C. Exposed Work: Make raceway runs in exposed work parallel to centerlines and structure surfaces, and perpendicular to centerlines where required, with right angle turns consisting of symmetrical bends or fittings. Maintain at least 6 inches clearance between raceway runs and mechanical systems pipes, ducts, flues, etc.

3.04 ANCHOR AND FASTENER INSTALLATIONS

A. Auxiliary Support Fabrication: As specified in Section 26 05 28.

B. Threaded Bolts: As specified in Section 26 05 28.

C. Drilled-In Expansion Anchor Installation: As specified in Section 26 05 28.

END OF SECTION

SECTION 26 05 33.23

BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, connecting, cleaning, and protecting electrical pull and junction boxes.

B. Related Section:
   1. Refer to Procurement Documents
   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 28 Hangers and Supports for Electrical Systems
   5. Section 26 05 63 Acceptance of Electrical Systems
   6. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables
   7. Section 26 05 33.13 Conduits for Electrical Systems

1.02 REFERENCES

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

B. 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.
   3. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

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

D. American National Standards Institute (ANSI):
   1. ANSI Z55.1 - Gray Finishes for Industrial Apparatus & Equipment (*withdrawn 1990, no replacement*).

E. Underwriters Laboratories, Inc. (UL):
   1. UL 886 - Standard for Outlet Boxes and Fittings for Use In hazardous (Classified) Locations.

1.03 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.
   4. Include Product Data for the equipment and material provided under this Section with the Operation and Maintenance Manuals submitted in accordance with the requirements of The Procurement Documents at project closeout.

1.04 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of The Procurement Documents:
   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 cast outlet boxes for general purpose applications used with coated conduit systems.
      d. Catalog cuts of sheet metal boxes for general purpose applications in dry locations.
      e. Catalog cuts of outlet boxes for hazardous locations.
      f. Catalog cuts of pull boxes for hazardous locations.
      g. Catalog cuts of equipment and control device enclosures for all areas except outdoor and corrosive locations.
      h. Catalog cuts of equipment and control device enclosures for outdoor locations.
      i. Catalog cuts of equipment and control device enclosures for corrosive 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.
         2) Qualifications of the Electrical Testing Laboratory (ETL).

1.05 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. 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.
   2. Electrical Testing Laboratory (ETL) Qualifications:
      a. Employ an independent testing agency, qualified as specified in Section The Procurement Documents, and Section 26 05 63 Acceptance of Electrical Systems, to perform testing required by this Section.
      b. Submit information verifying the ETL's qualifications.

C. 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.

D. 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.
      a. For items without such evidence, submit a written statement from the product manufacturer that indicates why it does not have quality assurance verification.

1.06 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

2.01 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.

2.02 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 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) EGS/Appleton Electric, www.appletonelec.com.
         2) EGS/O-Z/Gedney, www.o-zgedney.com.
         3) Crouse Hinds
         4) Killark
         5) Or Approved equal.
   2. For Use with Coated Conduit Systems:
      a. When boxes for use with coated conduit systems are indicated or specified, provide cast outlet boxes as specified for steel conduit systems, but having coatings as specified in Section 16131, Conduit and Tubing, for the system.
         1) Provide a 40 mils thick PVC coating conforming to the requirements of NEMA RN 1 outside, and a 2 mils thick fusion-bonded blue, red, or green urethane coating inside.
            a) Insure that the color of the PVC coating is uniform throughout the Work of this Contract.
         2) For internally threaded openings in the box, provide a 40 mil thick plastic sleeve extending one pipe diameter or 2 inches, whichever is less, beyond the openings with an inside sleeve diameter equal to the outside diameter of the conduit or pipe used.
      b. Manufacturers:

1) Thomas & Betts, Ocal®, http://www.tnb.com/contractor/docs/ocal.pdf.
2) Robroy Industries, www.robroy.com.
3) Or Approved Equal

B. Sheet Metal 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. Hoffman, Screw Cover SC Junction Boxes, www.hoffmanonline.com.
b. Rittal Corp
c. Milbank Manufacturing
d. Or Approved Equal

C. Outlet Boxes for Hazardous Locations:
1. For hazardous locations, provide junction boxes and covers that comply with the requirements of UL 886, and are sized according to the installation and NFPA 70 (NEC) requirements.
2. For suspended type or surface mounted conduit runs in hazardous locations, provide outlet boxes having a threaded cover and the proper size and number of tapped conduit hub openings.
a. Outlet Box Body:
1) Fabricate outlet box bodies from iron alloy, electrogalvanized and coated with aluminum acrylic paint.
2) Provide threaded access openings that can either accommodate threaded covers that create a seal against the hazard, or that allow the outlet box depth to be increased by using threaded extensions.
3) Provide taper-threaded hubs in the box capable of accommodating threaded rigid or IMC conduit, and having smooth integral hub bushings to protect conductor insulation during wire pulling.
4) Provide an internal ground screw.
b. Outlet Box Covers:
1) Provide copper-free aluminum threaded covers with cast “ears”, recesses, or other means to facilitate tightening and removing the cover.
a) Provide a neoprene O-ring with the cover.
2) If required, in lieu of providing standard covers provide threaded sealing covers having a removable threaded plug to allow the enclosure to be filled with sealing compound.

3) If required, in lieu of providing standard covers provide threaded covers or canopies capable of mounting pendant type lighting fixtures.

3. Manufacturers:
   a. Cooper Crouse Hinds Company, GUA and GUR Series Outlet Boxes, www.crouse-hinds.com.
   b. Or Approved Equal.

D. Pull Boxes for Hazardous Locations:
   1. For hazardous locations, provide pull boxes and covers that comply with the requirements of UL 886, and are sized according to installation and NFPA 70 (NEC) requirements.
      a. Pull Box Body:
         1) Provide copper-free aluminum or iron alloy bodies capable of being factory or field drilled and tapped for conduit entries of the proper size and number.
         2) Machine enclosures to accommodate field installed mounting plates.
         3) Provide an internal ground lug.
      b. Pull Box Cover:
         1) Provide threaded, bolted, or hinged and bolted covers, fabricated from copper-free aluminum or iron alloy, as required.
            a) Provide bolts for attaching bolted covers.
            b) Provide hinges for hinged covers.
         2) Provide a neoprene gasket with each cover.
      c. Manufacturers:
         1) Cooper Crouse Hinds Company, GUB and EJB Series Junction Boxes, www.crouse-hinds.com.
         2) Or Approved Equal.

E. 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) Hoffman, Single-Door Type 4 Enclosures or Type 12 and Type 13 Enclosures, www.hoffmanonline.com.
2) Rittal Corp
3) Milbank Manufacturing
4) Or Approved Equal

2. For outdoor locations, provide galvanized steel enclosures with covers that meet the NEMA 250 requirements for Type 3R enclosures, and as follows.
   a. Enclosure Body:
      1) Fabricate enclosures from galvanized steel sheets; and provide a drip shield on the top, and seam-free sides, fronts, and backs.
   b. Covers:
      1) Provide a removable slip-on cover with plated steel captivated screws along the bottom edge for each enclosure.
   c. Security:
      1) Provide a mechanism for padlocking the enclosure.
   d. Finish:
      1) Provide polyester powder coating applied over phosphatized surfaces.
      2) Color: ANSI Z55.1 Number 61 gray.
   e. Manufacturers:
      1) Hoffman, Screw Cover Type 3R Enclosures, www.hoffmanonline.com.
      2) Rittal Corp
      3) Milbank Manufacturing
      4) Or Approved Equal
3. For corrosive locations, provide enclosures that meet the NEMA 250 requirements for Type 4X enclosures, and as follows:
   a. Enclosure Cabinet:
      1) For wall mounted enclosures, fabricate enclosure bodies from 14 gauge Type 304 or Type 316L stainless steel sheets; and having continuously welded seams, ground smooth.
      2) For floor mounted enclosures, fabricate enclosure bodies from 12 gauge Type 304 stainless steel sheets and enclosure backs from 10 gauge Type 304 stainless steel sheets; and having continuously welded seams, ground smooth.
         a) Provide stainless steel floor stands, if required.
         b) Provide stainless steel lifting eyes.
      3) Provide a grounding stud on the enclosure body.
      4) Provide enclosures having no holes or knockouts.
   b. Enclosure Doors:
      1) For wall mounted enclosures, provide a removable hinged door fabricated from 14 gauge Type 304 or Type 316L stainless steel sheets; and having a rolled lip on three sides and a continuous stainless steel hinge with a removable hinge pin on the fourth side.
         a) Provide a stainless steel door clamp assembly that assures a watertight seal.
      2) For floor mounted enclosures, provide either doors similar to those specified for wall mounted enclosures, or 14 gauge Type 304 or Type 316L stainless steel sheets hinged doors with concealed die-cast hinges that allow 180 degree door opening and easy door removal.
      3) Provide a means of bonding on the door.
   c. Door Gasket:

1) Provide a seamless, foam-in-place, oil-resistant door gasket for each enclosure.

d. Security:
1) Provide a mechanism for padlocking the enclosure.

e. Finish:
1) Provide enclosures with unpainted, Number 4 brushed finish surfaces.

f. Manufacturers:
1) Hoffman, Type 4X Enclosures and General Purpose Two-Door Floor-Mount Type 4X Enclosures, www.hoffmanonline.com.
2) Rittal Corp
3) Milbank Manufacturing
4) Or Approved Equal

F. Ground Lug/Bus Bar:
1. Provide a copper ground lug or a 1/4-inch by 2-inch copper bus bar in large pull and junction boxes.

2.03 SOURCE QUALITY CONTROL

A. Tests:
1. Submit factory test reports to the Engineer as specified for the products in this Section.

PART 3 EXECUTION

3.01 INSTALLERS

A. Install the work of this Section only under the supervision of licensed electricians.

3.02 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.

3.03 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. Junction Boxes and Pull Boxes for Hazardous Locations:
1. Provide junction boxes rated for the hazard classification of the area where they are installed, whether explosionproof, dust-ignitionproof, raintight, wet locations, watertight, or other classification.

C. 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.

D. 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. 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.
3. Do not install flush mounting boxes back-to-back in walls.
   a. Provide a minimum separation of 6 inches (150 mm).
   b. Provide a minimum separation of 24inches (600 mm) s in acoustic rated walls.
4. When installing boxes outside or to exposed conduit in unfinished areas, provide cast boxes.
   a. 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.

E. 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 Hangars and Supports for Electrical Systems.

F. Make up all conduit connections to boxes in accordance with the requirements of Section 26 05 33.13 Conduits for Electrical Systems.

G. Install wiring in boxes in accordance with the requirements of Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.

H. Ground boxes in conformance with Section 26 05 26 Grounding and Bonding For Electrical Systems.

3.04 REPAIR/RESTORATION

A. Touch up damaged coatings on electrical boxes and enclosures.

3.05 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.
4. Record the actual installed elevations and locations of pull and junction boxes on record drawings specified in The Procurement Documents.

3.06 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.

3.07 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.

END OF SECTION

SECTION 26 05 36

CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting cable trays and fittings.
   1. Products Supplied and Installed Under This Section:
      a. Metallic cable trays, covers and fittings
      b. Bonding of cable trays

B. Related Sections:
   1. Refer to Procurement Documents
   2. Section 07 84 00 – Firestopping
   3. Section 26 05 26 – Grounding and Bonding for Electrical Systems
   4. Section 26 05 28 – Hangers and Supports for Electrical Systems
   5. Section 26 05 63 – Acceptance Testing of Electrical Systems
   6. Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables
   7. Section 26 05 33.13 – Conduits for Electrical Systems
   8. Section 26 05 33.23 – Boxes for Electrical Systems

1.02 REFERENCES

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

B. American Society for Testing Materials (ASTM):
   1. ASTM B 386 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA VE-1 Metal Cable Tray Systems
   2. NEMA VE-2 Metal Cable Tray Installation Guidelines

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

1.03 SUBMITTALS

A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Authority and the Engineer.

B. Product Data and Catalog Cuts: Provide product data for all products provided. Indicate clearly the usage of each product.

C. Shop drawings: Submit shop drawings within 60 days of contract award for approval for the following items:
   1. Overall plan of cable tray installation drawn to a scale of 1/4 inch or larger. Equipment backboards and support structures which are not fastened directly to the walls.
   2. Details of all connections to equipment enclosures, supports, and conduits.
   3. List of materials: Provide list indicating manufacturer and catalog number for all items other than standard hardware.
   4. Structural calculations: Provide structural calculations for all supports.

1.04 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. 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) unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.

C. Select manufacturers from the list of acceptable manufacturers in Part 2 or a manufacturer that is approved by the Authority's representative and that has been manufacturing similar products for over 5 years. Submit name of any manufacturer that is not listed in Part 2 for pre-approval.

D. Provide manufacturer's certification that all galvanizing and all products meet the ASTM standards specified.

E. Provide supervision of installation of cable tray by a representative of the manufacturer or a person trained by the manufacturer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver material to job-site in the original factory packaging.

B. Store all components indoors and undercover on supported ground and off the floors on blocking.

PART 2 PRODUCTS

2.01 MATERIALS

A. Support and Fasteners: Conform to Section 26 05 28.

B. Grounding: Conform to Section 26 05 26.

C. Wire and cable: Conform to Section 26 05 19.

D. Conduit: Conform to Section 26 05 33.13

2.02 METALLIC CABLE TRAY SYSTEMS - NEMA 1 AREAS

A. Acceptable Manufacturers:
   1. Provide products of a single manufacturer for metal framing systems and fittings for metal framing systems. Acceptable manufacturers:
      a. B – Line.
      b. Or Approved Equal

2.03 WIRE BASKET TRAY

A. Materials
   1. The tray shall be constructed of high strength steel rods. The tray shall be zinc plated in accordance with ASTM B 633 after fabrication.

B. Construction
   1. Cable tray shall be constructed of wire configured in a grid pattern wires welded at the intersection points. The ends of the wire mesh pattern shall be bent up to form the sides of the wire basket tray. The ends shall be trimmed at a 10 degree angle and ground to remove sharp edges.
   2. Straight sections of wire basket tray shall be provided in 3,048 mm [10 ft]. standard lengths.
   3. Basket tray shall be of sizes indicated on the drawings.

2.04 FITTINGS

A. Bolts, Nuts, and Washers: ASTM A 325 galvanized to ASTM A 153/A 153M for galvanized components.

B. Welding Materials: AWS D1.1; type required for materials being welded.

C. Shop and Touch-Up Primer: SSPC-Paint 15, Type 1, red oxide.

D. Touch-up Primer for Galvanized Surfaces: SSPC-Paint 20 Type I Inorganic zinc.

PART 3 EXECUTION

3.01 PREPARATION

A. Carefully investigate the structural and finish condition as well as other construction work, which may affect the work of this Section.

B. 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, etc.

C. Field Measurement: The Drawings are generally indicative of the work but due to their small scale it is not possible to indicate all offsets, fittings, and apparatus required nor

the minor structural obstructions that may be encountered. Make field measurements of the areas in which cable tray is to be installed.

D. Layout cable tray to suit actual field measurements and according to accepted Trade Standard Practice and NFPA 70 Articles 250, 300 and 392.

3.02 INSPECTION

A. Carefully investigate the structural and finish condition as well as other construction work, which may affect the work of this Section. 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.

3.03 INSTALLATION

A. In general, fabricate cable tray systems in accordance with accepted Trade standard practice and NEMA VE-2.

B. Firestopping of penetrations through fire rated assemblies is provided by the General Contractor as specified in Section 07 84 00 of the Contract documents.

C. Make all field cuts using power hacksaw equipped with both a table for supporting the cable tray and a means of holding the tray rigidly in place and making a clean square cut. Drill all holes using a drill press and templates to accurately locate splice plate holes. Equivalent means and methods, which produce accurate clean cuts and holes, are acceptable. Ends must be square to within 1/16-inch and holes located to within 1/32-inch of nominal. Center punch all hole locations. Use pilot holes as necessary. File off all burrs and rough edges.

D. Install all items in strict accordance with manufacturer's instructions; in conformity with any product listing and labeling restrictions and instructions; in conformity with NEMA Standard VE-2 and in accordance with NFPA Articles 250, 300 and 392.

E. Do not weaken the structure by excessive or unnecessary cutting.

F. Provide expansion plates in each straight run and at each building expansion joint. Install one or more expansion joints in each straight run. Set expansion joint openings to a position corresponding to the temperature at time of installation.

G. Make conduit drops from cable tray with approved fittings.

H. Construct in exposed work parallel and perpendicular to building lines and structure and level and plumb with right angle turns consisting of symmetrical bends or fittings, except as indicated and as follows. Construct changes in vertical elevation at 45 degrees to the horizontal and construct offsets of less than two medium radius with 30 degree or 45 degree bends. Maintain at least 6-inches clearance between cable tray runs and mechanical systems pipes, ducts, flues.

I. Provide structural supports conforming to Section 26 05 28 of adequate strength to conform to dead, live and seismic loads to be encountered.

J. Bond each cable tray end to the equipment with bonds sized as indicated in conformance with Section 26 05 26 and NFPA Article 250

K. Install wires in cable tray in conformance with Section 26 05 19 and in accordance with NFPA Articles 30, 392, and 340.

3.04 FIELD QUALITY CONTROL

A. Inspect all items for the following and correct any discrepancies.
   1. Adequacy of coating and damage to coatings. Touch up damaged coating surfaces. Use specified primer for primed steel surfaces, use zinc-rich primer for galvanized steel surfaces.
   2. Adherence to 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).

B. Test ground resistance from end to end of completed cable tray in conformance with Sections 26 05 26 and 26 05 63.

3.05 PROTECTION

A. Protect all items during work of other trades.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, and protecting identification signs and labels for electrical systems.

B. Related Section:
   1. Refer to Procurement Documents.
   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 Conduit for Electrical Systems
   5. Section 26 05 33.19 Wireways for Electrical Systems
   6. Section 26 05 33.23 Boxes for Electrical Systems
   7. Section 26 22 00 Low-Voltage Transformers
   8. Section 26 24 13 Switchboards
   9. Section 26 24 16 Panelboards
   10. Section 26 28 16.13 Low-Voltage Enclosed Switches
   11. Section 26 28 16.19 Low-Voltage Enclosed Circuit Breakers
   12. Section 26 29 13 Enclosed Controllers
   13. Section 26 32 13.13 Diesel Engine Driven Generator Sets
   14. Section 26 36 00 Transfer Switches
   15. Section 26 43 13 Surge Protective Devices for Low-Voltage Electric Power Circuits
   16. Section 27 00 00 Communications

1.02 REFERENCES

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

B. American National Standards Institute (ANSI):
   1. ANSI Z535.4, Product Safety Signs and Labels.

C. National Electrical Manufacturer's Association (NEMA):
   1. NEMA 250, Enclosures for Electrical Equipment.

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

E. U. S. Government:
   1. Code of Federal Regulations (CFR)
      a. 29 CFR 1910 Occupational Safety and Health Standards.

1.03 DEFINITIONS

A. Mimic bus refers to a graphical representation of the devices and bus work within an item of electric equipment.

1.04 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of the Procurement Documents and Section 26 05 00:
   1. Product Data:
      a. Provide catalog cuts for the actual products provided, and indicate clearly the usage of each product.
   2. Shop Drawings:
      a. Provide a schedule depicting all nametag legends.
      b. Provide drawings of typical nametags.

1.05 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. Regulatory Requirements:
   1. Comply with the all applicable requirements of OSHA, but particularly those stated in 29 CFR 1910.144 and 29 CFR 1910.145.
   2. Comply with the requirements of NFPA 70E that are applicable to electrical identification items as listed below in this Specification Section.

1.06 DELIVERY, STORAGE AND HANDLING

A. Protect items from damage during delivery, storage, and handling in accordance with Section 26 05 00 and as detailed below.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide products meeting the specified requirements from one of the following manufacturers, unless otherwise indicated:
   1. Brady Worldwide, Inc., P. O. Box 2131, Milwaukee, WI 53201-2131, Telephone (414) 358-6600.
   2. Seton Identification Products, 20 Thompson Road, P. O. Box 819, Branford, CT 06405-0819, Telephone (800) 243-6624..

3. LEM Products, Inc.; P. O. Box 190, 4089 Landisville Road, Doylestown, PA 18901, Telephone (800) 220-2400 or (215) 348-9900.

B. To serve as examples of the quality required of the specified products, several Brady Worldwide, Inc. Product Numbers are listed for informational purposes only.

2.02 MATERIALS

A. Laminated Phenolic or Plastic:
   1. Provide rigid, thermosetting resin or polymer material that is heat- and fire-resistant, abrasion resistant, electronically non-conductive, and non-corroding.
   2. Extrude the thermosetting resin or polymer into sheets, and laminate the sheets together so that colored top and bottom layers sandwich a contrasting color core in the middle.

B. Mounting Hardware:
   1. Provide number10 hex-head machine screws and lock-washers, or hex-head bolts, lock-washers, and nuts for mounting identification nameplates onto electrical equipment.
   2. Provide either type 316 stainless steel or brass fasteners; however, all fasteners used on the same nameplate must be of the same material.

2.03 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Provide laminated phenolic or plastic equipment identification nameplates having beveled edges and engraved lettering.
   1. Drill holes for mounting hardware in the equipment identification nameplates as follows:
      a. For nameplates that are more then 2 inches wide, drill four holes.
      b. For nameplates that are more than 1-1/2 inches high, drill four mounting holes.
      c. For smaller nameplates, drill holes for two fasteners.
   2. Provide equipment identification nameplates long enough to ensure that the heads of fastening hardware do not extend beyond the nameplate material, and come no closer than 1/16-inch to the nearest letter of the nameplate legend and no closer than 1/16-inch to the nearest edge.

B. Engrave the following information on each equipment identification nameplate, similar to that shown in Examples 1 and 2 below except appropriate for the specific equipment being identified:
   1. In the first line, indicate the equipment type and identification number.
   2. In the second line, indicate the equipment Voltage, the equipment current if known, the phase, and the number of wires.
      a. If the current is listed, provide a description that further identifies the current, such as “overload protection current”, full load amps (FLA), or other information identifying the current indicated.
   3. In the third line, indicate the words “SERVED FROM” followed by the serving equipment and the branch circuit.
      a. If multiple sources serve the equipment, list all sources on succeeding lines.

EXAMPLE 1:

POWER PANELBOARD PPB-2
208/120 VOLTS, 10.8 FLA, 3-PHASE, 4-WIRE
SERVED FROM
PPB-1, CIRCUITS F1 THROUGH T1

b. If the equipment is supplied through automatic transfer switches and transformers or other items without disconnects, include data on all upstream disconnects; and beneath the sources add the word “THROUGH” followed by the name of the equipment that the sources are connected through.

EXAMPLE 2:

POWER PANELBOARD PPB-2
208/120 VOLTS, 3-PHASE, 4-WIRE
SERVED FROM
BOTH EGS-2 AND MCC-1
THROUGH ATS-1

4. For motor starters, circuit breakers, transformers, and disconnect switches, provide an additional line with the word “SERVES” and the equipment served.

C. Engrave equipment identification nameplates with all capital, Helvetica Medium font, or equal, lettering.
   1. Provide white nameplate lettering centered on black backgrounds, except for warning nameplates provide white lettering centered on red backgrounds.
   2. Provide a minimum 1/8-inch border between the nameplate lettering and the tops and bottoms of the nameplates.
   3. Use 3/8-inch high letters for the first line, and 1/4-inch letters for succeeding lines; except, in cases where the tag will not fit because the equipment is too small, use 3/16-inch letters for the first line and 1/8-inch letters for succeeding lines.

2.04 CONDUIT AND RACEWAY LABELS

A. Conduit Voltage Markers:
   1. Provide conduit markers consisting of polymer-coated cloth tape with a printable top coat and a rubber based pressure sensitive adhesive on the back to provide oil and water resistance, good print durability, and the flexibility to allow it to be wrapped around curved surfaces.
   2. Clearly mark the voltages in black lettering on orange colored tape backgrounds.

B. Conduit Wiring System Identification:

1. Provide companion type labeling markers to indicate the wiring system in each raceway and consisting of a vinyl film substrate with a pressure sensitive acrylic adhesive backing.
2. Clearly mark the wiring systems in black lettering on orange colored tape backgrounds.
3. To properly identify each electrical system in the raceway, provide the following, or similar, wording on the labeling markers corresponding to the systems:
    a. For electrical power systems, word the labels "POWER".
    b. For control systems, word the labels "CONTROL".
    c. For telephone systems, word the labels "TELEPHONE"
    d. For local area networks, word the labels "LAN".

C. Conduit Feeder Identification:
1. Provide conduit feeder identification markers consisting of polymer-coated cloth tape with a printable top coat and a rubber based pressure sensitive adhesive on the back to provide oil and water resistance, good print durability, and the flexibility to allow it to be wrapped around curved surfaces.
2. Provide conduit feeder identification labels that identify the feeder circuit with 3/4-inch high black lettering on yellow backgrounds.

D. Conduit and Raceway Label Dimensions:
1. Provide label color field lengths and lettering height as indicated in Table 26 05 53 - 1:

Table 26 05 53 - 1 Conduit and Raceway Label Sizes

Raceway Outside Diameter (Inches)	Background Length (Inches)	Lettering Height (Inches)
3/4 to 2	7	1
1-1/2 to 2	7	1
2-1/2 to 6	14	1-1/4

E. Product Examples:
1. Conduit Voltage Markers: Brady Worldwide, Inc., B-946 custom self-sticking pipe markers or color code tape.
2. Conduit Wiring System: Brady Worldwide, Inc., B-946 custom self-sticking pipe markers or color code tape.
3. Conduit Feeder Identification: Brady Worldwide, Inc., Product Number 31964.

2.05 ARC-FLASH WARNING LABELS:

A. Arc Flash Warning Labels shall be prepared in accordance with NFPA 70, NFPA 70E, IEEE-1584 latest editions and ANSI Z535.
1. Minimum label size shall be 4" x 6" as provided by Duralabel or Brady with applicable header information identifying both warning and danger based upon the findings.
2. Minimum information to be included on the Arc Flash label shall consist of the following:
    a. Prefaced electrical warning including universal symbol identification, approved safety color, and preface description noting that arc and shock hazard are present. Note where dual labeling is provided/required with the

use of arc flash reduction maintenance settings within the equipment, such labels shall be uniquely identified by a different label safety color l, as approved by the Authority. Consult the Authority for acceptable color schemes to be used for the equipment.

b. Statement noting that personnel protective equipment (PPE) requirements are required. Also clearly identify all equipment as “Dangerous” where work on energized equipment is otherwise prohibited and/or where no safe PPE protection so exists.
c. Calculated arc flash hazard boundary, in inches.
d. Calculated arc flash hazard at 18 inches, in calories/cm^2.
e. Arc flash hazard risk category, including descriptive summary of required PPE items necessary for entry into energized equipment.
f. Voltage classification and description of conditions present for shock hazard.
g. Insulated glove classification rating, as required for contact conditions and measurements.
h. Limited approach boundary, in inches.
i. Restricted approach boundary, in inches.
j. Prohibited approach boundary, in inches.
k. Unique equipment locator identification, corresponding to applicable one-line diagram and ESOD as specified in Section 26 05 00 device abbreviation identifiers.
l. Name, address & phone number of the responsible engineer, engineering company or agency contracted to perform the analysis. Also include the preparer’s name, where prepared by a subcontract to the named company or agency contracted to perform the analysis report.
m. Respective contract (job) number for the analysis report.
n. Preparation date of the issued/approved Arc Flash Study (analysis) supporting the equipment labeling, as installed.
o. Suffix cautionary warning that “Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements.”

2.06 DANGER WARNING LABELS:

A. Provide danger signage in accordance with the requirements of 29 CFR 1910.145 and NFPA 70E.
   1. For enclosures, provide signs with the caption “DANGER HIGH VOLTAGE KEEP OUT”
   2. For fences, provide signs similar to the signs for enclosures, except provide dual language sign captions in both Spanish and English and add Mister Ouch symbols.
   3. For poles, provide dual language signs similar to the signs for fences, except add the words “KEEP OFF”.

B. Product Examples:
   1. Enclosure danger signs: Brady Worldwide, Inc Product Number 84083.
   2. Fence Danger signs: Brady Worldwide, Inc Product Number 69737.
   3. Pole danger signs: Brady Worldwide, Inc Custom markers.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installing electrical identification items, verify with the Engineer that the data on each is correct.

3.02 INSTALLATION

A. Wiring Identification:
   1. Identify wiring in conformance with the requirements of Section 26 05 19.

B. Conduit and Raceway Identification:
   1. Identify the wiring systems in conduit and raceway by providing companion type labeling markers to indicate the systems in each.
   2. Identify the Voltages carried in conduit and raceway by providing voltage labeling markers on all accessible raceways.
   3. Identify feeders by providing identification labels.

C. Electrical Box Identification:
   1. For each wiring device box, outlet box, pull box, and junction box, if it is not otherwise indicated, install a laminated phenolic identification nameplate with 1/8-inch white letters on a black background above or next to the box identifying its source of power; for example, indicate the panelboard and circuit number supplying power to a box with an identification nameplate.
   2. For above ground wiring device boxes, outlets boxes, pull boxes, and junction boxes, install nameplates adjacent to or above the item in a visible location.
      a. For NEMA 1 and 12 enclosures constructed as specified in NEMA 250, fasten the nameplate to the enclosure using 316 stainless steel screws or an approved equal.
      b. For other than NEMA 1 and 12 enclosures, fasten the nameplate to the enclosure using Seton number15660 adhesive or an approved equal.
   3. For in-ground pull boxes and junction boxes, install nameplates adjacent to or above the item in a visible location and inside the box immediately below the cover.
      a. For NEMA 1 and 12 enclosures constructed as specified in NEMA 250, fasten the nameplate to the enclosure using 316 stainless steel screws or an approved equal.
      b. For other than NEMA 1 and 12 enclosures, fasten the nameplate to the enclosure using Seton number 15660 adhesive or an approved equal.

D. Electrical Equipment Identification:
   1. Provide identification nameplates on the front of the following electrical equipment:
      a. Diesel electric generators, as specified in Section 26 32 13.13.
      b. Surge Protective Devices (SPD), as specified in Section 26 43 13.
      c. Enclosed circuit breakers as specified in Section 26 28 16.19.
      d. Low-voltage enclosed switches as specified in Section 26 28 16.13.
      e. Low-voltage enclosed transfer switches as specified in Section 26 36 00.

f. Low-voltage motor starter switches and controllers as specified in Section 26 29 13.
g. Low-voltage enclosed lighting contactors as specified in Section 26 50 00.
h. AC distribution switchboards as specified in Section 26 24 13.
i. Panelboards as specified in Section 26 24 16.
j. Low-voltage transformers as specified in Section 26 22 00.

2. Install nameplates in the top center of the front face of the electrical equipment in a visible location.
   a. For NEMA 1 and NEMA 12 enclosures constructed as specified in NEMA 250, fasten the nameplate to the enclosure using 316 stainless steel screws or an approved equal.
   b. For other than NEMA 1 and 12 enclosures, fasten the nameplate to the enclosure using Seton number 15660 adhesive or an approved equal.

E. Arc-Flash Warning Signage:
1. For each arc location or circuit analyzed as part of the Arc Flash Study in Section 26 05 00, provide Arc Flash Warning labels.

F. High Voltage Warning Signage:
1. Install high voltage warning signage on all personnel entry points to electrical rooms or fenced electrical areas, and on all equipment enclosures within those spaces.
   a. Install high voltage warning signage on all fence gates and every 10 feet on the perimeter fence around electrical areas.
   b. Install high voltage warning signage on both sides of all electrical poles.

END OF SECTION

SECTION 26 05 63

ACCEPTANCE OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of materials to performance test electrical systems and equipment.
   1. Items Supplied Under This Section:
      a. Electrical System Testing
      b. Thermographic Testing
      c. Ground System Testing
      d. Insulation Testing
      e. Equipment Testing
      f. Performance Test
      g. Test Procedure
      h. Test Report

B. Related Sections:
   1. Refer to Procurement Documents.
   2. Division 26 Sections, As Applicable

1.02 REFERENCES

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

B. Applicable Documents and Testing Requirements of:
   1. America National Standards Institute (ANSI): as applicable, including:
      a. ANSI C2, National Electrical Safety Code.
      b. ANSI Z244.1 American National Standards for Personnel Protection.
   2. National Electrical Manufacturer's Association (NEMA): as applicable, including:
      a. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
      b. NEMA ICS 7.1 - Safety Standards for Construction and Guide for selection, Installation, and Operation of Adjustable Speed Drive Systems.
      c. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
      d. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
   3. American Society for Testing and Materials (ASTM), as applicable.
   4. Institute of Electrical and Electronics Engineers (IEEE), as applicable, including:
      a. IEEE C.57.13, IEEE Standard Requirements for Instrument Transformers.
   5. National Fire Protection Association (NFPA), as applicable, including:
      a. NFPA 70 - National Electrical Code (NEC).

b. NFPA 70E - Electrical Safety Requirements for Employee Workplaces.
c. NFPA 72 - National Fire Alarm Code (NFAC).

6. International Electrical Testing Association (IETA) as applicable, including:
   a. Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
7. Insulated Cable Engineer's Association (ICEA), as applicable.
8. State and Local Codes and Ordinances as applicable, including:
   a. Fire and Panic Regulations, Commonwealth of Pennsylvania Code, Title 34, Labor & Industry, Chapters 49 to 59.
9. Local Utility Codes and Ordinances.
10. Occupational Safety and Health Administration (OSHA), as applicable, including:
11. Title 29, Parts 1907, 1910 and 1936.
12. International Electrical Testing Association (NETA) as applicable, including:
    a. ATS: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
    b. MTS: Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems.

1.03 SUBMITTALS

A. Submit documentation as required by this Section of the Contract to the Design Engineer in strict accordance with the provisions of Section 26 05 00 for review, comments and subsequent approval.

B. Submission to include the following:
1. Field inspection report as required for each item of material and/or equipment outlined herein.
2. Manufacturer's directions for use of ground megger with proposed method indicated.

C. Test Reports:
1. Each test report prepared by the respective testing firm(s) comply, where applicable, to all stipulations specified in Section 26 05 00 for Operation, Maintenance and Installation Manuals with reference to preparation, paper requirements, indexing and binders. Include in each test report the following:
   a. Summary of project.
   b. Description of equipment tested.
   c. Description of test.
   d. Test results.
   e. Conclusions and recommendations.
   f. Appendix, including appropriate test forms.
   g. Identification of test equipment used.
   h. Signature of responsible test organization authority.
   i. Furnish five copies of each completed report to the Design Electrical Engineer no later than 30 days after completion of each test. Assemble and certify the testing firm each final test report, which must be submitted to the Design Engineer for review, comments and subsequent approval.

1.04 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. Qualifications of Testing Laboratory: Select an independent nationally recognized testing laboratory that is independent from electrical contractor that either is a member of The International Electrical Testing Association or meets the following qualifications:
   1. Is nationally recognized as an electrical testing laboratory.
   2. Has been regularly engaged in the testing of electrical systems and equipment for at least 5 years.
   3. Is independent from the electrical contractor, the Authority, the Engineer and all other contractors on the job.
   4. Has at least one Professional Engineer on staff that is licensed in the State where the project site is located.
   5. Derives more than 80 percent of its income from electrical testing.
   6. Owns or leases sufficient calibrated equipment to do the testing required.
   7. Has a means to trace all test instrument calibration to The National Bureau of Standards.

C. Membership in the International Electrical Testing Association (NETA) shall be considered evidence of meeting items B.1 through and including B.5

D. Testing shall be done under the supervision of a technician certified by International Electrical Testing Association or by technicians that are both certified by the National Society of Professional Engineers and experienced in electrical testing with 5 years of testing experience.

E. The testing laboratory shall supervise or perform all testing of equipment and oversee setting of all circuit breakers and calibration of all instruments.

F. The testing firm used must be approved by the Engineer.

G. Include the cost of such tests in the Contractors Bid Price for the applicable bid item.

1.05 GENERAL REQUIREMENTS

A. Refer to Procurement Documents.

B. Field Inspection:
   1. This Contractor is responsible for a complete inspection of all equipment, prior to testing and energizing to ascertain that it is free from any damage, scratches, or missing components and that all power connections are correct, and that they are tight in conformance with recommended standard practice. The inspection is to also include a check of control wiring, terminal connections and all bolts and nuts.

2. Perform field inspection by this Contractor during a time when the Field Engineer and the Design Engineer are present to witness each inspection and its performance.
3. Correct any deficiencies found during the inspection by this Contractor prior to the energizing and testing of the equipment.

1.06 SCHEDULING

A. Schedule all testing with work of other contractors to ensure an orderly sequence of startup and completion of work.

1.07 UNDERGROUND CONDUIT SYSTEM INSPECTION

A. General Requirements (Refer to Procurement Documents): Perform inspection of the underground conduit systems installation by a representative of the Engineer as the work progresses. Inspect each of the following prior to proceeding to the next phase of the installation.
1. Trench bed.
2. Lower sand bed.
3. Lower concrete protection slab, where indicated or required.
4. Upper sand bed for conduits.
5. Each layer of conduits.
6. Soil backfill.
7. Warning Tape.
8. Soil backfill.

B. Failure to comply with any of the above, indicated sequential inspection requirements is just cause for the Engineer to request removal of the work and reinstall as per these specifications.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 ELECTRICAL INSPECTIONS AND TESTS

A. Perform, supervise, and furnish all test equipment needed to perform tests and provide safety measures, procedures and equipment required for each test.

B. Schedule all testing with the Engineer. Perform testing in the presence of the Engineer except when the Engineer approves in writing conducting a specific test without the Engineer's presence.

C. Notify all involved parties including the Engineer prior to tests, advising them of the test to be performed and the scheduled date and time.

D. Coordinate the tests with others involved.

E. Prepare written test procedures and forms used in the test reports and submit for approval prior to commencement of testing.

F. Include in each test report the following information:
1. Job title.
2. Date of test.
3. Equipment, system or cable identification.
4. Type of test.
5. Description of test instrument and date of latest calibration.
6. Section of specification defining test along with description of test and evaluations as reported by the testing company.
7. Test results (correct all readings at 20 degrees C).
8. Signature of person supervising test.
9. Signature of Contractor.
10. Space for Engineer's signature.

G. Refer to individual tests and inspections hereinafter specified for any additional or specified requirements.

H. Test Instrument Calibration:
1. The testing firm is to have a calibration program, which assures that all applicable test instrumentation are maintained within rated accuracy.
2. The accuracy is to be directly traceable to the National Bureau of Standards.
3. Instruments are to be calibrated in accordance with the following frequency schedule.
   a. Field Instruments: Analog - 6 months maximum
Digital - 12 months maximum
   b. Laboratory Instruments: 12 months
   c. Leased specialty equipment: 12 months
4. Make dated calibration labels visible on all test equipment.
5. Keep records up-to-date, which show date and results of instruments calibrated or tested.
6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.
7. Calibrating standard is to be of higher accuracy than that of the instrument tested.

I. Safety and Precautions:
1. Safety practices are to include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act of 1970-OSHA.
   b. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4.
   c. Applicable State and Local safety operating procedures.
   d. IETA Safety/Accident Prevention Program.
   e. Authority's safety practices.
   f. National Fire Protection Association - NFPA 70E.
   g. ANSI Z244.1 American National Standards for Personnel Protection.
2. Perform all tests with apparatus de-energized except where otherwise specifically required.

3. The testing firm is to have a designated safety representative on the project to supervise operations with respect to safety.

3.02 TESTING TO BE PERFORMED BY THE CONTRACTOR

A. Continuity Test: Make test for continuity and correctness of wiring and identification on all conductors installed.

B. Wire and Cable:
1. Test all wires and cables sized No. 2 and larger in accordance with NETA ATS, paragraph 7.3.1.1 and 7.3.1.2.
2. Perform visual, mechanical, and electrical tests on all No. 4 and No. 6 power cables that operate at voltages exceeding 150 volts to ground in accordance with NETA ATS, paragraph 7.3.1.1 and 7.3.1.2.
3. Perform visual, mechanical, and electrical tests on all other wires and cables in accordance with NETA ATS, paragraph 7.3.1.1.
4. Replace any wires which have been damaged.
5. Correct causes of all readings which do not meet the acceptable minimum insulation readings are as stated in NETA ATS, paragraph 7.3.1.3. Exceed the nominal expected temperatures for the actual load.
6. Retest items requiring correction.

C. Surge Protective Device (SPD):
1. Visually and mechanically inspect the SPD unit and connections.
2. Use an AC voltmeter to check all voltages and ensure that normal operating voltages of the power system match the voltage rating on the SPD nameplate.
3. Check LED status indicators on the display panels and suppression modules to confirm normal status.
4. Press the alarm test button to confirm the audible alarm and LED.
5. Operate the alarm silence switch to confirm proper operation.

D. Ground Fault Circuit Interrupter (GFCI) Receptacles:
1. Test all GFCI receptacles as specified in Section 26 27 26.

E. Initial Mechanical Performance Test
1. Provide on-site electricians and support to the general contractor during the mechanical performance test.
2. With the personnel of the Authority observing, demonstrate to the satisfaction of the Engineer the mechanical performance of each item of equipment when operated in accordance with the design intent indicated by the Drawings and described in the applicable sections of the Specifications.
3. Correct all deficiencies and demonstrate that they have been corrected.
4. Without reliance on Authority's personnel, operate and maintain the equipment in continuous, day to day, 24 hour operation until commencement of the Final Mechanical Performance Test.
5. During this interim, instruct and train the Authority's personnel in their duties.
6. Final Mechanical Performance Test: During a 48-hour period.
    a. With equipment in continuous normal operation, under supervision turn operation of the plant over to the personnel of the Authority beginning with the final tests.

b. Demonstrate that equipment is coordinated and that installation complies with the applicable Drawings and Specifications.
c. Measure all major feeders, the total power, total power factor, current on all lines, and voltage, phase and phase to ground, and on all phases.
d. Measure all motors over 5 horsepower, power, power factor and voltage under load.
e. Correct all deficiencies and demonstrate that they have been corrected.
f. Authority will pay operating costs for the Final Mechanical Performance Tests.
g. Test will be considered complete after a continuous 48-hours of satisfactory operation without any failure of equipment.

F. Test Interim:
1. Contractor's Personnel, without reliance of Authority's Personnel, are to operate and maintain the equipment in continuous, day to day, 24 hour operation except as otherwise approved by the Engineer until commencement of the Final Mechanical Performance Test.
2. During this interim the Contractor's Personnel are to instruct and train the Authority's Personnel in their duties.

G. Final Mechanical Performance Test: Final Mechanical Performance Test is to cover a 48 hour period while the plant is in continuous, normal operation.
1. With equipment in continuous, normal operation, the Personnel of the Authority are to assume day to day operation of the equipment under the direct supervision of the Contractor's Personnel beginning with the Final Tests.
2. Contractor's Personnel are to demonstrate to the satisfaction of the Engineer that equipment is coordinated and that installation complies with the applicable Drawings and Specifications.
3. Performance Tests are to be considered concluded at the end of the forty-eight hour period designated for the tests if the Engineer is satisfied with the test results or should deficiencies be found as a result of said test, then when the deficiencies have been corrected to the satisfaction of the Engineer.

H. Operating Costs: Costs for Final Mechanical Performance Tests: The Authority will pay operating costs for the Final Mechanical Performance Tests except those costs for chemicals required to complete Process Performance Tests and Acceptance Tests, if required on equipment.

3.03 TESTING TO BE PERFORMED BY THE TESTING LABORATORY

A. Select, hire and pay an independent nationally recognized electrical testing laboratory to perform all testing specified in this article. Obtain Authority’s approval of the testing laboratory and the testing laboratory proposed test procedure prior to commencement of any tests.

B. Set all adjustments for all overcurrent protection devices in accordance with the protection and coordination study of Section 26 05 00.

C. Visually and mechanically inspect and electrically test items as scheduled in attached schedule for equipment in attached schedule equipment as listed in

attached schedule in using the procedures of NETA ATS. When a test for a particular item is not called out in ATS, test using the procedures in NETA MTS.

D. Thermographic Inspection:

1. Perform thermographic inspection of the electrical equipment and installations as listed below in accordance with NETA ATS section 9, and as detailed below. The following equipment is to be scanned:

a.	Switchboards	all ratings
b.	Distribution Panelboards	50-Ampere and larger
c.	Lighting Panelboards	50-Ampere and larger
d.	Power Panelboards	50-Ampere and larger
e.	Dry Type Transformers	10 kVA and Larger
f.	Individually Mounted Circuit Breakers	100 amp and larger
g.	Disconnect Switches	100 amp and larger
h.	Individually Mounted Motor Starters	Size 1 and larger
i.	Motors	30 HP and larger

2. Provide report including the following items:
   a. Items scanned
   b. Whether item passed or failed
   c. All items in NETA ATS, Paragraph 9.3
   d. The probable cause
   e. Severity of defect
   f. Recommended corrective measures
   g. Video recording of test.
3. Scan using an infrared camera with video scanner output to a display screen with a range of at least 1 degree C to 75 degrees C with an accuracy of 0.1 degree C and with the following equipment:
   a. One 7 degree telephoto lens
   b. One 20 degree wide angle lens
   c. One 40 degree extra-wide angle lens
4. Record output of camera during testing onto a DVD or store digital images of each piece of equipment inspected onto a CD as a record of the temperature variations. Record either by order or by digital imprinting the actual equipment being scanned. Turn off recordings during inactive periods or edit DVD to eliminate dead periods.
5. Display data on a monitor capable of providing both a gray step mode and color monitor. These capabilities allow distinct temperature levels to be shown in black and white and color on the thermogram.
6. Submit three copies of report and two copies of the DVD or CD.
7. Include DVD or CD of thermographs of the defective equipment and installations. Also include in report.
8. Submit both copies of the report to the Engineer who will make the determination of corrective measurements.

E. Lighting Tests

1. Emergency, standby, equipment and lighting test-trip all incoming utility power and ascertain that all standby and emergency equipment operates. Additionally measure lighting levels on all egress paths, at each stair landing at middle of stairs, at changes in direction at doorways and every 25’ along path. Replace and correct defective equipment. However report lighting levels to engineer.

Correction of low lighting levels will be by change order as needed. Operate battery systems for emergency lighting without power for 90 minutes and correct all defects and retest.

F. Low Voltage Molded Case Circuit Breaker Tests:
1. Visually and mechanically inspect and electrically test all low voltage circuit breakers in frame sizes rated 100-amperes or more in accordance with NETA ATS.
2. Acceptable values are as stated in NETA ATS.

G. Instrument Transformer Tests:
1. Visually and mechanically inspect and electrically test all instrument transformers in accordance with NETA ATS.
2. Acceptable values are as stated in NETA ATS.

H. Metering Tests:
1. Visually and mechanically inspect and electrically test all meters using standards traceable to the National Bureau of Standards in accordance with NETA ATS.
2. Acceptable values are as stated in NETA ATS.
3. Meters should be accurate to within their stated calibration.

I. Grounding Electrode System Tests:
1. Visually and mechanically inspect and electrically test all made grounding electrode systems in accordance with NETA ATS. For the point-to-point tests of NETA ATS, measurements are only required for equipment conductors run with services, and feeders and branch circuits rated over 400 amperes.
2. Determine acceptable values as follows:
   a. Main service entrance ground: 5 ohms.
   b. Emergency/standby generator ground grid: 5 ohms.
   c. Panelboards ground bus: 10 ohms.
   d. Manhole ground rod electrodes: 25 ohms
   e. Prior to the electric service being energized and prior to the installed products being covered, measure the ground system resistance to earth in the presence of the Engineer.
   f. Grounds not otherwise covered in this Specification with a maximum of 25 ohms.
   g. For continuity tests, determine the acceptable value for the equipment grounding conductor by the following formula:

$$R_{EquipGndCond} \leq 0.1x \frac{V_{LineToGnd}}{I_{OverCurrentProtection}}$$

Where the following definitions apply:

$R_{equipGndCond}$ = The measured resistance of the Equipment Grounding Conductor.

$V_{linetoGnd}$ = The Nominal Line to Ground Voltage of the circuit or feeder.

$I_{overcurrentprotection}$ = The Trip, or Melting Current of the overcurrent protective device for the circuit.

J. Low Voltage Switchboard Tests:
1. Visually and mechanically inspect and electrically test all low voltage switchboards in accordance with NETA ATS NETA ATS.
2. Acceptable values are as stated in NETA ATS.
3. Test all components as specified in this Section.

K. Dry-Type Transformers Tests:
1. Visually and mechanically inspect and electrically test low voltage dry-type transformers in sizes rated over 7.5 kVA, 3-phase and rated less than 500 kVA, 3-phase in accordance with NETA ATS.
2. Acceptable test values are as stated in NETA ATS.

L. Ground Fault Protection Testing:
1. Visually and mechanically inspect and electrically test all ground fault protection systems in accordance with NETA ATS.
2. Acceptable values are as stated in NETA ATS.

M. AC Motor Testing:
1. Visually and mechanically inspect and electrically test all AC motors rated 10-horsepower or more in accordance with NETA ATS.
2. Acceptable values are as stated in NETA ATS.
3. Immediately report all motors, which fail inspection to the Engineer for correction.

N. Low Voltage Motor Starter Tests:
1. Visually and mechanically inspect and electrically test all low voltage motor starters rated 10-horsepower or more in accordance with NETA ATS.
2. Acceptable values are as stated in NETA ATS.

O. Voltage Adjustment:
1. Measure the plant voltage with the plant operated at both no load and at nominal load at the following locations.
    a. Main Distribution Switchboard.
    b. Each panelboard bus.
2. Adjust all transformer taps to bring the no-load voltage above nominal, but in no case, higher than 105.8% of nominal. Adjust the operated loaded voltage to a value above 91.7%, (ANSI Range A), with only momentary excursions to a maximum of 105.8% and a minimum of 88.3% for all loads and 86.7% for motor loads. (ANSI Range B).
3. After all adjustments have been made, re-measure all voltages.
4. For record purposes measure and record on all 3-phases, actual plant load at all switchboard and panelboard buses.
5. With a minimum/maximum recording voltmeter measure starting voltage dip for the largest motor at:
    a. Starter terminals.
    b. Panelboard.
    c. Main Distribution Switchboard.

6. Measure minimum/maximum/average voltage at Main Distribution Switchboard over a 24 hour period with the plant running on at least one phase with recording voltmeter.

P. Harmonic Testing
1. Conduct harmonic testing at:
   a. Main Distribution Switchboard.
   b. Points of Common Coupling (PCC). PCC defined as nearest switchboard or panelboard which directly serves each variable frequency drive.
   c. Generator terminals.
   d. Transformer primary terminals.
2. Measure and record the following data at each location where harmonic testing is required:
   a. Current Distortion: Total harmonic distortion (THD) and individual harmonic components up to and including the 35th harmonic.
   b. Voltage Distortion: Total harmonic distortion (THD) and individual harmonic components up to and including the 35th harmonic.
   c. Voltage Notching: Notch area (volt-microseconds) and depth (volts).
   d. For record purposes measure and record on all 3-phases, actual plant load at all switchboard and panelboard buses.
3. Conduct harmonic testing with harmonic producing loads in operation. Record the following information for variable frequency drives, taken at the time harmonic distortion measurements are made:
   a. Output frequency.
   b. Output current.
   c. Output voltage.
   d. Output power factor when motor metering includes this capability.
4. Conduct harmonic testing with variable frequency drives operating at full load and half load.
5. Test report shall include the following calculated values at each location where harmonic testing is required:
   a. Total demand distortion (TDD).
   b. Individual harmonic current distortion in percent of the maximum demand load current up to and including the 35^{th} harmonic.

3.04 TESTING TO BE PERFORMED BY MANUFACTURER'S REPRESENTATIVE

A. Emergency Generator Tests:
1. On completion of the installation, the initial start-up shall be performed by a factory-trained representative of the generator supplier. Two copies of operating and maintenance instruction books shall be supplied for the test of the generator set and such auxiliary equipment as may require same.
2. Provide equipment manufacturer's certification that the power generation equipment is installed, inspected, tested, adjusted and approved satisfactory by equipment manufacturer's service engineer.
3. Provide lubricating oils, lubrication, coolant water treatment and anti-freeze solution, Prestone or as approved, to -30 degrees F. (1 degree C.) fuel, electrical instruments, portable load bank, etc., as required for tests. Load bank shall be similar to those manufactured by Avtron Manufacturing Inc., Cleveland, Ohio.

4. With Authority's operating personnel observing, demonstrate to the satisfaction of the Engineer the mechanical performance of power generation equipment, when operated in accordance with design intent of the Drawings and Specifications, and when tested with a portable load bank as follows:
    a. Start and idle for ten minutes.
    b. Operate generator set at 25 percent rated load for 10 minutes.
    c. Operate generator set at 50 percent rated load for 30 minutes.
    d. Operate generator set at 75 percent rated load for 30 minutes.
    e. Operate generator set at 100 percent rated load for three hours.
5. Record voltage, frequency, load current, oil pressure and coolant temperature at periodic intervals during test.
6. Prior to acceptance, any defects, which become evident during this test shall be corrected by this Contractor at no additional cost to the Authority.
7. After acceptance of performance test:
    a. Change oil, oil filters and fuel filters.
    b. Fill fuel tanks.
    c. Provide one complete spare set of filters and related gaskets as specified hereinbefore.
    d. Instruct Authority's personnel regarding equipment operation and maintenance procedures.
8. Furnish copies of complete lists of spare parts and special tools recommended for 2 years of normal operation of the complete system including the manufacturer's name, addresses, catalog numbers and prices.

B. Automatic Transfer Switch Tests:
1. On completion of the installation, the initial start-up shall be performed by a factory-trained representative of the generator supplier. Two copies of operating and maintenance instruction books shall be supplied for the test of the automatic transfer switches.
2. Provide equipment manufacturer's certification that the automatic transfer switch equipment is installed, inspected, tested, adjusted and approved satisfactory by equipment manufacturer's service engineer.
3. Visually and mechanically inspect and electrically test automatic transfer switches in accordance with NETA ATS.
4. Acceptable values are as stated in NETA ATS.
5. Instruct Authority's personnel regarding equipment operation and maintenance procedures.
6. Furnish copies of complete lists of spare parts and special tools recommended for 2 years of normal operation of the complete system including the manufacturer's name, addresses, catalog numbers and prices.

C. AC Variable Frequency Drive (VFD) Tests:
1. On completion of the installation, the initial start-up shall be performed by a factory-trained representative of the AC drive manufacturer. Two copies of operating and maintenance instruction books shall be supplied for the test of the AC drives.
2. Provide equipment manufacturer's certification that the AC drives are installed, inspected, tested, adjusted and approved satisfactory by equipment manufacturer's service engineer.

3. Instruct Authority's personnel regarding equipment operation and maintenance procedures.
4. Furnish copies of complete lists of spare parts and special tools recommended for 2 years of normal operation of the complete system including the manufacturer's name, addresses, catalog numbers and prices.

D. Furnish copies of complete lists of spare parts and special tools recommended for 2 years of normal operation of the complete system including the manufacturer's name, addresses, catalog numbers and prices.

3.05 CORRECTION OF DEFICIENCIES

A. Report all unacceptable values immediately. Correct all deficiencies found in work of this contract and separately report deficiencies in work of items of other contracts.
1. Retest items requiring correction. Correct or have corrected any remaining deficiencies and retest until work is acceptable.

END OF SECTION

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting transformers.

B. Related Section:

1.	Section 26 05 00	Common Work Results for Electrical
2.	Section 26 05 26	Grounding and Bonding for Electrical Systems
3.	Section 26 05 63	Acceptance of Electrical Systems
4.	Section 26 05 33.13	Conduits for Electrical Systems

1.02 REFERENCES

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

B. Institute of Electrical And Electronic Engineers/American National Standards Institute (IEEE/ANSI):

1.	IEEE/ANSI C57.12.01	General Requirements for Dry-type Distribution and Power Transformers.
2.	IEEE/ANSI C57.12.59	Guide for Dry-type Transformer Through-Fault Current Duration.
3.	IEEE/ANSI C57.12.70	Terminal Markings and Connections for Power and Distribution Transformers.
4.	IEEE/ANSI C57.12.80	Standard Terminology for Power and Distribution Transformers.
5.	IEEE/ANSI C57.12.91	Test Code for Power and Distribution Transformers.
6.	IEEE/ANSI C57.94	Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers.
7.	IEEE/ANSI C57.96	Guide for Loading Dry-Type Distribution and Power Transformers.

C. National Electric Manufacturer's Association (NEMA):

1.	NEMA ST 20	Dry Type Transformers for General Applications.
2.	NEMA TR 1	Transformers, Regulators, and Reactors.

D. Underwriter’s Laboratory, Inc. (UL):

1.	UL 1561	Transformers, Dry-Type General Purpose and

Power.

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

1.03 DEFINITIONS

A. Definitions of terms are as indicated in NFPA 70, IEEE/ANSI C57.12.80 and NEMA ST 20 unless otherwise indicated, noted or specified.

1.04 SYSTEM DESCRIPTION

A. Design Criteria:
   1. Provide transformers with ratings as indicated.
   2. Provide transformers designed for the following conditions:
      a. 40 degrees C. maximum ambient temperature.
      b. -20 degrees C. minimum ambient.
      c. 1,000 feet (300m) above sea-level.
      d. Indoors unless otherwise indicated or specified.

B. Provide transformers for connecting to primary and secondary systems as shown on the drawings, with nominal voltages and operating ranges as specified in IEEE/ANSI C84.1.

C. Provide transformers for connecting to systems with a let-through fault capability up to the limits of IEEE/ANSI C57.12.59.

1.05 SUBMITTALS

A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.

B. Product Data:
   1. List of transformers and accessories to be furnished and installed.
   2. Catalog cuts of all transformers and accessories.

C. Shop Drawings: Provide shop drawings for the following:
   1. Complete outline drawing, showing overall length, width, and height and including ratings of equipment, impedance, and installation restrictions.

D. Submit Operation and Maintenance Manual.

1.06 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. 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 unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.

C. Conform all work to NFPA 70, National Electrical Code.

D. Install work under supervision of skilled licensed electricians.

1.07 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 manufacturers 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

2.01 SECONDARY TRANSFORMERS

A. Provide transformers of the general purpose, indoor, double-wound, ventilated, dry-type designed and tested in accordance with NEMA Standard ST 20 and ANSI Standard C57.12.01, Underwriter's Laboratories Standard UL-1561, and ANSI C57.12.91 of capacities and mounting arrangements, (floor or wall) as indicated on the Drawings. Provide wall-mounted transformers with the wall bracket that is adequate for the supporting weight.

B. Design transformers for continuous operation at rated KVA, 24 hours a day, 365 days a year, with normal life expectancy as defined in ANSI/IEEE C57.96. Provide a

transformer which will make this performance obtainable without exceeding 115 degree C average temperature rise in a 40 degree C maximum ambient and 30 degree C average ambient. Do not exceed 220 degree C as the maximum coil hot spot temperature.

C. Provide proven 220 degree C insulation systems.

D. Wind the coils with copper, which has insulated, proven, high temperature resistant, 220 degree C materials.

E. Use all materials in the transformer that are flame retardant and do not support combustion as defined in ASTM Standard Test Method D635.

F. Totally immerse the transformer in an insulating varnish, which will maintain superior bond strength, high dielectric strength, and outstanding power factors at temperatures associated with the 220 degree C. system as a final insulation treatment. After immersion, cure the varnish at normal operating temperatures for such a period of time as to assure complete curing of the varnish and scourging of volatiles in the varnish solvent.

G. Construct transformers with core materials of a high quality, low loss nature as to minimize exciting current, no-load losses, and interlaminar vibrations.

H. The core and coil assembly shall be installed on vibration-absorbing pads.

I. Transformer average sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:
   1. Up to 9 kVA 40 db
   2. 10 to 50 kVA 45 db
   3. 51 to 150 kVA 50 db

J. Design the core-coil assembly and mechanically brace to withstand short circuit tests as defined in ANSI C57.12.91 by the use of full scale testing. The coil construction and mechanical bracing members shall be such as to prevent mechanical degradation of the insulation structures during short circuit.

K. Provide single phase transformers 2 KVA and below without taps. Provide 3 KVA and 5 KVA with 2-2 ½ percent above nominal full capacity (ANFC) and 2-2 ½ percent below nominal full capacity (BNFC) taps. Provide 7-1/2 KVA and above with 2-2 ½ percent ANFC and 4-2 ½ percent BNFC taps.

L. Provide three phase transformers with 2-2 ½ percent ANFC and 4-2 ½ percent BNFC taps.

M. Provide transformer with enclosures removable front and back panels, and must have screened or grilled ventilation openings designed to prevent accidental access to electrified parts.

N. The following factory tests shall be made on all transformers:
   1. Ratio tests at the rated voltage connection and at all tap connections.
   2. Polarity and phase relation tests on the rated voltage connection.

3. Applied potential tests.
4. Induced potential tests.
5. No-load and excitation current at rated voltage on the rated voltage connection.

O. Transformers shall be low loss type with minimum efficiencies per NEMA TP-1 when operated at 35% of full load capacity.

2.02 TRANSFORMER FOR NON-LINEAR LOADS

A. Provide transformers for non-linear loads conforming to requirements for secondary transformers except as noted herein.

B. Winding temperature rise shall be 115 degrees C.

C. The transformer shall include an electrostatic shield between the primary and secondary windings.

D. The neutral conductor shall be rated to carry 200 percent of normal phase current.

E. The natural terminal shall be double size.

F. Transformers shall be low loss type with minimum efficiencies per NEMA TP-1 when operated at 35% of full load capacity.

G. The transformers shall be specifically designed to supply circuits with a harmonic profile equal to or less than a K-factor of 4 or 13 as described below without exceeding 115 degrees C temperature rise.

Harmonic	K-4	K-13
Fundamental	100%	100%
3rd	34.0%	70%
5th	22.0%	42%
7th	3.0%	5.0%
9th	1.0%	3.0%
11th	0.7%	3.0%
13th	0.5%	1.0%
15th	0.3%	0.7%
17th	0.3%	0.6%

2.03 ACCEPTABLE MANUFACTURERS:

A. Eaton Electric (Basis of Design)

B. Square D Company

C. General Electric

D. Siemens

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, connect, and interconnect products where indicated, and in accordance with NEMA Standards, manufacturer's printed installation instructions, and this Section. Make connections in a manner, which will insure electrical continuity and operability of the products.

B. Protect the equipment against foreign matter and moisture during installation.

C. Install a 3-foot (1m) length of liquid-tight flexible metal conduit between transformer and fixed conduit system in accordance with Section 26 05 33.13. Make power conductor connections in accordance with manufacturer's drawings, and as indicated on the Drawings.

D. Ground in accordance with Section 26 05 26. Provide ground bond for enclosure and neutral, minimum size #6 AWG to nearest structural steel and nearest water pipes to conform with Section 26 05 26 and the NEC.

3.02 FIELD QUALITY CONTROL

A. Dry out dry type transformers before they are energized.

B. Check transformer for tightness of external structural members and mechanical joints in order to minimize audible sound levels. Check the ground connections.

C. Test as specified in Section 26 05 63.

END OF SECTION

SECTION 26 24 13

SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for AC distribution switchboards, components and related installations.

B. Related Sections:

1.	Section 03 30 00	Cast-in-Place Concrete
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 63	Acceptance of Electrical Systems
5.	Section 26 43 13	Surge Protective Devices for Low Voltage Electric Power Circuits

1.02 REFERENCES

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

B. Institute of Electrical and Electronic Engineers (IEEE)/America National Standards Institute (ANSI):
   1. ANSI/IEEE C12.1 - Code for Electricity Metering.
   2. ANSI C57.13 - Instrument Transformers.

C. Federal Specifications (Fed Spec.):
   1. Fed Spec. W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit And Service.

D. National Electrical Manufacturers Association (NEMA):
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
   2. NEMA ICS 6 - Industrial Control and Systems - Enclosures.
   3. NEMA PB 2 - Deadfront Distribution Switchboards.
   4. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
   5. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.
   6. NEMA Standard 250 - Enclosures for Electrical Equipment.

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

F. Underwriters Laboratories (UL):
   1. UL 489 - Molded Case Circuit Breakers.

2. UL 891 - Dead-Front Switchboards.
3. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.03 SUBMITTALS

A. General: Include shop drawings, manufacturer's descriptive literature and published details with performance/capacity rating schedules or charts as applicable, and where required by the cited reference standards.

B. Shop Drawings: All mechanical and electrical equipment and components specified herein must be included to be considered a complete shop drawing.
   1. Product Data: For each mechanical and electrical component, include manufacturers descriptive literature; product specifications; published details; technical bulletins; performance and capacity rating curves, charts, and schedules; catalogue data sheets; and other submittal materials as required to verify that the proposed products conform to the quality and functionability of the specified products.
      a. Identification - Clearly indicate by an arrow on submissions covering more than one product type or style exactly which product is being submitted for approval.
      b. Manufacturer - Include the catalogue name, company name, address, and telephone number for each product submitted.
   2. Equipment Drawings: Submit completely dimensioned plan, elevations, and cross-sections of system equipment and sub-assemblies. Shop drawings clearly indicate enclosure size, gutter space, breaker frame sizes and trips, main bus type and rating.
   3. Layout Drawing: Submit an integrated, completely dimensioned drawing of the switchboard equipment that includes foundation details (where applicable), anchor bolt size and patterns, supports, installation notes, and other pertinent setting details.
   4. Details: Provide detail drawings of the switchboard equipment as specified in this Section. Submit complete detail drawings of the main bus and all sub-assemblies including line and load connections, bus transitions, bus joints and bus sizes.
   5. Product List: Provide a list of equipment and components on all drawings with each product identified by legend reference. Include product name, manufacturer, and model number.
   6. Wiring Diagrams: Submit wiring diagrams for electrical apparatus showing numbered wiring terminals where applicable. In addition, submittal to contain detailed single line diagrams and assembly wiring diagrams. Submit control diagrams indicating control devices mounted in each switchboard, interconnecting wiring, and remote control devices, if any. In addition, submittal to contain detailed single-line diagrams.
   7. Breaker coordination curves to be provided for all circuit breakers furnished in each switchboard.
   8. Detailed calculations of the bus bar selection and sizing submitted to ascertain compliance with ANSI and NEMA requirements.

C. Submit Operation and Maintenance (O & M) Manuals, which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, circuit breaker coordination curves, maintenance procedures, and operating instructions.

1.04 SHORT CIRCUIT, ARC-FLASH, AND PROTECTIVE DEVICE COORDINATION STUDY

A. The computerized short-circuit, arc-flash, and protective coordination study will be performed and submitted as outlined in Section 26 05 00 of these specifications.

B. The Contractor is responsible for supplying the necessary and required information in order that this study may be completed and submitted at least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.

1.05 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. 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) unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are for the location installed and listed and labeled or approved as indicated and specified for the short circuit currents, voltages, and currents applied and listed and labeled or approved for the applications the items are intended.

C. Conform all work to NFPA 70, National Electrical Code.

D. Perform all electrical work under the supervision of a licensed electrician.

1.06 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 manufacturers 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.

1.07 DESIGN CRITERIA

A. 480Y/277 volts, three-phase, four-wire, 60 Hertz, grounded system voltage, unless indicated otherwise. All components in the system have adequate capacity, capability and bracing for the fault current indicated on the Drawings.

1.08 FACTORY TESTS

A. Upon receipt of all approved shop drawings for the switchboards, the manufacturer shall fabricate and factory test the equipment in question.

B. Upon completion of the factory tests, and prior to shipment, forward the following to the Engineer for review and comments.
   1. Certified test report, or in lieu thereof certified letter, ascertaining that the equipment in question was tested in strict conformance with all applicable Standards, and that the equipment met or exceeded all tests requirements.
   2. A certified quality control report indicating the items checked, the date when checked and initialed by the individual performing the quality control.
   3. Provide as part of this submittal the Operational and Maintenance Manuals for the referenced equipment as specified herein in this Section of the Specifications.

C. Equipment not accepted at the job site without prior receipt of the associated certified test report or the certified letter and the certified quality control report referenced to above.

1.09 SPARE BREAKERS

A. Furnish spare breakers as indicated on Drawings.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Refer to Procurement Documents.

B. Furnish all items of the materials, design, sizes and ratings shown on the Drawings and herein specified.

C. Furnish materials and equipment bearing evidence of UL listing where UL standards exist and manufacturer identification and customary size and rating data.

D. Provide products that are free from defects impairing performance, durability, or appearance, and of the commercial quality best suited for the purpose shown on the Drawings or specified herein.

2.02 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Provide Products such as conduit, wireways, wire and connectors, cable, support devices, fasteners, and similar devices, as required for Work of this Section as specified in the various Sections of the Division 26 Specifications.

2.03 DISTRIBUTION SWITCHBOARDS

A. Furnish, install, connect, adjust, test and place in proper working conditions distribution switchboards at locations where so indicated on the drawings. Switchboards are of the type classified as individually mounted circuit breakers as indicated herein and/or as indicated on the Drawings. Each switchboard shall be a dead front type, metal enclosed, self-supporting, free standing structure independent of wall supports of the required number of vertical sections bolted together to form a front accessible rigid switchboard 90-3/8 inch high, incorporating switching and protective devices of the number, type and rating as noted on the drawings with the necessary interconnections, terminal blocks, mechanical solderless connectors, controls and instrumentation.

B. Provide switchboards meeting Underwriter's Laboratories and NEMA Standard 250 enclosure requirements and furnished with a UL label as service entrance equipment.

C. Provide the switchboard framework consisting of steel channels welded or bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. Form the framework from code gauge steel, rigidly welded and bolted together to support all cover plates, bussing, and component devices during shipment and installation. Provide full-height and -depth steel barriers between adjacent sections, with insulating bushings for passage of bus bars and interconnecting wiring between sections.

D. Provide switchboard section with an open bottom and an individual removable top plate for installation and termination of all conduit runs. Top and bottom conduit areas are to be clearly shown and dimensioned on the shop drawings. The wireway front covers are to be hinged to permit access to the branch circuit breaker load side terminals without removing the covers. All front plates used for mounting meters, selector switches or other front mounted devices are hinged with all wiring installed and laced with flexibility at the hinged side. All closure plates are screw removable and small enough for easy handling by one man. The paint finish is gray enamel over a rust-inhibiting phosphate Primer.

E. Switchboard Bussing: Internal bus including ground bus of tin plated copper. Bus to be of sufficient cross-sectional area to carry the rated ampere load and not exceed the maximum heat rise above ambient temperature as specified by UL and NEMA. In addition, as a minimum, bus sized such that the current density at full rated load does not exceed 1000 amperes per square inch or a temperature rise of 50 degrees C above an ambient of 40 degrees C in still but unconfined air, as per NEMA requirements. Bus joints and connections made with hardened steel bolts and Belleville pressure washers. Maintain bus size as indicated on Drawings through all

compartments including full size neutral and ground. Insulate neutral bus from ground bus and provide removable link to ground bus.

F. The bus bars are rigidly braced to comply with the withstand rating of the switchboard.

G. The main horizontal bus bars between sections are located at the back of the switchboard to permit a maximum of available conduit area. The horizontal main bus bar supports, connections, and joints are to be bolted with Grade 5 carriage bolts and Belleville washers to minimize maintenance requirements.

H. A ground bus, sized as required by all governing regulations and codes, and lugs are furnished firmly secured to each vertical section structure and extend the entire length of the switchboard.

I. Small wiring, necessary fuse blocks and terminal blocks within the switchboard furnished as required. All groups of control wires leaving the switchboard provided with terminal blocks with suitable numbering strips. Provide engraved terminals for external wiring between components and for internal wiring between removable assemblies; terminal boards associated with current transformers shall be short-circuiting type. Mark control and metering conductors at each end. All hardware used on conductors have a high tensile strength and an anti-corrosive zinc plating.

J. The switchboard, as a complete unit, shall be given a single withstand short circuit rating by the manufacturer. This rating shall equal or exceed the AIC rating indicated on the Drawings. Switchboards shall be fully rated; series connected ratings are not permitted. Such rating is established by actual tests by the manufacturer on equipment constructed similarly to the subject switchboard.

K. The main service disconnect shall be an individually mounted insulated case circuit breaker with solid state trip unit. The circuit breaker element shall be electrically and mechanically trip-free. The circuit breaker shall be UL listed to UL 489. The circuit breaker shall have provision for padlocking in the off position. Circuit breaker shall be manually operated and shall utilize a stored energy closing mechanism. Frame and trip ratings shall be as indicated on the Drawings.
   1. Solid state trip unit shall digitally measure the current waveform in each phase to determine the true RMS value of the current regardless of the wave shape. The trip unit shall include a digital liquid crystal display with a five-button keypad for local setup and readout of trip settings. The trip unit shall include a lithium battery for cold setup capability and viewing of targets without external power. The trip unit shall include a three-phase ammeter and trip indicators. The trip unit shall include a field-installable, interchangeable rating plug and adjustable settings for long time pickup, long time delay, short time pickup, short time delay, and instantaneous pickup.
      a. Long Time Pickup: 0.4 through 1.0 times rating plug, in steps of 0.05.
      b. Long Time Delay: 2 through 24 seconds at 600 percent of long time pickup.
      c. Short Time Pickup: 2.0 through 10.0 times long time pickup, in steps of 0.5.
      d. Short Time Delay: 0.1 through 0.5 seconds at 800 percent of long time pickup with I^2T, or 0.1 through 0.5 seconds flat, selectable.
      e. Instantaneous Pickup: 2.0 through 10.0 times rating plug, in steps of 0.5.

2. The solid state trip unit shall provide an Arc-Flash Reduction Maintenance System (ARMS) function. The ARMS function shall reduce the trip unit Instantaneous pickup value when activated in order to achieve reduced arc flash incident energy via fast fault clearing. The ARMS function shall not compromise breaker phase protection even when enabled. Once the ARMS function is disabled, the recalibration of trip unit phase protection shall not be required. Activation and deactivation of the ARMS trip setting shall be accomplished without opening the circuit breaker door and exposing operators to energized parts. The ARMS function shall provide a total clearing time of 0.05 seconds, adjustable with a minimum of five settings ranging from 2.5X to 10X of the sensor value.
    a. The ARMS function shall be enabled via a switchboard panel mounted enable 30mm blue LED illuminated selector switch which is illuminated when the ARMS function is enabled. The selector switch shall be provided with a padlockable cover allowing the switch to be locked in either the ON or OFF position.
    b. Control power shall be derived directly from the switchboard power bus via properly sized fuses, but without the use of separate control power transformers.
3. The circuit breaker shall include the following accessories:
    a. Auxiliary switch with two normally-open and two normally-closed contacts.
4. The circuit breaker shall be equipped with an externally accessible test port for use with a universal test set. Disassembly of the circuit breaker shall not be required for testing. Test set shall be capable of verifying the operation of all trip functions with or without tripping the circuit breaker.

L. The feeder breakers shall be group mounted molded case circuit breakers with thermal magnetic trip units. Molded case circuit breakers shall be UL listed per UL 489. Breakers shall be constructed with an over-center, toggle handle-operated, trip-free mechanism with quick-make, quick-break action independent of the toggle handle operation. The breaker design shall provide common tripping of all poles. Frame and trip ratings shall be as indicated on the Drawings. Breakers shall be suitable for reverse feed. Breakers shall be constructed with high-strength molded-glass-reinforced polyester cases and covers. Breakers shall include a push-to-trip button to manually trip the breaker and exercise the mechanism and trip latch member.

M. Power Meters:
1. The information provided by the Power Meter shall include the following quantities:
    a. Current, per phase & neutral
    b. Volts, phase-to-phase & phase-neutral
    c. Real Power (kW), per phase & three phase total
    d. Reactive Power (kVAR), per phase & three phase total
    e. Apparent Power (kVA), per phase & three phase total
    f. Power Factor (true), per phase & three phase total
    g. Frequency
    h. Demand Current, per phase & neutral, present & peak
    i. Real Power Demand (kWd), three phase total, present & peak
    j. Reactive Power Demand (kVARd), three phase total, present & peak
    k. Apparent Power Demand (kVAd), three phase total, present & peak

l. Real Energy (kWh), three phase total
m. Reactive Energy (kVARh), three phase total
n. Apparent Energy (kVAh), three phase total
o. Energy Accumulation modes, signed, absolute, energy in, energy out
p. Total Harmonic Distortion (THD), voltage & current, per phase
q. Date and Time Stamping, peak demands, power up/restart and resets

2. The Power Meter shall be accurate to 0.25 percent of reading plus 0.05% of full scale for voltage and current sensing, and 0.5 percent of reading plus 0.05 percent of full scale for power and energy, accurate through the 31st harmonic.
   a. These accuracies shall be maintained for both light and full loads.
   b. No annual recalibration by users shall be required to maintain these accuracies.
   c. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy.
3. The meter shall be UL listed per UL 508, FCC compliant per FCC Part 15, Class A, and vibration and temperature tested. The meter module shall be rated for an operating temperature range of 0-60 degrees C.
4. The Power Meter metering inputs shall utilize current transformers for the current inputs. It shall be rated 5A nominal and 10A full scale. In addition, it shall be industrially and utility hardened to have an overload withstand rating of 15A continuous and 500A for 1 second.
5. The device shall not require potential transformers or control power transformers when applied at 600V or less. The power meter shall accept control power over a range of 90-600Vac, 50 or 50 Hz, or 100-350Vdc.
6. Each Power Meter shall have built in RS-485 data communications to allow multipoint communication to multiple computer workstations, programmable controllers, and other host devices, up to a data rate of 19,200 baud.
7. All information shall be available from the display or via RS-485 communications. It shall be possible to perform the setup via the display. No dip switches or other hardware adjustments shall be required for setup.
8. The data communications shall be optically isolated to provide reliable operation.
9. When connected via network to a computer, the power meter shall provide logging, trending, and alarming information.
10. Each Power Meter shall be equipped with a two-line LCD display as indicated on the project drawings.
11. The display shall scale readings automatically, without the need for multipliers.
12. All setup information and reset commands shall be password protected.
13. A KYZ pulse initiator for communication of kWh, kVARh, or kVAh information to third-party energy management systems shall be provided.
14. The power meter shall provide diagnostics to trouble shoot miswired installations.
15. Acceptable Manufacturers:
    a. Square D Company, Model PM-620
    b. Or Approved Equal

N. Surge Protective Devices (SPD): Provide a Surge Protective Device as specified in Section 26 43 13. Factory install and wire SPD within the switchboard prior to shipment to the job site. Mount SPD audible alarm, alarm silence and test switches, and failure indicators (LEDs) on front of switchboard. Provide terminal blocks for external circuit connections.

O. Finish: Metal structural and unit parts completely factory finished using an electrode position process so that interior and exterior surfaces, as well as bolted joints, have complete finish coats on and between them, also see Drawings.
   1. Paint process consists of cleaning, rinsing, phosphatizing, prepaint and post paint rinses, bake-cure and cool down.
   2. Finish switchboards with rust-inhibiting primers and a top coating of ANSI-61 light grey baked acrylic enamel, meeting NEMA ICS 6-110.57.
   3. UL recognized acrylic electrodisposition baked enamel paint and be able to pass at least 300 hour salt spray per ASTM B117 with less than 1/8 inch loss of paint from a scribed line.

P. Identification: Each main and branch circuit breaker shall be furnished with a nameplate having 1/4 inch high letters. Nameplates to be of engraved Bakelite or Lamacoid and be fastened to bottom of each section. These engraved nameplates indicates the equipment being served and its designation; such as "Main Switchboard MSB". Submit an identification nameplate schedule with the shop drawings.

Q. Acceptable Manufacturers:
   1. Eaton Electric (Basis of Design)
   2. Square D Company
   3. General Electric
   4. Siemens

2.04 CIRCUIT BREAKER TEST SET

A. Provide a universal test set to test and verify performance of solid state (electronic trip) circuit breakers. One test set is required for testing all mains and branch solid state trip circuit breakers. Provide a test set capable of testing the following:
   1. Long Time Ampere Rating.
   2. Long Time Delay.
   3. Short Time Pickup.
   4. Short Time Delay.
   5. Instantaneous Pickup.
   6. Trip Solenoid Operation.
   7. Rating Plug.

B. Design circuit breakers so neither disassembling of circuit breaker nor trip unit removal is required for testing.

C. Furnish test set installed within a rugged carrying case.

D. Acceptable Manufacturer:
   1. Eaton Electric (Basis of Design)
   2. Square D Company
   3. General Electric
   4. Siemens

2.05 SAFETY EQUIPMENT:

A. Rubber Matting:

1. Provide each Switchboard lineup with a separately provided safety rubber mat having dielectric strength of 40,000 volts, as tested under strict requirements of ASTM D178 regulations to:
    a. Ensure personnel safety against 8,000 volts to ground.
    b. To be a minimum 1/4-inch thick and 36 inches wide
    c. To extend in continuous fashion for the full length of the motor control center assembly. Multiple mats are not to be accepted.
    d. To be black in color.

2.06 UNDERCOATING

A. Undercoat underside of each distribution switchboard base, thoroughly coating that which comes in contact with the concrete with a rust and corrosion resistant mastic conforming to the manufacturer's standards, 4 mils (6mm) thick.

2.07 SUPPORTING STEEL

A. Provide all steel floor channels and epoxy resin filler necessary and required for the installation of each distribution switchboard. Install steel floor channels flush with top of concrete pad.

2.08 CONCRETE PADS

A. Provide 3-1/2-inch (9cm) high concrete pad for each distribution switchboard extending 3-inch (8cm) beyond the overall dimensions of the equipment (included noted future sections). Concrete shall be as specified in Section 03 30 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products, connected, and interconnected, where indicated, and in accordance with NEMA Standard PB2.1, manufacturer's printed instructions and as specified herein. Connections made in a manner, which will insure electrical continuity and operability of the products. Vertical lines made plumb, and horizontal lines made level. Verify the work of other trades is complete to the extent that substrates on which electrical apparatus is to be installed is ready to receive same.

B. Protect the equipment against foreign matter and moisture during installation.

C. Connect feeders to individual circuit breakers. The neutral wire of each feeder directly connected to the neutral bar.

D. Over current and short circuit protection devices are of the sizes and types indicated and install in a manner, which will ensure selective coordination of the devices.

E. Ground switchboards in accordance with Section 26 05 26.

3.02 TESTING

A. Test switchboards as specified in Section 26 05 63.

B. Test grounding as specified in Sections 26 05 26 and 26 05 63.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of all materials for furnishing, installing connecting, energizing, testing, cleaning and protecting wall-mounted panelboards.

B. Related Section:

1.	Section 26 05 00	Common Work Results for Electrical
2.	Section 26 05 28	Hangers and Supports for Electrical Systems
3.	Section 26 05 53	Identification for Electrical Systems
4.	Section 26 05 63	Acceptance of Electrical Systems
5.	Section 26 05 19	Low Voltage Electrical Power Conductors and Cables
6.	Section 26 43 13	Surge Protective Devices for Low Voltage Electric Power Circuits

1.02 REFERENCES

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

B. American Society for Testing and Materials (ASTM):
1. ASTM B164 Nickel-Copper Alloy, Bar and Wire.
2. ASTM B187 Standard Specifications for Copper Bus, Bus Bar, Rod and Shapes

C. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 Electrical Enclosures.
2. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches.
3. NEMA AB 2 Molded Case Circuit Breakers and their Application.
4. NEMA PB 1 Panelboards.
5. NEMA PB 1.1 General Instructions for Proper installation, Operation, and Maintenance of Panelboards.

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

E. Underwriters Laboratories (UL):
1. UL 489 Molded Case Circuit Breakers and Circuit Breaker Enclosures
2. UL 50 Cabinets and Boxes
3. UL 67 Panelboards

1.03 SYSTEM DESCRIPTION

A. Panelboards are connected to system voltages as follows:
   1. 480Y/277 Volt, 3-phase, 4-wire.
   2. 208Y/120 Volt, 3-phase, 4-wire.

1.04 SUBMITTALS

A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.

B. Product Data and Catalog Cuts: Provide product data for all products provided. Indicate clearly the usage and designation of each product.

C. Shop Drawings: Submit shop drawings for all panelboards.

D. Provide manufacturer's instructions for all panelboards.

1.05 SHORT CIRCUIT, ARC-FLASH, AND PROTECTIVE DEVICE COORDINATION STUDY

A. The computerized short-circuit, arc-flash, and protective coordination study will be performed and submitted as outlined in Section 26 05 00 of these specifications.

B. The Contractor is responsible for supplying the necessary and required information in order that this study may be completed and submitted at least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.

1.06 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. Provide panelboards, which have been design tested in accordance with NEMA PB 1.

C. Provide panelboards which have been production tested in accordance with NEMA PB 1.

D. Conform all work to NFPA 70, National Electrical Code.

E. Install work under supervision of licensed electricians.

1.07 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 manufacturers 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

2.01 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Those products such as conduit, wireways, wire and connectors, cable, support devices, fasteners, and similar devices as required for work of this Section are as specified in other Sections of these Specifications.

2.02 PANELBOARDS

A. Provide dead-front panelboards as follows:
   1. Accommodate bolt-on molded case circuit breakers as specified below.
   2. Conform to NEMA PB 1 and NFPA 70, Article 384.
   3. Consist of interiors, matching enclosures and covers of a single manufacturer as specified below.
   4. Have circuit breakers of frame sizes, trip ratings, number of poles, and types as scheduled, indicated and noted.
   5. Provide branch circuits phased in sequence vertically and numbered uniformly left to right, top to bottom.

B. Provide panelboards that are fully rated for a short circuit capacity as scheduled, indicated and noted on the Drawings.

C. Interiors: Provide interiors, as follows:
   1. Provide tin plated main, ground and neutral copper buses conforming to ASTM B187 having not less than 98 percent conductivity.
   2. Mount interiors on galvanized steel backplate.

3. Make provisions for future breakers and for circuit breakers in all future spaces as indicated, scheduled or noted and so that additional breakers can be mounted without additional connectors or extension of busses.

D. Provide solderless type main, sub-feed, and through feed lugs rated for copper and aluminum conductors of size, number and type, as indicated, scheduled and noted on the Drawings.

E. Enclosures:
   1. Provide enclosures conforming to NEMA 250 for the types as indicated, scheduled, noted, and specified. Provide NEMA 1 enclosures unless otherwise indicated on the Drawings.
   2. Fabricate from galvanized steel without knockouts.
   3. Provide side, bottom, and top gutters of minimum 4-inch (10cm) width, of minimum 5-1/2 inch (14cm) depth, and sized as indicated, scheduled, and noted and as required by NFPA 70 Article 373 for the actual entry point.
   4. Provide circuit directory of sufficient size to allow 40-characters per circuit; indicate the source of service (i.e. upstream panelboard, switchboard, motor control center, etc.) to the panelboard. Mount the directory in a transparent protective covering.

F. Doors: Provide doors as follows:
   1. Provide concealed hinges and trim clamps.
   2. Provide combination catch and master keyed, flat key lock with two keys for each lock and common keying throughout each building of the facility.

G. Finishes:
   1. Factory finish enclosure cover completely using an electro-deposition process that deposits a complete finish coat of paint on all interior and exterior surfaces as well as bolted joints.
   2. Include in the paint process cleaning, rinsing, phosphatizing, prepaint and post paint rinses, bake-cure and cool down steps.
   3. Finish switchboards with rust inhibiting primers and electro-disposition acrylic baked enamel top coating of No. 49 medium light grey conforming to ANSI Z55.1.
   4. Provide overall finish capable of passing a 300-hour salt spray per ASTM B117 with less than 1/8 loss of paint from a scribed line.

H. Molded case circuit breakers:
   1. Provide inverse time and instantaneous tripping characteristics.
   2. Provide trip ratings, frame sizes, and number of poles as indicated, scheduled, and noted on the Drawings.
   3. Provide full rated circuit breakers with short circuit ratings equal to the panelboard installed as scheduled on the Drawings.
   4. Provide molded case circuit breakers conforming to NEMA AB 1, and UL 489.
   5. Provide circuit breakers of the same manufacture and type as the panelboard installed.

I. Surge Protective Devices (SPD): Provide a Surge Protective Device as specified in Section 26 43 13. Factory install and wire SPD within the panelboard prior to shipment to the job site. Mount SPD audible alarm, alarm silence and test switches,

and failure indicators (LEDs) on front of panelboard. Provide terminal blocks for external circuit connections.

J. Acceptable Manufacturers:
   1. Eaton Electric (Basis of Design)
   2. Square D Company
   3. General Electric
   4. Siemens

PART 3 EXECUTION

3.01 PREPARATION

A. Painted surfaces, which will be covered by items of this Section have a prime and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

3.02 INSTALLATION

A. Space enclosures out from surfaces mounted on 1/4-inch (6mm) spacers or U-channel supports. Provide supports as specified in Section 26 05 28.

B. Install all panelboards and circuit-breakers in accordance with the manufacturer's instructions and NEMA PB 1.1.

C. Set enclosure top 6-feet 6-inches above finished floor or grade unless otherwise indicated or specified.

D. Punch holes for conduit entries in the enclosures.

E. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

F. Interface with other work:
   1. Connect conduits to enclosure with watertight hubs, except in damp locations on the bottom of enclosures a sealing locknut may be used in place of watertight hubs, and in dry locations two locknuts and bushings may be used.
   2. Connect wiring to line and load terminals with lugs provided or approved by manufacturer in conformance with Section 26 05 19. Remove interior or protect interior components during wire pulling.
   3. Identify in accordance with Section 26 05 53.

G. At the end of the project update the circuit directories to reflect as-built conditions. Circuit directions shall be typed.

3.03 CLEANING

A. After wiring, vacuum out interior and wipe clean of all foreign material.

B. After painting in areas, remove all over paint, drips and splashes.

3.04 FIELD QUALITY CONTROL

A. Site Testing:
   1. Prior to Energizing:
      a. Have insulation testing and setting of overcurrent protective device adjustments made in conformance of Section 26 05 63.
      b. Ensure that all load side wiring is clear of shorts and has received and passed the insulation tests of Section 26 05 63.
      c. Open all downstream disconnects and open circuit breaker.
   2. Final testing after energizing:
      a. Perform thermographic test and record circuit parameters in conformity with Section 26 05 63.

3.05 PROTECTION

A. During painting, mask all nameplates, all plastic parts, and all items not to be painted.

B. Protect all items during work of other trades including welding and cutting.

C. Protect panelboards against overloads, short circuits, and improper operation, padlock off when work is being done on downstream circuits.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Requirements for furnishing, installing, connecting, energizing, testing, cleaning, and protecting wiring devices and cover plates.

B. Related Sections:
1. Refer to Procurement Documents.
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 28 Hangers and Supports for Electrical Systems
5. Section 26 05 63 Acceptance of Electrical Systems
6. Section 26 05 53 Identification for Electrical Systems
7. Section 26 05 33.13 Conduits for Electrical Systems
8. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables
9. Section 26 05 33.23 Boxes for Electrical Systems

1.02 REFERENCES

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

B. National Electric Manufacturer's Association (NEMA):
1. NEMA WD 1 - General Color Requirements for Wiring Devices.
2. NEMA WD 6 - Wiring Devices - Dimensional Requirements.

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

D. Underwriter’s Laboratories, Inc. (UL):
1. UL 20 - Standard for Safety for General-Use Snap Switches.
2. UL 231 - Standard for Power Outlets.
3. UL 498 - Standard for Safety for Attachment Plugs and Receptacles.
4. UL 943 - Standard for Safety for Ground-Fault Circuit-Interrupters.
5. UL 1449 - Standard for Transient Voltage Surge Suppressors.
6. UL 1472 - Solid-State Dimming Controls.
7. UL 1681 - Standard for Safety for Wiring Device Configurations.

E. U. S. General Services Administration (GSA):
1. Federal Specifications:

a. W-C-596/40D - Connector, Receptacle, Electrical, General Purpose, Duplex, General Grade and Hospital Grade, Grounding, 2 Pole, 3 Wire, 20 Amperes, 125 Volts, 50/60 Hertz, Box Mount and Snap-In Mount.
b. W-C-596/41D - Connector, Receptacle, Electrical, General Purpose, Single, Hospital Grade, Grounding, 2 Pole, 3 Wire, 20 Amperes, 125 Volts, 50/60 Hertz.
c. W-C-596/107A - Connectors, Receptacle, Electrical, Special Purpose, Single, Grounding, 2 Pole, 3 Wire, 20 Amperes, 277 Volts, 50/60 Hertz.
d. W-S-896F - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

1.03 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.

1.04 DESIGN REQUIREMENTS

A. Provide electrical power outlets designed in accordance with the requirements of UL 231 and 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.
3. Include Product Data for the equipment and material provided under this Section with the Operation and Maintenance Manuals submitted in accordance with the requirements of the Procurement Documents at project closeout.

1.05 SUBMITTALS

A. Submit the following information to the Engineer for approval in accordance with the requirements of the Procurement Documents:
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 dimmer switches.
   e. Catalog cuts of emergency power shut-off switches.
   f. Catalog cuts of self contained occupancy sensor switches.
   g. Catalog cuts of heavy duty specification grade receptacles.
   h. Catalog cuts of commercial specification grade receptacles.
   i. Catalog cuts of heavy duty specification grade GFCI receptacles.

j. Catalog cuts of commercial specification grade GFCI receptacles.
k. Catalog cuts of standard grade surge suppression receptacles.
l. Catalog cuts of power outlet receptacles.
m. 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. Manufacturers Instructions.
      1) Manufacturer's printed installation instructions.
   d. Qualification Statements.
      1) Qualifications of the Electrical Testing Laboratory (ETL).

1.06 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. Qualifications:
   1. Electrical Testing Laboratory (ETL) Qualifications:
      a. Employ an independent testing agency, qualified as specified in the Procurement Documents, and Section 26 05 63 Acceptance of Electrical Systems, to perform testing required by this Section.
      b. Submit information verifying the ETL’s qualifications.

C. 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.

D. 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.
   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.
      a. For items without such evidence, submit a written statement from the product manufacturer that indicates why it does not have quality assurance verification.

1.07 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.

B. Acceptance at Site:
   1. Accept products at the Site in accordance with the requirements of Section 26 05 00.

C. Storage and Protection:
   1. Store products in accordance with the requirements of Section 26 05 00.

PART 2 PRODUCTS

2.01 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.

2.02 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. Color shall be as selected by the Authority during construction.
      c. Control Switches:
         1) For control switches, provide SPDT switches with center OFF and maintained contacts, or SPDT with center OFF and momentary contacts, of the same basic type, construction, and rating as specified for other toggle handle snap switches.
         2) See the Contract Drawings for additional information.
      d. Manufacturers:
         1) Hubbell, www.hubbell-wiring.com.
            a) Heavy Duty Specification Grade Switches: HBL1220 Series.
         2) Pass & Seymour, www.passandseymour.com.
         3) Leviton Manufacturing Co., www.leviton.com.
         4) Approved equal.

3. Dimmer Switches:
    a. Provide slide type, solid-state, positive off dimmer switches that comply with the requirements of UL 20 and UL 1472.
        1) Provide fully rated dimmer switches rated for a minimum of 1500 Watts, provide a larger size if necessary to accommodate the loads indicated on the Contract Drawings.
        2) Provide dimmer switches rated for incandescent or fluorescent lighting as shown on the Contract Drawings, and capable of being gang mounted without breaking off their cooling fins.
        3) Color shall be as selected by the Authority during construction.
    b. Manufacturers:
        1) Lutron, "Nova" Series, www.lutron.com.
        2) Pass & Seymour, www.passandseymour.com.
        3) Leviton Manufacturing Co., www.leviton.com.
        4) Approved equal.
4. Self Contained Occupancy Sensor Switches:
    a. Provide self-contained, single gang, occupancy and vacancy sensor switches designed to fit behind a standard decorator switch plate and to replace existing wall switches.
        1) Provide occupancy and vacancy sensor switches rated for dual 120/277 Volt operation.
        2) Provide occupancy and vacancy sensor switches having a passive infrared detector mounted behind a Fresnel lens.
    b. Sensitivity:
        1) Provide occupancy and vacancy sensor switches capable of detecting motion in 10 to 150 foot-candles, and capable of detecting both vertical and horizontal motion.
    c. Coverage:
        1) Sensing Field: 180 degrees.
        2) Sensing Distance: Up to 35 feet.
        3) Sensing Area: Up to 900 square feet.
    d. Time Delay:
        1) Provide occupancy and vacancy sensor switches having a time delay adjustable from 30 seconds to 30 minutes.
    e. Acceptable Manufacturers for interior dry/conditioned locations:
        1) Sensorswitch – LWS PDT
        2) Or Approved Equal
    f. Acceptable Manufacturers for interior unconditioned locations with low temperature and/or high humidity:
        1) Sensorswitch - LWS PDT LT.
        2) Or 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) Color shall be as selected by the Authority during construction.
3) Manufacturers:
a) Hubbell, HBL5352 Series, www.hubbell-wiring.com.
b) Pass & Seymour, www.passandseymour.com.
c) Leviton Manufacturing Co., www.leviton.com.
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) Color shall be as selected by the Authority during construction.
3) Manufacturers:
a) Hubbell, GFR5362TR Series, www.hubbell-wiring.com.
b) Pass & Seymour, www.passandseymour.com.
c) Leviton Manufacturing Co., www.leviton.com.
d) Approved equal.

2.03 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.
b. For locations subject to wet or rain conditions, provide wet location wall plates marked with the words “Suitable for Wet Locations While in Use”.
2. Thickness (Minimum): 0.040 inches thick (1mm).
3. Finish:
a. For finished areas, provide wall plates having a satin finish.
4. Fasteners:
a. For installing wiring devices and wall plates, provide the following of fastener types:
1) For affixing metal wall plates, provide stainless steel screws.
5. Manufacturers:
a. Hubbell, www.hubbell-wiring.com.
b. Pass & Seymour, www.passandseymour.com.
c. Appleton, www.appletonelec.com.
d. Cooper Crouse-Hinds, http://crouse-hinds.com.
e. Approved equal.

PART 3 EXECUTION

3.01 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.

3.02 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 and 26 05 28.
   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) Emergency Power Shut-Off Switches:
            a) Locate emergency power shut-off switches 5’- 0” above the finished floor on the hinge side of the exit door, or where shown on the Contract Drawings.
         2) Lighting Control Switches:
            a) Locate lighting control switches on the strike side of doors, and at 48-inches above the finished floor to the centerline of the switch, unless indicated otherwise on the Contract Drawings.
            b) Where it is not possible to mount lighting control switches side-by-side with a common device plate, mount them in tandem.
         3) Electrical Duplex Convenience Outlets:
            a) In Finished Areas:
               (1) Locate electrical duplex convenience outlets 18 inches above the finished floor to the centerline of the outlet, unless indicated otherwise on the Contract Drawings.
               (2) In concrete block walls, locate convenience outlets so they fall at the top of the second course, and at the top center of the respective block in which they are placed.

(3) Locate electrical duplex convenience outlets that are above counters or backsplashes horizontally 6 inches above the counter or backsplash.

b) In Unfinished Areas:
(1) Locate electrical duplex convenience outlets 36 inches above the finished floor, unless this interferes with equipment or another obstacle.
(2) If locating electrical duplex convenience outlets 36 inches above the finished floor interferes with equipment or another obstacle; then install the outlet above or below the obstruction as directed by the Engineer.

c) For Water Coolers Receptacles:
(1) Locate electrical outlets for water coolers directly behind the water cooler in order to hide the cord and attachment plug.
(2) Prior to installing the box for the outlet, coordinate the mounting height of the wiring device with the height of the cooler to be installed to insure that the cord and attachment plug will be hidden.

4) Wiring Devices in Mill Work:
a) Mount wiring devices in mill work where shown in details or elevations, or as directed by the Engineer.

3.03 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 and 26 05 33.13.
3. Ground the devices in accordance with the requirements of Section 26 05 26
4. Emergency Circuits:
a. Emergency Power Shut-Off Switches:
1) Generators:
a) Connect the emergency power shut-off switch for each emergency generator into the shunt-trip device of the main circuit breaker serving the respective generator.
2) Boilers:
a) Connect the emergency power shut-off switch for each boiler into the main run contact serving the respective boiler control panel.
b. Provide red receptacles for emergency circuits.

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.

C. Identify the wiring devices in accordance with the requirements of Section 26 05 53.

1. Label emergency power shut-off switches appropriately.

3.04 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.

3.05 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 the Procurement Documents.

B. Inspection:
   1. Inspect boxes to verify proper operation, for visual appearance, and to verify correct mounting height.

3.06 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.

3.07 CLEANING

A. Waste Management and Disposal:
   1. Clear and dispose of waste materials in accordance with the requirements of Section 26 05 00.

3.08 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.

END OF SECTION

SECTION 26 28 16.13

LOW-VOLTAGE ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, connecting, energizing, testing, cleaning, and protecting enclosed disconnect switches, hazardous location switches, and fuses.

B. Related Sections:
   1. Section 26 05 28 Hangers and Supports for Electrical Systems
   2. Section 26 05 53 Identification for Electrical Systems
   3. Section 26 05 63 Acceptance of Electrical Systems
   4. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables

1.02 REFERENCES

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

B. InterNational Electrical Testing Association, Inc. (NETA):
   1. ANSI/NETA ETT Standard for Certification of Electrical Testing Technicians.

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250; Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA KS 1; Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

D. National Fire Protection Association (NFPA):
   1. NFPA 70; National Electrical Code (NEC).

E. Underwriter's Laboratories, Inc. (UL):
   1. UL 98; Standard for Enclosed and Dead-Front Switches.

1.03 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of the Procurement Documents:
   1. Product Data:
      a. Enclosed disconnect switches
      b. Enclosed hazardous location switches
      c. Fuses
   2. Shop Drawings:

a. Enclosed disconnect switches
b. Enclosed hazardous location switches

3. Quality Assurance/Control Submittals:
   a. Certificates:
      1) Testing agency/quality verification listing cards, if required
      2) Manufacturers written statement indicating why items do not have quality assurance verification, if required
   b. Manufacturer's instructions:
      1) Enclosed disconnect switches
   c. Qualification Statements:
      1) Electrical testing laboratory's qualifications

1.04 SHORT CIRCUIT, ARC-FLASH, AND PROTECTIVE DEVICE COORDINATION STUDY

A. The computerized short-circuit, arc-flash, and protective coordination study will be performed and submitted as outlined in Section 26 05 00 of these specifications.

B. The Contractor is responsible for supplying the necessary and required information in order that this study may be completed and submitted at least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.

1.05 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. Qualifications:
   1. Installer Qualifications:
      a. Employ licensed electricians to supervise installation of the work of this Section.
   2. Electrical Testing Laboratory (ETL) Qualifications:
      a. Use a NETA accredited electrical testing laboratory, or approved equal, that is accredited according to ANSI/NETA ETT for the region in which the Contract work is performed.
      b. Submit the electrical testing laboratory's qualifications to the Engineer for approval.

C. Regulatory Requirements:
   1. Conform all work to NFPA 70, the National Electrical Code.

D. Certifications:
   1. Provide products that are either 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.

1.06 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 manufacturers 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.

1.07 MAINTENANCE

A. Extra Materials:
   1. Provide one set of spare fuses for each point of use including all of the ampere sizes indicated for the location.

PART 2 PRODUCTS

2.01 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.

2.02 MANUFACTURED UNITS

A. Enclosed Disconnect Switches:
   1. Provide enclosed disconnect switches that meet the requirements of NEMA KS l and UL 98, and that are as shown on the Contract Drawings.
      a. Types:
         1) Heavy duty fusible type.

a) Provide positive pressure fuse clips.
b) Provide fuses as specified

2) Heavy duty non-fusible type.

b. Provide enclosed disconnect switches rated for the horsepower, voltage, and amperage as indicated on the Contract Drawings.

c. Provide enclosed disconnect switches with the number of poles and of the type indicated on the Contract Drawings.

2. Enclosure:

a. Provide enclosures consisting of a box and cover conforming to the requirements of NEMA 250 and of the type indicated or scheduled on the Contract Drawings.

1) If not otherwise specified, provide enclosures conforming to the requirements of NEMA 250, type 1.

b. Material:

1) Construct enclosures of code gauge sheet steel per the requirements of UL 98.

c. Finish:

1) Apply a rust-inhibiting phosphate coating to the enclosure's sheet steel, and then finish the enclosure in gray baked enamel.

d. Provide a permanent label with the manufacturer's switch type, catalog number, and horsepower rating on the enclosure.

3. Switch Mechanism:

a. Provide a quick-make, quick-break operating handle and switch mechanism integral to the box or body, not the cover.

1) Provide dead front construction with permanent arc suppressors and dual cover interlocks to prevent an unauthorized opening of the switch enclosure when the switch is in the ON position.

2) Provide the means to positively padlock the switch in the OFF position.

b. Provide a switch designed so that the switch blades are visible in the OFF position when door is open.

c. Provide UL-listed switch lugs for front removable copper cables.

d. Electroplate the switch's current carrying parts to provide resistance to corrosion.

4. Acceptable Manufacturers:

a. Eaton Electric (Basis of Design)

b. Square D Company

c. General Electric

d. Siemens

B. Fuses:

1. Provide current limiting type fuses rated for the voltage and amperage as indicated on the Contract Drawings for those low-voltage switches requiring fuses.

a. For non-motor loads, provide UL Class RK1 single element, fast-acting type fuses.

b. For motor, welder, and transformer loads, provide UL Class RK5 dual element, time-delay type fuses.

c. Where the above requirements conflict with the manufacturer's requirements for a specific piece of equipment, comply with the manufacturer's requirements.

2. Acceptable Manufacturers:
    a. Cooper Bussman
    b. Ferraz-Shawmut.
    c. Or Approved Equal.

2.03 SOURCE QUALITY CONTROL

A. Testing Agency/Quality Verification:
    1. Perform the standard low-voltage enclosed switch factory tests specified in NEMA KS l and UL 98.
    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.
        a. For items without such evidence, provide a written statement from the product manufacturer that indicates why it does not have quality assurance verification.
        b. Such statements are subject to the approval of the Engineer.

PART 3 EXECUTION

3.01 INSTALLERS

A. Install the work of this Section only under the supervision of licensed electricians.

3.02 PREPARATION

A. Provide a prime and finish coat of paint for painted surfaces that will be covered by items provided under this Section.

B. Prior to painting operations, mask all nameplates, plastic parts, push buttons, operating shafts, and other items not to be painted.

C. Ensure that all indoor areas to receive the items provided under this Section are enclosed from the weather.

3.03 INSTALLATION

A. Install disconnect switches and hazardous location switches in accordance with the switch manufacturer=s instructions.
    1. Mount enclosures on 1/4-inch (6mm) spacers or U-channel supports to provide a space between enclosures and mounting surfaces.
        a. Provide supports as specified in Section 26 05 28.
    2. Set the top of enclosures 6’-6” above the finished floor or grade unless otherwise indicated or specified.

B. Install the switch’s conduit and wiring:
    1. Punch holes in the disconnect switch enclosures for conduit entries, except use the pre-tapped hubs and integral bushings for attaching conduit to hazardous location switch enclosures.

a. Connect conduit to disconnect switch enclosures with water-tight hubs except as follows:
    1) In dry locations, either the watertight hubs or two locknuts and bushings may be used to connect conduits to the disconnect switch enclosure.
    2) In damp locations, either the watertight hubs or a sealing locknut, interior locknut, and grounding bushing may be used on the bottom of the enclosures.
b. In wet and/or hazardous areas, install a conduit drain-fitting in a hole punched in the bottom of the enclosure, and install a conduit breather fitting in a hole punched in the top of the enclosure.

2. Remove or protect components installed in the interior of enclosures during wire pulling.
3. Use lugs provided by or approved by the disconnect switch manufacturer to connect wiring to the disconnect switch's line and load terminals in conformance with Section 26 05 19.

C. Identify low-voltage enclosed switches in accordance with Section 26 05 53.

3.04 FIELD QUALITY CONTROL

A. Site Testing:
1. Prior to energizing the low-voltage enclosed switches:
    a. Perform insulation testing and ensure that all load-side wiring is clear of shorts in accordance with the requirements of Section 26 05 63.
2. Final testing after energizing the circuit breakers:
    a. Perform the thermographic test in conformity with Section 26 05 63, and record the circuit parameters.

3.05 PROTECTION

A. Protect the items provided under this Section during the performance of work provided under other Sections, especially during welding and cutting operations.

B. Protect the low-voltage enclosed switches against overloads, short-circuits, and improper operation.
1. Pad-lock the low-voltage enclosed switches in the off position when work is being done on downstream circuits.

END OF SECTION

SECTION 26 28 16.19

LOW-VOLTAGE ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for furnishing, installing, connecting, energizing, testing, cleaning, and protecting enclosed, low-voltage, individually mounted molded-case circuit breakers.

B. Related Sections:
   1. Section 26 05 28 Hangers and Supports for Electrical Systems
   2. Section 26 05 53 Identification for Electrical Systems
   3. Section 26 05 63 Acceptance of Electrical Systems
   4. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables

1.02 REFERENCES

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

B. American Society for Testing and Materials (ASTM):
   1. ASTM B 258, Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors.

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250; Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA AB 1; Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.

D. National Fire Protection Association (NFPA):
   1. NFPA 70; National Electrical Code (NEC).

E. Underwriter's Laboratories, Inc. (UL):
   1. UL 489; Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.03 DEFINITIONS

A. AIC: An acronym for ampere interrupting capacity.

B. AWG: An acronym for American Wire Gage, which is a standard system of designating electrical wire sizes specified in ASTM B 258.

1.04 DESIGN REQUIREMENTS

A. Design molded-case circuit breakers in conformance with the requirements of both NEMA AB 1 and UL 489.

1.05 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of the Procurement Documents:
   1. Product Data:
      a. Enclosed molded-case circuit breakers
      b. Circuit breaker enclosures
   2. Shop Drawings:
      a. Enclosed molded-case circuit breakers
   3. Quality Assurance/Control Submittals:
      a. Certificates:
         1) Testing agency/quality verification listing cards, if required
         2) Manufacturers written statement indicating why items do not have quality assurance verification, if required
      b. Manufacturer's instructions:
         1) Enclosed circuit breakers

1.06 SHORT CIRCUIT, ARC-FLASH, AND PROTECTIVE DEVICE COORDINATION STUDY

A. The computerized short-circuit, arc-flash, and protective coordination study will be performed and submitted as outlined in Section 26 05 00 of these specifications.

B. The Contractor is responsible for supplying the necessary and required information in order that this study may be completed and submitted at least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.

1.07 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. Qualifications:
   1. Employ licensed electricians to supervise installation of the work of this Section.

C. Regulatory Requirements:
   1. Conform all work to NFPA 70, the National Electrical Code.

D. Certifications:
   1. Provide products that are either 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.

1.08 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 manufacturers 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

2.01 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 circuit-breaker enclosures from the same manufacturer as the circuit-breaker.

C. Acceptable Manufacturers:
   1. Manufacturers offering products which can meet the requirements of this Section include, but are not limited to, the following:
      a. Eaton Electric (Basis of Design)
      b. Square D Company
      c. General Electric
      d. Siemens

2.02 MANUFACTURED UNITS

A. Enclosed Molded-Case Circuit-Breakers:

1. Provide quick make-quick break, unit type molded-case circuit breakers with a thermal magnetic overload trip and lugs on both ends.
    a. Equip the circuit breakers with mechanically trip-free toggle handles.
    b. Equip multiple pole breakers with an internal common trip.
    c. Provide 15 and 20 ampere circuit breakers with lugs capable of accommodating one wire between 14 AWG and 10 AWG.
2. Provide circuit breakers with the Voltage rating, poles, trip setting, and UL listed AIC rating as indicated on the Contract Drawings.
3. Provide factory-installed accessories as indicated and specified.

B. Enclosures:
1. Provide enclosures conforming to the requirements of NEMA 250, type 1.
    a. Provide enclosures of the type indicated or scheduled on the Contract Drawings.
    b. Unless otherwise indicated or scheduled, provide surface-mounted enclosures.
2. Provide enclosures sized to contain the circuit breaker and all other required items.
    a. Provide an interlock that prevents opening the enclosure door when the circuit breaker is in the “ON” position.
        1) Provide an interlock defeater, which requires a common hand-tool to operate.
    b. Provide a copper ground-bus or ground-stud rated for 100 percent of the circuit breaker’s capacity.
3. Provide each enclosure with an external operator that positively indicates the “ON”, “OFF”, and “TRIPPED” positions of the enclosed circuit breaker.
4. Provide the capability to pad-lock the circuit breaker in the “ON” and the “OFF” positions by using three padlocks.
5. If the circuit-breaker is connected to a system with a grounded neutral, provide a copper solid-neutral bus or terminal-lug with a 100 percent rating, and suitable lugs for all incoming and outgoing cables.

2.03 SOURCE QUALITY CONTROL

A. Testing Agency/Quality Verification:
1. Perform the standard circuit breaker factory tests specified in NEMA AB 1 and UL 489.
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.
    a. For items without such evidence, provide a written statement from the product manufacturer that indicates why it does not have quality assurance verification.
    b. Such statements are subject to the approval of the Engineer.

PART 3 EXECUTION

3.01 INSTALLERS

A. Install the work of this Section only under the supervision of licensed electricians.

3.02 PREPARATION

A. Provide a prime and finish coat of paint for painted surfaces that will be covered by items provided under this Section.

B. Prior to painting operations, mask all nameplates, plastic parts, operating shafts, and other items not to be painted.

C. Ensure that all indoor areas to receive the items provided under this Section are enclosed from the weather.

3.03 INSTALLATION

A. Install circuit breakers in accordance with the circuit breaker manufacturer=s instructions.
   1. Mount enclosures on 1/4-inch (6mm) spacers or U-channel supports to provide a space between enclosures and mounting surfaces.
      a. Provide supports as specified in Section 26 05 28.
   2. Set the top of enclosures 6'-6" above the finished floor or grade unless otherwise indicated or specified.

B. Install circuit breaker conduit and wiring:
   1. Punch holes in the enclosures for conduit entries.
   2. In dry locations, two locknuts and bushings may be used to connect conduits to the circuit breaker enclosure.
   3. In damp locations and on the bottom of enclosures, connect conduits to the circuit breaker enclosure with watertight hubs or a sealing locknut.
   4. Except in dry areas, install a conduit drain-fitting in a hole punched in the bottom of the enclosure, and install a conduit breather fitting in the top of the enclosure.
   5. Remove or protect components installed in the interior of enclosures during wire pulling.
   6. Use lugs provided or approved by the circuit breaker manufacturer to connect wiring to the circuit breaker's line and load terminals in conformance with Section 26 05 19.

C. Identify circuit breakers in accordance with Section 26 05 53.

3.04 FIELD QUALITY CONTROL

A. Site Testing:
   1. Prior to energizing the circuit breakers:
      a. Perform insulation testing and ensure that all load-side wiring is clear of shorts in accordance with the requirements of Section 26 05 63.
      b. Set and adjust overcurrent protective devices in conformance with the requirements of Section 26 05 63.
      c. Open all downstream disconnects and the circuit breaker.
   2. Final testing after energizing the circuit breakers:
      a. Perform the thermographic test in conformity with Section 26 05 63, and record the circuit parameters.

3.05 PROTECTION

A. Protect the items provided under this Section during the performance of work provided under other Sections, especially during welding and cutting operations.

B. Protect circuit breakers against overloads, short-circuits, and improper operation.
   1. Pad-lock the circuit breakers in the off position when work is being done on downstream circuits.

END OF SECTION

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: he work specified in this Section consists of materials for furnishing; installing, connecting, energizing, testing, cleaning and protecting enclosed low-voltage individually mounted enclosed starters and contactors, and related accessories.

B. Related Sections:
1. Section 26 05 00 Common Work Results for Electrical
2. Section 26 05 28 Hangers and Supports for Electrical Systems
3. Section 26 05 63 Acceptance of Electrical Systems
4. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables

1.02 REFERENCES

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

B. National Electrical Manufacturers Association (NEMA):
1. NEMA 250 Electrical Enclosures
2. NEMA AB 1 Molded Case Circuit Breakers and Molded Case Switches
3. NEMA FU 1 Low Voltage Cartridge Fuses
4. NEMA ICS 1 Industrial Control and Systems: General Requirements
5. NEMA ICS 2 Industrial Control and Systems: Contractors and starters
6. NEMA ICS 4 Industrial Control and Systems: Terminal Blocks
7. NEMA ICS 5 Industrial Control and Systems: Control Circuit and Pilot devices
8. NEMA ICS 6 Industrial Control and Systems: Enclosures
9. NEMA ST 1 Speciality Transformers

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

1.03 SUBMITTALS

A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.

B. Product Data and Catalog Cuts: Provide product data for all products provided. Indicate clearly the usage of each product.

C. Shop Drawings: Submit shop drawings of all enclosed low voltage starters.

D. Provide manufacturer's instructions for all enclosed starters and contactors.

1.04 SHORT CIRCUIT, ARC-FLASH, AND PROTECTIVE DEVICE COORDINATION STUDY

A. The computerized short-circuit, arc-flash, and protective coordination study will be performed and submitted as outlined in Section 26 05 00 of these specifications.

B. The Contractor is responsible for supplying the necessary and required information in order that this study may be completed and submitted at least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.

1.05 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. Source Quality Control: Provide standard prototype and routine factory tests of starters conforming to NEMA Standard 250, NEMA ICS 1, NEMA ICS 2, NEMA ICS 4, NEMA ICS 5 and NEMA ICS 5 and UL 508.

C. Conform all work to NFPA 70, National Electrical Code.

D. Install work under supervision of skilled licensed electricians.

1.06 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 manufacturers

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

2.01 MOTOR STARTERS

A. Manual Motor Starters: Provide starters in NEMA Standard 250 Type 1 enclosure, unless indicated otherwise on the Drawings, and having the correct number of poles needed and sufficient horsepower, or fractional horsepower rating to operate the connected motors.
   1. Fractional Horsepower Manual Starters: Starter consisting of a manually operated quick-make, quick-break toggle switch equipped with melting alloy type thermal overload relay. Thermal unit sized to suit imposed load and of one-piece construction and interchangeable. Starter rendered inoperative when thermal unit is removed. Starter contacts of double break silver alloy type in a trip-free switch mechanism.
   2. Acceptable Manufacturers:
      a. Eaton Electric (Basis of Design)
      b. Square D Company
      c. General Electric
      d. Siemens
      e. ABB
      f. Allen-Bradley

B. Combination Linestarters: Provide starter units as indicated on the Drawings and meeting the following requirements:
   1. Magnetically held, electrically operated, three pole assemblies with arc extinguishing characteristics and double break silver-alloy renewable contacts meeting NEMA ICS 2. Full voltage reversing (FVR) type single speed, full voltage non-reversing (FVNR) type single speed, reduced voltage non-reversing (RVNR) type single speed or three winding autotransformer closed transition type having 3 taps at 80%, 65% and 50% as indicated on the Drawings. Starters to accommodate three overload relay thermal units properly sized and installed on each phase of the respective motor to be controlled. Thermal unit must be in position to operate starter.
   2. Provisions to add a minimum of four normally open, or normally closed, electrical interlocks.
   3. Three pole melting-alloy-element block-type overload relays, trip-free hand reset. Furnish thermal units.
   4. Circuit breakers of the magnetic trip type meeting NEMA AB 1. Provide adjustment screw to simultaneously set the magnetic trip level of each individual pole with a single magnetic adjustment, with adjustment continuous throughout the trip range. Provide clear indication of whether the breakers are in the ON, OFF or TRIPPED position by the position of the external operating handle. Mechanically interlock handle with the unit door to prevent access unless the breaker is in the OFF position. Provide padlocking facilities to positively lock the

breaker in the OFF position with from one to three padlocks with the door open or closed.

5. UL Listed short circuit rating not less than short circuit current indicated on the Drawings.
6. Operating and Indicating Devices: Provide starters with operating and indicating devices as indicated on the Drawings.
7. Terminal Boards: Provide each starter with an individual terminal board within the unit, completely accessible from the front, and so arranged that connection to starter can be made from the front when unit frame and starter are in place. Provide clearly marked studs for line, load and control connections. Clearly mark terminals and indicate on the manufacturer's supplied interconnection diagrams.
8. Voltage:
    a. Control Voltage: 120 volts, using individual control transformers. Control transformers having a capacity of 100VA more than the capacity required to operate external solenoids, relays, alarms, and such other control voltage components, as indicated on the Drawings.
    b. Service Voltage: As indicated on the Drawings.
9. Enclosure: NEMA Standard 250 Type 1, unless indicated otherwise on the Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust-inhibiting phosphate and finished in gray baked enamel.
10. Acceptable Manufacturers:
    a. Eaton Electric (Basis of Design)
    b. Square D Company
    c. General Electric
    d. Siemens
    e. ABB
    f. Allen-Bradley

2.02 CONTACTORS

A. Provide contactors which meet the following:
1. Multipole, electrically operated, mechanically or magnetically held type as indicated on Drawings.
2. Continuous duty for each type of load.
3. Number of poles per contactor, amperages and load voltages as indicated on Drawings.
4. Construction: Flush dead back design with arc shields and barriers to prevent pole-to-pole flashover. Parts accessible for inspection and maintenance. Contacts readily replaceable from front. Contactors suited for tungsten and ballast lighting and resistance heating loads. Interrupting capacity 150 percent of rating with no derating for high inrush loads.
5. Enclosure: NEMA 1 surface type, unless indicated otherwise on Drawings, with provision for padlocking.

B. Acceptable Manufacturers:
1. Eaton Electric (Basis of Design)
2. Square D Company
3. General Electric
4. Siemens
5. ABB

6. Allen-Bradley

2.03 CONTROL RELAYS

A. Unless otherwise noted on the Drawings, provide industrial control relays having characteristics, components and enclosure as follows:
   1. Relay coil voltage of 120VAC.
   2. Number of normally open convertible contacts as indicated on the Drawings. Contacts rated 600V, 10 Amp.
   3. NEMA Standard 250 Type 1 enclosure unless indicated otherwise on the Drawings.

B. Acceptable Manufacturers:
   1. Eaton Electric (Basis of Design)
   2. Square D Company
   3. General Electric
   4. Siemens
   5. ABB
   6. Allen-Bradley

2.04 OPERATING AND INDICATING DEVICES

A. Provide operating and indicating devices manufactured in accordance with current NEMA ICS 1 and ICS 5 standards for heavy, duty control stations.
   1. Selector Switches: Multi-Position Selector Switches: Single hole mounted, heavy-duty, oiltight, watertight, industrial-type multiple-position selector switches. Double break silver switch contacts rated 600VAC, 7200VA make, 720 VA break, 10Amp continuous at 35% inductive power factor. Switch contacts, operator type, configuration, and other switch information as indicated on the Drawings.
   2. Pushbutton Switches: Single hole mounted, heavy duty, oiltight, watertight, industrial-type pushbutton switches with momentary contacts. Double break silver switch contacts rated 600VAC, 7200VA make, 720 VA break, 10Amp continuous at 35% inductive power factor. Switch contacts, operator type, configuration, color requirements, and other switch information as indicated on the Drawings.
   3. Pilot Lights: Single hole mounted, heavy duty, oiltight, watertight, industrial type transformer pilot lights with interchangeable fresnel lenses. Lens color as indicated on the Drawings.

B. Acceptable Manufacturers:
   1. Eaton Electric (Basis of Design)
   2. Square D Company
   3. General Electric
   4. Siemens
   5. ABB
   6. Allen-Bradley

2.05 TIMING RELAYS AND REPEAT CYCLE TIMERS

A. Provide relays having characteristics and components as follows:

1. Solid state CMOS timing circuit with transient protection. Type of timing circuit as indicated on the Drawings.
2. Knob adjustable time delay. Time range as indicated on the Drawings.
3. DPDT contacts, 10 Amp at 120V AC.
4. High impact plastic case with 8 pin octal or 11 pin round base. Include matching socket with screw terminals.
5. 120V AC operation.
6. UL Recognized component.

B. Acceptable Manufacturers:
1. Eaton Electric (Basis of Design)
2. Square D Company
3. General Electric
4. Siemens
5. ABB
6. Allen-Bradley
7. Telemecanique
8. IDEC
9. Diversified Electronics
10. Agastat
11. Potter & Brumfield

PART 3 EXECUTION

3.01 PREPARATION

A. Ensure that painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

C. Verify direction of motor rotation in equipment being served by motor starters before making final connections of such to motor starters.

3.02 INSTALLATION

A. Space enclosures out from surfaces mounted on 1/4-inch (6mm) spacers or U-Channel supports. Provide supports as specified in Section 26 05 28.

B. Install all starters in accordance with the manufacturer's instructions.

C. Set enclosure top 6-feet 6-inches (198cm) above finished floor, or grade unless otherwise indicated or specified. If other equipment is installed in an area the top of the circuit breaker may be set lower than 6-feet 6-inches (198cm) but in no case set the bottom of the enclosure lower than 6-inches (15cm) above the finish floor or grade.

D. Punch holes for conduit entries in the enclosures.

E. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

F. Interface with other work:
   1. Connect conduits to enclosure with watertight hubs except in damp locations on the bottom of enclosures. A sealing locknut may be used in place of watertight hubs and in dry locations two locknuts and bushings may be used.
   2. Connect wiring to line and load terminals with lugs provided or approved by manufacturer in conformance with Section 26 05 19. Remove interior or protect interior components during wire pulling.

G. Cleaning: Clean installed products of this Section where deposits of oil, grease, dirt, dust, mud, or debris is present after installation. Use detergent-water solution, solvents where necessary, or other liquid cleaners not harmful to material and equipment finishes.

3.03 TESTING

A. Consult Section 26 05 63 for requirements for field inspection and testing of motor starters.

3.04 PROTECTION

A. During painting mask all nameplates, all plastic parts, pushbuttons, operating shafts and all items not to be painted.

B. Protect all items during work of other trades including welding and cutting.

C. Protect circuit breaker against overloads, short circuits and improper operation. Padlock off when work is being done on downstream circuits.

END OF SECTION

SECTION 26 32 13.13

DIESEL ELECTRIC GENERATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of services and work to install a standby power generator system for Building B.

B. Related Sections:
1. Section 03 30 00 - Cast-in-Place Concrete
2. Section 26 05 00 – Common Work Results for Electrical
3. Section 26 05 19 - Grounding and Bonding for Electrical Systems
4. Section 26 05 28 - Hangers and Supports for Electrical Systems
5. Section 26 05 63 – Acceptance of Electrical Systems

1.02 MANUFACTURERS QUALIFICATIONS

A. Provide generating sets built, tested and shipped by one manufacturer to insure single source of supply and responsibility. Consideration shall be given only to manufacturers meetings the following qualifications:
1. The emergency generating units shall receive the manufacturer's standard testing to ascertain that they are functioning correctly prior to shipment.
2. Twenty-four hours, seven days a week operating service facility with complete spare parts stock within 150 miles (240 km) of Project Site. Delegation of this service responsibility for any or all of the equipment listed herein shall not be considered fulfillment of these Specifications.
3. Service capability to provide, after acceptance of equipment, four service calls per year in two years by a qualified maintenance or service representative, with provision that each call shall not exceed one day of service. Service calls shall not include materials, parts or equipment.

1.03 DESIGN CRITERIA

A. Standby generator sets rated continuous standby (defined as continuous for the duration of any power outage) at the following capacities:
1. Generator Rating capacities as herein specified at 0.8 power factor for standby applications (without fan), and rated in accordance with NEMA Class F temperature rise.
2. Generator Characteristics: (Minimum Nameplate Rating Values at Specified Design Conditions Including Step Loading and Ambient Temperature.)
   a. Two (2) non-paralleled 500 KW units
   b. All units shall conform to:
      1) Voltage (Grounded Wye) 480Y/277
      2) Phase 3
      3) No. Of Service Wires 4

B. Load Starting Requirements: Each generator shall be capable of starting the loads as indicated in the one line distribution schematic on the Drawings as well as 10% of additional load on each transfer switch. Motor starting capability shall be a minimum of 2,208 kVA. Each generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to each generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 25%.

C. The basis of design is a Cummins Power System Diesel Generator Model No. DFEK 500 kW with permanent magnet excitation and 105 degree C rise alternator.
   1. Load and sizing calculations must be submitted to the Engineer for approval as specified below for any substitution to the above generator.

D. Site Conditions:
   1. The operating environment of the power generating system shall be:

a.	Altitude	580 feet
b.	Outside temperature, max.	104 deg. F
c.	Outside temperature, min.	-20 deg. F
d.	Engine jacket water, glycol	50 percent
e.	Installation desc.	Outdoor Weather Protective Sound Attenuated Enclosure
f.	Fuel type	Diesel Fuel Oil No. 2
g.	Cooling system type	Radiator, blower fan, engine mounted

1.04 RREFERENCES

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

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 120; Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
   2. ASTM A 126; Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   3. ASTM D 396; Specification for Fuel Oils.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. IEEE Standard 446; Recommended Practice for Emergency and Standby Power Systems.

D. National Electric Manufacturer's Association (NEMA):
   1. NEMA MG 1 - Motors and Generators
   2. NEMA ICS 2 - Industrial Control and Systems - Controllers, Contactors and Overload Relays.
   3. NEMA ICS 6 - Industrial Control and Systems - Enclosures.
   4. NEMA MG 1-78; Motors and Generators.

E. National Fire Protection Association (NFPA):
   1. NFPA 37: Stationary Combustion Engines and Gas Turbines.
   2. NFPA 70: National Electrical Code. (NEC)
   3. NFPA 110: Emergency and Standby Power Systems.

F. Underwriter's Laboratories, Inc. (UL):
   1. UL 142 - Above Ground Tanks for Flammable and Combustible Liquids.

1.05 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. Product Quality Control:
   1. Manufacturers must fabricate their products in such a manner that ensures all criteria for appearance, fit and tolerances are met.
   2. Each manufacturer must carefully control his operations to ensure that the engineering, quality, safety and reliability of product are achieved.

1.06 SUBMITTALS

A. As specified in Section 26 05 00; submit product data for the products contained within this Section, including:
   1. List of materials to be used.
   2. Catalog cuts of all materials and equipment.

B. Shop Drawings: Shop drawings are required for the following:
   1. Diesel Engine.
   2. Generator.
   3. Engine and Generator Foundation Details.
   4. Engine and Generator Vibration Isolators.
   5. Generator Engine Systems Interface; Detail Drawings.
   6. Engine/Generator Control Schematics, One-Lines, and Generator Accessories Wiring Diagrams.
   7. Weather-Protective Housing.
   8. Main Line Circuit Breaker.
   9. Exhaust Silencer.
   10. Battery Charger.
   11. Batteries.
   12. All Heaters and Controls.
   13. Control Panel with Safety Controls.
   14. Manufacturer shall submit curves/calculations to indicate each generator meets the load starting and transient voltage dip requirements.

C. Calculations:
   1. Furnish manufacturer's comprehensive study including calculations used to ascertain size requirements for each generator and engine. Size and

performance of each generator set shall be adequate for connected worse case starting load amperes, to maintain voltage and frequency regulation as specified.

2. Furnish this study, with authorized manufacturer's representative signature for proof of preparation and liability, along with the shop drawings, to the Engineer for review and comments.

D. Factory Tests:
   1. Upon approval of all shop drawings and the engine generator calculations, the manufacturer shall fabricate and factory test each unit. A certified factory test report certifying each units full power rating, stability along with voltage and frequency regulation shall be forwarded to the Engineer for review, comments and approval.
   2. Upon receipt of the above referenced factory test approval, the manufacturer shall release the units for shipment; and forward the Operational and Maintenance Manuals to the Engineer for review and comments.

E. Field Tests: Field test of the engine generator set shall take place after the installation of the unit is completed; and shall conform to stipulations outlined in Section 26 05 63. A factory authorized representative shall be present during the tests; and a manufacturer's certification indicating acceptance and approval of each engine generator installation and the associated field tests shall be forwarded to the Engineer for review and comments and subsequent insertion into the O & M Manuals.

F. Operation and Maintenance Manual Contents: shall include spare parts lists, fuel types, lubricating oils, special tools, maintenance requirements and schedule, equipment/systems operation for the following:
   1. Engine.
   2. Generator.
   3. Cooling system - complete.
   4. Air intake and discharge system.
   5. Fuel system.
   6. Fuel tank.
   7. Control panel/control system.
   8. Main circuit breaker, solid-state type.
   9. Battery charger.
   10. Batteries.
   11. Exhaust system.
   12. Other auxiliaries as called out in this section.

1.07 WARRANTY TERMS

A. The manufacturer’s and dealer’s extended warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Applicable deductible costs shall be specified in the manufacturer’s warranty. Running hours shall not be a limiting factor for the system warranty by either the manufacturer or servicing dealer.

Submittals received without written warranties as specified will be rejected in their entirety.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Those Products such as conduit, wireways, wire and connectors, cable, support devices, fasteners, and similar devices, as required for Work of this Section are as specified in other Sections of these Specifications.

B. Diesel Engine Generator Sets:
   1. Diesel Engine: Heavy duty industrial type, water-cooled, of four stroke cycle compression ignition operation, having solid-injection, and of either vertical in-line or V-type design. Minimum displacement shall be 440 cubic inches, with 8 cylinders.
      a. Engine designed to operate at 1800 RPM at normal full load operation.
      b. Provide engine with removable wet or dry type cylinder liners of close-grained alloy cast iron.
      c. Provide engine capable of satisfactory performance when operating on commercial grade No. 2 Fuel Oil (ASTM D 396). Engines requiring premium or special fuels will not be considered.
      d. Provide engine capable of operating without loss in power up to 5,000 feet (1525 m) elevation in an ambient temperature of 125 degrees F (52 degrees C).
   2. Electronic Governor: Engine provided with an electronic solid state governing system for precise speed control of the prime mover. Provide a governor capable of operation in a droop or constant speed system with control at any set speed to be isochronous within plus or minus .25 percent.
      a. Governing system shall comprise an electronic control module, a speed setting potentiometer, a magnetic pick-up and a hydraulic actuator with fail-safe provisions for loss of power or speed. A sensor signal is incorporated in control module to shutdown the prime mover.
      b. The governor system shall operate from starting batteries and allow automatic paralleling with one or more generator sets.
      c. Fail-safe features shall include a separate overspeed device to prevent prime mover run-away in the event of any failure, which might render the governor inoperative.
   3. Diesel Fuel System Components:
      a. Fuel system equipped with a fuel filter having replaceable elements, which may be easily removed from their housing for replacement without breaking any fuel line connections, or disturbing the fuel pumps or any other part of the engine. Locate fuel filters in one easily accessible housing, ahead of fuel injection pumps so fuel is thoroughly filtered before it reaches the pumps. No screens or filters requiring cleaning or replacement permitted in the injection pump or injection valve assemblies.
      b. Injection pump of positive action, constant-stroke design and actuated by a cam driven by gears from the engine camshaft. Engine shall have an individual mechanical injection pump and injection valve for each cylinder, of

a type not requiring adjustment in service and capable of replacement within a few minutes.

c. Provide a manual shut-off valve on the fuel line and any check valves, flexible fuel connections and such other items that may be required for proper operation of the engine.

4. Lubrication:
   a. Engine provided with a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, cam-shaft bearings and valve rocker arm mechanism.
   b. Provide a suitable water-cooled oil cooler.
   c. Threaded spin-on type oil filters provided and so located and connected that lubricating oil is continuously filtered and cleaned. Filters shall be conveniently located for servicing. Equip filters with a spring loaded bypass valve as an assurance against stoppage of lubricating oil circulation in the event filters become clogged.
5. Air Cleaners: Engine provided with one or more dry type replaceable element air cleaners of sufficient capacity to effectively protect working parts of the engine from dust and grit. Crankcase connected together with engine air intake with a tube to eliminate crankcase emissions.
6. Automatic Starting System:
   a. Provide engine equipped with an electric starting system with positive engagement drive and of sufficient capacity to crank the engine at a speed, which will allow full diesel starting of the engine. System shall be 24 volts or as recommended by engine manufacturer.
   b. Automatic Controls: Fully automatic start-stop controls provided in generator set control panel. Controls shall provide shutdown for low oil pressure, high coolant temperature, engine overspeed, engine overcrank, and three single pole double throw auxiliary contacts for activating accessory items, contacts actuate upon an engine start signal. Include a minimum 30 second single cranking cycle limit with lockout. Also provide two timed output contacts meeting intake louver control requirements.
   c. Batteries: Lead-acid storage battery set of heavy-duty diesel starting type. Battery voltage compatible with starting system. Batteries of sufficient capacity to provide for four consecutive full starts consisting of four complete cranking cycles of ten seconds each and ten seconds rest, and in no case less than 225 AH (minimum of 1000A. CC). Provide battery rack, necessary cables, and clamps.
7. Heaters:
   a. An engine mounted, thermostatically controlled immersion type engine water jacket heater to be provided to insure maintaining engine block coolant temperature in the range of 120 to 140 degrees F (49 to 60 degrees C).
      1) Heater to be suitable for operation on 480 volts, 3-phase AC power, wattages per manufacturer’s recommendations.
      2) Heater shall include a lube oil pressure switch for automatic cut-out on engine start.
      3) Provide isolation ball valves on water jacket heater
   b. Generator winding anti-condensation strip heater, 120 volts A.C. thermostatically controlled. Factory wired to each generator control panel. Wattage as per manufacturer's recommendations.

c. Generator control panel heater, 120 volts A.C. thermostatically controlled. Factory wired to each generator control panel. Wattage as per manufacturer's recommendations.
d. Battery heater, 120 volts A.C. thermostatically controlled. Factory wired to each generator control panel. Wattage as per manufacturer's recommendations.

8. Engine Cooling: The cooling system for each emergency standby unit shall have sufficient capacity for cooling the respective engine when each generator set is delivering full-rated load at the design ambient temperature.
   a. Engine Circulating System:
      1) Each engine shall be equipped with an engine driven, centrifugal-type water circulating pump for circulating water through engine jacket, cylinder heads and radiator;
      2) Thermostatic valve to maintain the engine at recommended temperature level under all load conditions.
      3) Each cooling system shall be equipped with one or more spin-on type engine water filters, which will treat the coolant and prevent corrosion and scale deposits from forming inside the cooling system.
      4) Provide a gate valve between engine and jacket water heater to facilitate maintenance on jacket water heater.
   b. Antifreeze: Cooling system shall be filled with a minimum concentration of 50 percent enthylene glycol.
9. Generator: Generator shall be a 4 pole revolving field synchronous type, brushless, with a permanent magnet exciter, coupled directly to the engine flywheel through a flexible coupling arrangement designed for positive alignment. Each generator shall be of a single sealed bearing design, bearing being maintenance free and lifetime lubricated. Each generator housing shall bolt directly to the engine flywheel housing. The rotor shall be dynamically balanced for operating speeds up to 125 percent of rated speed. The rotor shall be constructed using techniques such that shaft currents are negligible and an insulated bearing is not needed. The rotor shall be provided with full amortisseur windings.
   a. Generator construction shall comply with all applicable sections of NEMA Standard MG-1, including NEMA MG-1 - 78. Generator insulation shall be Class H protected with 100 percent epoxy impregnation and an overcoat of resilient insulating material on the stator and rotor to reduce possible fungus and/or abrasion deterioration. Incorporate reactive droop compensation.
   b. Generator field excitation performed through a solid state, brushless, full wave rectification, rotating diode system.
   c. Each generator shall be capable of maintaining 300 percent of the standby current during short circuit conditions for a minimum of 10 seconds without the addition of external hardware such as a current boost system.
   d. Generator provided with a solid state voltage regulator. Voltage regulator mounted in the control panel on each generator. A built-in voltage adjusting rheostat shall provide five percent voltage adjustment. The voltage regulator shall have an adjustable maximum voltage dip. The voltage regulator shall also include overexcitation protection that will turn the voltage regulator off to protect each generator in the event of extended operation in an overload condition. Each generator shall be equipped with an overvoltage protection

device as standard equipment to prevent damage to each generator and connected loads in the event that each generator goes into an overvoltage situation. The overvoltage device shall be factory set for 125 percent of rated voltage. The voltage regulator shall have been designed for use with a diesel engine prime mover. The voltage regulator shall have been designed around the engine generator match for optimum load pick up.

e. Voltage Regulation: From no load to rated load maintained within a band of plus or minus 0.5 percent of rated voltage. The steady state voltage stability shall remain within a 0.5 percent band of rated voltage. Steady state voltage modulation shall not exceed one cycle per second.

f. One step load acceptance shall be 100 percent of nameplate KW rating to meet NFPA 110, Paragraph 5-13.2.6.

g. For any addition of load up to and including 100 percent of rated load, the transient voltage dip shall not exceed 20 percent of rated voltage. The voltage shall recover to, and remain within, the steady band in not more than 1.5 seconds. The unit to be able to nameplate power output in ambient temperature of 125 degrees F (52 degrees C).

10. Frequency Regulation: Under varying loads from no load to full load shall be isochronous. Random frequency variation shall not exceed plus or minus 0.25 percent.

11. Circuit Breaker:

a. A generator mounted main line molded case circuit breaker shall be provided for each unit. Each circuit breaker shall serve as a load circuit interrupting and protective device which shall operate both manually for normal switching functions and automatically during overloads and short circuit conditions.

b. Circuit breakers shall be sized as follows:

Unit Size	Circuit Breaker	
	Frame Size	Trip
KW	Amps	Amps
500	1000	1000

c. Circuit breakers shall be a solid state trip breaker with electronic trip unit having the following adjustable trip unit functions:
   1) Long time rating and delay
   2) Short time pickup and delay
   3) Instantaneous pickup
   4) Ground fault pickup (alarm only)

d. Circuit breaker shall be 80% rated; and be provided with a shunt trip attachment for emergency power shut-off.

e. Emergency Power shut-off shall be located just inside main electrical room adjacent to generator transfer switch.

f. Circuit breakers shall conform to types indicated above as manufactured by the Square D Company, General Electric, Siemens Industry for LV Power Distribution, Eaton Electric or Approved Equal.

12. Engine-Generator Set Control. A NEMA 1 enclosed control panel shall be mounted on each generator set with vibration isolators. The control shall be vibration isolated and prototype tested to verify the durability of all components under the vibration conditions encountered. Each generator set mounted control shall include the following features and functions:

a. Three position control switch labeled RUN/OFF/AUTO. In the RUN position each generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position each generator set shall immediately stop, bypassing all time delays. In the AUTO position each generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
b. RESET switch. The RESET switch shall be used to clear a fault and allow restarting each generator set after it has shut down for any fault condition.
c. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power.
d. Generator Set AC Output Metering: Each generator set shall be provided with a metering set with the following features and functions:
    1) Analog AC Voltmeter, dual range, 90 degree scale, 2% accuracy; Analog AC Ammeter, dual range, 90 degree scale, 2% accuracy; Analog Frequency/RPM meter, 45-65 Hz, 1350-1950 RPM, 90 degree scale, +/- 0.6 Hz accuracy.
    2) Seven position phase selector switch with OFF position to allow meter display of current and voltage in each generator phase. When supplied with reconnectable generators, the meter panel shall be reconnectable for the voltage specified.
e. Generator Set Alarm and Status Display: Each generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamp condition shall be clearly apparent under bright room lighting conditions. Each generator set control shall indicate the existence of the following alarm and shutdown conditions on the display panel:
    1) Low oil pressure (alarm)
    2) Low oil pressure (shutdown)
    3) Low coolant temperature (alarm)
    4) High coolant temperature (alarm)
    5) High coolant temperature (shutdown)
    6) Low coolant level (shutdown)
    7) Overcrank (shutdown)
    8) Overspeed (shutdown)
    9) Low fuel (alarm)
    10) Fuel leak (alarm)
    11) Ground fault (alarm)
    12) The non-automatic indicating lamp shall be red, and shall flash to indicate that each generator set is not able to automatically respond to a command to start from a remote location.
f. Engine Status Monitoring: The following devices shall be provided on each generator set control :
    1) Engine oil pressure gauge
    2) Engine coolant temperature gauge
    3) Engine operation hour gauge
    4) Battery voltage (DC volts)
g. Engine Control Functions. The control system provided shall include a cycle cranking system, which shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods. Fail to start shall be

indicated by operation of the overcrank alarm indication lamp. The control system shall also include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification.

h. Alternator Control Functions:
   1) Each generator set shall include an automatic voltage regulation system, which is matched and prototype tested with the governing system provided. It shall be immune from mis-operation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ.
   2) Voltage adjusting rheostat, locking screwdriver type, to adjust voltage +/- 5% from rated value;

i. Control Interfaces for Remote Monitoring. Provide the following features in the control system:
   1) Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on each generator set.
   2) One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
   3) A fused 10 amp switched 12VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever each generator set is running.
   4) A fused 20 amp 12VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

j. Furnish and install a 20-light LED type remote alarm annunciator with horn, in the electrical room of Building B. The remote annunciator shall provide all the audible and visual alarms called for by NFPA Standard 110 for level 1 systems; and in addition shall provide indications for fuel leak, high battery voltage, low battery voltage, loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA110 3-5.6.2.

13. Battery Charger:
   a. Fully automatic, transistorized controlled, constant voltage, current-limiting charger having and equalize charge timer with SCR controls. Equalizing charge must be up to 12 hours. Instruments must include a DC voltmeter, DC ammeter, ON/OFF switch, loss of AC power light, low battery voltage light, high battery voltage light and power ON light.
   b. Charging range must be adjustable from 25.3 volts to 30.6 volts and taper to 0 at full charge. Amperage must be 10 amps, tapering to 0 amps at full

charge. Operating temperature must be -40 degrees F to 140 degrees F. Battery charging system must be negative ground.

c. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, for remote indication of:
   1) Loss of AC power - red light
   2) Low battery voltage - red light
   3) High battery voltage - red light
   4) Power ON - green light (no relay contact)

d. Acceptable Manufacturers:
   1) Lamarche Manufacturing Company.
   2) Master Control Systems, Inc.

14. Exhaust System Components:
    a. Provide following as part of generator set:
       1) Gas-proof, seamless, 150 lb. (68 kg.) ASA steel turbo ell with petcock for bleeding off any condensation that might accumulate within the exhaust piping, and a ASA steel companion flange shall be furnished with each engine-generator set.
       2) A complete exhaust straight assembly shall be provided consisting of the following for the emergency generator unit.
          a) Gas-proof, 150 lb. (68 kg.) ASA steel floating flanges.
          b) Gas-proof, seamless, T-321 stainless steel, spiral wound, bellows type, flexible exhaust connections; 18 inches maximum length.
          c) Gas-proof, seamless, T-321 stainless steel, straight pipe lengths, which shall be cut, mitered and welded utilizing the tungsten inert gas (heli-arc) method.
       3) Silencer as specified below in this Section.
       4) Silencer and tailpipe shall be painted with a high temperature black enamel, corrosion resistant coating.
       5) Contractor shall be held responsible for required changes to the exhaust piping size, routing or other equipment that is a part of the exhaust system as a result of a substitution to the above generator.

15. Base: The engine-generator set shall be mounted on a heavy, duty steel base to maintain alignment between components. The base shall include a battery tray with hold-down clamps within the rails.
16. Outdoor, Weather-Protective, Sound Attenuating, Skin-Tight Enclosure
    a. Each generator set shall be provided with a sound-attenuated housing which allows each generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of each generator set while operating at full rated load by a minimum of 10 dBA at any location 7 meters from each generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.
    b. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and pad

lockable door latches shall be provided for all doors. Door hinges shall be stainless steel.

c. The enclosure shall be provided with a critical exhaust silencer, which is mounted inside of the enclosure, and allows each generator set package to meet specified sound level requirements. Silencer and exhaust shall include a raincap and rainshield.
d. All sheetmetal shall be primed for corrosion protection and finish painted with the manufacturers standard color. All surfaces of all metal parts shall be primed and painted.
e. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
f. Provide a sub-base fuel tank for each generator set, sized to allow for full load operation of each generator set for 26 hours. The sub-base fuel tank shall be UL142 listed and labeled. Installation shall be in compliance to NFPA37. The fuel tank shall be a double-walled, steel construction and include the following features:
    1) Emergency tank and basin vents.
    2) Mechanical level gauge.
    3) Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.
    4) Leak detection provisions, wired to each generator set control for local and remote alarm indication.
    5) High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level
    6) Basin drain.
    7) Integral lifting provisions.

17. Acceptable manufacturers for the diesel engine generator sets:
    a. Cummins Power Generation
    b. Kohler Power Systems
    c. Caterpillar
    d. Katolight
    e. Generac
    f. Or Approved Equal.

2.02 SPARE PARTS

A. Filters:
    1. Provide three complete sets of filters for each unit as required for normal service and maintenance routines.
        a. Corrosion Filter(s). D.C.A.
        b. Primary Fuel Filter(s).
        c. Secondary Fuel Filter(s).
        d. Lubrication Filter(s).
        e. Air Intake Filter(s).
        f. Related Gasket(s).
        g. Coolant Filter(s). D.C.A.

2. Pack spare filters in manufacturer's standard cartons and turned over to Authority upon the completion of the final performance test and acceptance of equipment by Authority.

2.03 SAFETY PROTECTION EQUIPMENT

A. Personal Hearing Protection:
   1. Provide two pair of industrial type earmuffs for each engine generator set location having wide ear cushions that spread pressure over the entire area of the cushion and an adjustable padded headband for added stability.
   2. Acoustic fibers shall fill the extra deep cups to protect hearing from all noises, including low frequencies. Earmuffs shall be rated NRR 29db when worn overhead.
   3. Acceptable Manufacturer: Lab Safety Supply - UM-6898.

2.04 FOUNDATION FOR GENERATOR SET

A. Concrete work shall be as specified in Section 03 30 00.

B. Provide conduit turn-ups and cable entrance spaces as required by the equipment to be installed thereon.

C. Conduits shall extend 3-inches (76mm) above concrete slab surface. All conduits shall have bushings to protect cables and provide means for grounding.

D. Final connections shall be made with liquid tight flexible metallic conduit.

E. The construction of each concrete pad and the installation of same shall be in strict conformance with these specifications and the details indicated on the drawings.

2.05 GROUNDING MATERIALS

A. Grounding materials shall be as specified in Section 26 05 26.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install equipment with skilled mechanical erection labor in accordance with manufacturer's instructions. Provide such operations and work as may be necessary to provide a complete installation in accordance with these Specifications and/or Drawings, or as may be reasonably interpreted there from for a complete installation ready for service operation.
   1. Following the mechanical performance test, instruct Authority's operating personnel regarding each engine-generator operation and maintenance.

B. Mounting:
   1. Provide spring-type vibration isolators between each engine-generator unit and the sound attenuating/weatherproof enclosure base. Vibration isolators shall

deflect statically at least 1-1/2-inches (38 mm). The number and size of isolators as recommended by the engine-generator manufacturer.

2. Provide pre-set anchor bolts as specified in Section 26 05 28, to anchor each engine-generator in place on concrete foundation.

3.02 GROUNDING

A. Generator set shall have all ground pads connected to a solid earth ground using cone pointed drive ground rods as specified in Section 26 05 26 of these specifications. Install as indicated to provide an earth ground having a test resistance of no more than 5 ohms.

3.03 TESTING/CERTIFICATION

A. Testing/Certification: Consult Section 26 05 63 for requirements for field inspection and testing of the diesel-engine generator set.

END OF SECTION

SECTION 26 33 53

STATIC UNINTERRUPTIBLE POWER SUPPLIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for uninterruptible power supply systems, components and related installations.

B. Related Sections:
   1. Section 26 05 00 – Common Work Results for Electrical Systems
   2. Section 26 05 26 - Grounding and Bonding for Electrical Systems

1.02 REFERENCES

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

B. Institute of Electrical and Electronic Engineers (IEEE)/America National Standards Institute (ANSI):
   1. ANSI/IEEE C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

C. National Electrical Manufacturer's Association (NEMA):
   1. NEMA PE 1 - Uninterruptible Power Systems.

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

E. Federal Communication Commission, FCC Part 15, Class A requirements.
   1. Manufacturer's ISO 9001 Certification Program.
   2. Underwriters Laboratories (UL):
   3. UL 1778 – Uninterruptible Power Supplies.
   4. Occupation Safety and Health Administration (OSHA) requirements.

1.03 DESIGN REQUIREMENTS

A. This Section defines the electrical and mechanical characteristics and requirements for a continuous-duty, three-phase, solid-state, uninterruptible power supply system. The uninterruptible power supply systems, hereafter referred to as the UPS, shall provide high-quality AC power for sensitive electronic equipment loads.

B. The UPS shall be designed and manufactured in accordance with Article 1.02 of this Section, containing applicable documents, regulations and industry manufacturing requirements, associated with this equipment.

C. The UPS shall be UL or ETL Listed per UL Standard 1778.

D. Building B:
   1. System Requirements
      a. The UPS in Building B shall utilize a rack-mounted N+1 redundant, scalable array architecture. The system power train shall be comprised of (7) 25 kVA/25 kW power modules and shall be configured for N+X redundant operation at the initial rated system load of 150kVA.
      b. The UPS battery shall be sized for 150 kVA for 3 minutes and 30 seconds of operation and upgradable to 225 kVA for 4 minutes and 30 seconds
      c. The UPS shall facilitate the replacement of power modules while the system remains in normal operation, without the requirement to transfer to bypass (hot swappable power modules).
      d. Each hot-swappable/user replaceable 25 kVA/25 kW power module shall contain a fully rated, power factor corrected input rectifier/boost converter hereafter referred to as the PFC input stage, a fully rated output inverter, battery charging circuit and field replaceable fans. Power module fans shall be variable speed controlled and capable of maintaining the system in the event of a single fan failure. The system shall also be comprised of a hot swappable continuous duty bypass static switch module, redundant control modules, redundant logic power supplies, and touch screen user interface/display. Hot swappable/user-replaceable battery modules shall be available as an option.
      e. In addition, this Section describes the performance, functionality, and design of the UPS maintenance bypass cabinet with output distribution and the battery system.
      f. The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.
      g. All programming and miscellaneous components for a fully operational system as described in this Section shall be available as part of the UPS.
   2. System Characteristics:
      a. Input: The system input shall be configurable as either single or dual mains derived from a three phase wye source. Standard cable entry shall be through the top. Bottom cable entry shall also be facilitated. Depending on the specific configuration, the use of the optional bottom feed enclosure may be required. An option shall be available to facilitate the connection of NEMA 2 compression lugs for main input, bypass input, DC input, and output cable connections.
         1) AC Input Nominal Voltage: System voltage shall support 480V, 3-phase + neutral + ground in a single main configuration:
         2) AC Input Voltage Window:
            a) ±15 percent for full performance.
            b) -50 percent for reduced load.
         3) Short Circuit Withstand Rating:
            a) UPS: 65,000 Symmetrical Amperes
            b) Maintenance Bypass with Distribution Panel: 50,000 Symmetrical Amperes
         4) Maximum Frequency Range: 40 to 70 hertz.

a) Frequency shall be synchronized to bypass input when available over the standard range of 57 to 63 hertz. Frequency tolerance range shall be configurable from 0.5 percent to 8 percent from front panel. Default shall be +/-1% (+/-0.6Hz at 60Hz).

5) Input Power Factor:
   a) Greater than 0.995 with load at 100 percent.
   b) Greater than 0.99 with loads above 50 percent.
   c) Greater than 0.97 with loads above 25 percent.
6) Input Current in Normal Operation:
   a) As a percentage of output current, with no charging, will be limited to a maximum of 105 percent of system capacity
7) Input Current Distortion with No Additional Filters:
   a) Less than 5 percent.
8) Soft-Start:
   a) Shall be linear from 0 percent to 100 percent input current and shall not exhibit inrush. This shall take place over an Authority-selectable 1 second to 40 second time period with a factory default of 15 seconds.

b. UPS Output:
1) AC Output Nominal Output: System voltage shall support 480V, 3-phase + neutral + ground.
2) AC Output Voltage Distortion: Less than 2 percent at 100 percent linear load, less than 3 percent for SMPS load as defined by IEC 62040-3.
3) AC Output Voltage Regulation: ±1 percent for 100 percent linear or non-linear load.
4) Voltage Transient Response: ±5 percent maximum RMS change in a half cycle at load step 0 percent to 100 percent or 100 percent to 0 percent.
5) Voltage Transient Recovery: Within less than 50 milliseconds.
6) Output Voltage Harmonic Distortion: Less than 2 percent THD maximum and 1 percent single harmonic for a 100 percent linear load.
7) Overload Rating:
   a) Normal Operation:
      (1) 150 percent for 30 seconds before transfer to bypass.
      (2) 125 percent for 10 minutes before transfer to bypass.
   b) Battery Operation: 125 percent for 30 seconds (up to 10 minutes with fully configured battery solution)
   c) Bypass Operation:
      (1) 125 percent continuous at 480 volts.
      (2) 110 percent continuous at 400 volts
      (3) 1000 percent for 100 milliseconds.
8) System AC-AC Efficiency:
   a) Normal operation greater than 96 percent at 40 percent to 100 percent load.
   b) Battery operation greater than 95 percent at 40 percent to 100 percent load.
9) Output Power Factor Rating: 0.5 leading to 0.5 lagging without any derating.

c. Charge current:
1) 20% of charging capacity when the load is less than 90%

2) 10% of charging capacity with 100% load

E. Building A & C:
1. System Requirements
   a. The UPS shall utilize double conversion online topology designed to protect electronic equipment by supplying reliable, network-grade power with extremely tight voltage and frequency regulation. The UPS shall feature an internal bypass and input power factor correction.
   b. The primary sections of the UPS are: input disconnect and filter stage, input PFC power stage (converters), energy storage stage (DC bus capacitor bank), output power stage (inverters), bypass and a battery charger.
   c. The system shall also include user field-replaceable battery modules, battery disconnects, Emergency Power Off (EPO) facility, and an integrated UPS Network Interface Card (NIC), with temperature monitoring.
   d. In addition, this specification describes the performance, functionality, and design of a UPS Service Bypass Panel, hereafter referred to as the SBP, the external Battery Systems, and connectivity solutions.
   e. The UPS battery shall be sized for 6 kVA for 30 minutes of operation.
   f. The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.
   g. All programming and miscellaneous components for a fully operational system as described in this specification shall be available as part of the UPS.
2. Modes of Operation
   a. Online: The input Power Factor Correction (PFC) power stage (converters) and the output power stage (inverters) shall operate in an on-line manner to continuously regulate power to the critical load. The input PFC stage shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.
   b. On Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output power stage (inverters), which shall derive their power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to online operation.
   c. Bypass: The bypass mode shall be used to provide transfer of critical load from the inverter outputs to the primary power source. This transfer, along with its retransfer, shall take place in a time less than or equal to 4ms. In the event of an emergency, this transfer shall be an automatic function.
   d. External Service Bypass Panel (SBP): The maintenance service bypass panel shall provide power to the critical load from the bypass power source during times where maintenance or service of the UPS is required or the removal of the UPS is desired. The SBP shall provide a mechanical means of complete isolation of the UPS from the electrical wiring of the installation. The SBP shall be constructed in a free-standing, rack mounted or wall-mounted NEMA 1 enclosure, unless otherwise stated in this specification. It shall be designed for single phase input with a “no break” transfer between bypass and UPS power. The UPS shall have the option of a hardwire Input / Output kit to facilitate External Service Bypass connections.

3. Mechanical Design
    a. The UPS shall be contained in a rugged steel cabinet with a plastic front bezel.
    b. The UPS dimensions shall be 5.1 x 17 x 26 in. (HxWxD).
    c. The UPS cabinet shall be configurable between Tower and Rack-Mount configurations.
4. System Characteristics
    a. System Capacity via the standard NEMA L14-30P input connector:
        1) The 6000VA (120V / 208V) system shall be rated as follows:
            a) 5,000VA or 3,675W, line – line, whichever limit is reached first.
            b) 2,880VA or 2,100W, per phase, whichever limit is reached first.
5. Input:
    a. AC input nominal voltage:
        1) 200VAC or 208VAC or 240VAC, split phase, 4-wire (2PH+N+G).
    b. AC input voltage window:
        1) Full Load, 85 - 138 (Line to Neutral) VAC, per phase.
        2) Half Load, 50 - 138 (Line to Neutral) VAC, per phase.

    c. Input frequency range: 45-65Hz.
    d. Input Power Factor; > 0.95 at 100% load.
    e. Input Current Distortion:
        1) <4.5% at 100% load. (SURTD6000RMXLJP3U)
6. UPS Output:
    a. AC Output Nominal Output: (Customer configurable), 100V (200V) or 120V (208V/240V), 4 wire (2Phase + N + G), 50 / 60 Hz.
    b. AC output voltage distortion: < 2% @ 100% linear load; < 5% @ 100% non-linear Load (SURTD5000RMXLP3U & SURTD6000RMXLP3U) and < 7% @ 100% non-linear Load (SURTD6000RMXLJP3U)
    c. AC output voltage regulation (Static): +/-1%.
    d. AC output voltage regulation (Dynamic): +/-5%, for 10 to 90% load step.
    e. Voltage Transient Recovery within < 50ms recovery time, 10 to 90% load step.
    f. Overload Rating:
        1) Online: 104% - infinite; 125% - 1 minute; 150% - 30 seconds.
        2) In bypass: Overload shall be limited by the external input circuit breakers feeding the UPS.
    g. Crest factor: 3:1.
    h. System AC-AC Efficiency: 89% at 100% load
    i. Output Power Factor Rating: 0.5 Lagging to 0.5 Leading.
    j. Output frequency: 50/60 +/- 3Hz (Tracking) or 50/60 +/- 0.1Hz (Free running) or 50/60 +/- 1Hz (Free running) - user selectable.
    k. Output connectors: (1) L6-30R, (1) L14-30R & (4) 5-20R.
    l. Output frequency Slew rate: 0.1Hz/sec.

1.04 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. Products for, and the execution of, the work of this Section shall satisfy the applicable requirements of the latest NEC Codes and Regulations of Jurisdictional Authorities, and the Occupational Safety and Health Act. Products shall satisfy the applicable requirements of ANSI, NEMA, UL, and ASTM.

C. Select a manufacturer who has been engaged in production of similar Uninterruptible Power Supply Systems for a minimum of ten years. The system shall be designed and manufactured according to world class quality standards. The manufacturer shall be ISO 9001 certified.

D. Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

1.05 SUBMITTALS

A. Shop drawings and manufacturers' literature shall be submitted and shall consist of single-line diagrams, assembly wiring diagrams, equipment drawings, breaker and fuse coordination curves, product description, and installation instructions. Shop drawings shall clearly indicate enclosure size, gutter space, breaker frame sizes and trips, main bus type and rating.

B. An Installation and Maintenance Manual shall be submitted and shall include equipment fabrications details, installation instructions and testing procedures.

C. Maintenance and Operating Manuals shall be submitted and shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures, and operating instructions.

D. Certified copies of factory test results shall be submitted.

E. Installation Certificates shall be submitted as specified in Section 26 05 00.

1.06 MODES OF OPERATION

A. The UPS shall be designed to operate as an on-line reverse transfer system in the following modes:
   1. Normal. The PFC input stage and output inverter shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.
   2. Emergency. Upon failure of the AC input source, the critical load shall continue being supplied by the output inverter, which shall derive its power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation.

Upon restoration of utility power to the UPS input, the UPS shall recharge the battery.

3. Recharge. Upon restoration of utility AC power, after a utility AC power outage, the rectifier/charge shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.
4. Bypass. The system shall be equipped with an optional integrated, bus connected external MBwD to electrically isolate the UPS during routine maintenance and service of the UPS. The MBwD shall allow for the completely electrical isolation of the UPS. An option for an external make-before-break external maintenance bypass panel shall be available.

1.07 ENVIRONMENTAL RATINGS

A. Ambient Temperature Ranges:
   1. Operating Temperature:
      a. UPS: 0 to +40 □C.
      b. Battery: +25 □5□C.
   2. Storage Temperature:
      a. UPS: -20 to +70 □C.
      b. Battery: -20 to 33 □C.

B. Relative Humidity: 0 to 95 percent, non-condensing.

C. Altitude:
   1. Operating: 0 to 2,000 meters. Derated for higher altitudes.
   2. Storage: 0 to 12,000 meters.

D. Audible Noise: Noise generated by the UPS under any condition of normal operation shall not exceed a sound pressure level of 65 dBA measured at 1 meter from the surface of the UPS.

PART 2 PRODUCTS

2.01 BUILDING B

A. FABRICATION
   1. Materials:
      a. All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.
      b. The maximum working voltage, current, and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. The operating temperature of solid-state component sub-assembly shall not be greater than 75% of their ratings. Electrolytic capacitors shall be computer grade and be operated at no more than 95% of their voltage rating at the maximum rectifier charging voltage.
   2. Wiring:
      a. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70). All bolted connections of bus bars, lugs, and cables shall be in accordance with

requirements of the National Electrical Code and other applicable standards. All electrical power connections are to be torqued to the required value and marked with a visual indicator.

b. Provision shall be made for power cables to enter or leave from the top or bottom of the UPS cabinet.

3. Construction and Mounting:
   a. The UPS unit, comprised of input transformer (if required), rectifier/charger with input filter, inverter, static transfer switch, output transformer and maintenance bypass switch, shall be housed in a single free-standing NEMA type 1 enclosure. Cabinet doors/covers shall require a tool for gaining access. Casters and stops shall be provided for ease of installation. Front access only shall be required for expedient servicing, adjustments, and installation. The UPS cabinet shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling.
   b. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color. The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug connections. Like assemblies and like components shall be interchangeable.
4. Cooling:
   a. Cooling of the UPS shall be by forced air. Low-velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output.
   b. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.
5. Grounding:
   a. The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.

B. PFC INPUT STAGE
1. General: The PFC input stage converters of the system shall be housed within the removable power modules, and shall constantly control the power imported from the mains input of the system, to provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and main inverter regulated output power. These power modules shall be connected in parallel within the UPS frame
2. Input Current Total Harmonic Distortion: The input current THDI shall be held to less than 5 percent at system load greater than 50 percent while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting both a linear or non-linear load. This shall be accomplished without the requirement for additional or optional filters, magnetic devices, or other components.
3. Soft-Start Operation: As a standard feature, the UPS shall contain soft-start functionality, capable of limiting the input current from 0 percent to 100 percent of the nominal input over a default 10 second period, when returning to the AC utility source from battery operation. The change in current over the change in time shall take place in a linear manner throughout the entire operation.
4. Magnetization Inrush Current: The UPS shall exhibit zero inrush current. The default softstart is 15 seconds.

5. Input Current Limit:
    a. The PFC input stage shall control and limit the input current draw from utility to 124 percent of the UPS output. During conditions where input current limit is active, the UPS shall be able to support 100 percent load at -15% utility power and no charge power.
    b. In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100 percent of UPS capacity, input current shall not exceed 116 percent of UPS output current, while providing full battery recharge power and importing necessary power to account for system losses.
6. Redundancy: The UPS shall be capable of being configured with redundant PFC input stages, each with semiconductor fusing, and logic-controlled contactors to isolate a failed module from the input bus.
7. Charging:
    a. The battery charging shall keep the DC bus float voltage of ±327 volts, ±1 percent.
    b. The battery charging circuit shall contain a temperature compensation circuit, which shall regulate the battery charging to optimize battery life.
    c. The battery charging circuit shall remain active when in static bypass and in normal operation.
    d. The UPS shall be capable of reducing the battery charging current under low input voltage conditions as long as utility power for the PFC is being provided.
    e. Battery charge shall be limited to 10 percent of the system capacity by default (or optionally, 20% with reduced load).
    f. The battery charging circuit will support boost, auto boost and equalization functions
    g. An input connection will be provided that will allow the user to inhibit boost charging.
    h. The UPS shall be capable of reducing the battery charging current down to zero based on user defined input.
8. Back-Feed Protection: The above mentioned logic-controlled contactor shall also provide the back-feed protection required by UL 1778.

C. COMPONENTS
1. OUTPUT INVERTER
    a. General: The UPS output inverter shall constantly develop the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT driven bi-directional power converters. In both normal operation and battery operation, the output inverters shall create an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal nature of the output voltage sine wave of the inverters.
    b. Overload Capability: The output power converters shall be capable of 230 percent for short circuit clearing. Steady-state overload conditions of up to 150 percent of system capacity shall be sustained by the inverter for 30 seconds in normal operation. Steady-state overload conditions of up to 125 percent of system capacity shall be sustained by the inverter for 10 minutes in normal operation. Overloads persisting past the outlined time

limitation the critical load shall be switched to the automatic static bypass output of the UPS.

c. Output Contactor: The output inverter shall be provided with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter shall be isolated from the critical bus.
d. Battery Protection: The inverter shall be provided with monitoring and control circuits to limit the level of discharge on the battery system.
e. Redundancy: The UPS shall be capable of being configured with redundant output inverters, each with semiconductor fusing, and logic-controlled contactors to remove a failed component from the input, DC, and output critical bus.

2. STATIC BYPASS
   a. General: As part of the UPS, a system static bypass module shall be provided. The system static bypass shall be hot swappable and provide no break transfer of the critical load from the inverter output to the static bypass input source during times where maintenance is required, or the inverter can not support the critical bus. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS and static bypass module shall constantly monitor the auxiliary contacts of their respective circuit breakers, as well as the bypass source voltage, and inhibit potentially unsuccessful transfers to static bypass from taking place.
   b. Design: The design of the static switch power path shall consist of silicon-controlled rectifiers (SCR) with a continuous duty rating of 125 percent of the UPS output rating.
   c. Automatic Transfers: An automatic transfer of load to static bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from static bypass back to normal operation shall take place when the overload condition is removed from the critical output bus of the system. Automatic transfers of load to static bypass shall also take place if for any reason the UPS cannot support the critical bus.
   d. Manual Transfers: Manually initiated transfers to and from static bypass shall be initiated through the UPS graphical user interface. [For parallel configurations, transfers to and from bypass can be initiated from any online UPS in the system.]
   e. Overloads: For 480V systems, the static bypass shall be rated and capable of handling overloads equal to or less than 125 percent of the rated system output continuously. For 400/415V systems, the static bypass shall be rated and capable of handling overloads equal to or less than 110 percent of the rated system output continuously. For instantaneous overloads caused by inrush current from magnetic devices, or short circuit conditions, the static bypass shall be capable of sustaining overloads of 1000 percent of system capacity for periods of up to 100 milliseconds.
   f. Modular: The static bypass switch shall be of a modular design.
   g. System Protection: As a requirement of UL 1778, back-feed protection in the static bypass circuit shall also be incorporated in the system design. To achieve back-feed protection, a mechanical contactor in series with the bypass SCR(s) shall be controlled by the UPS/static switch, to open immediately upon sensing a condition where back-feeding of the static

switch by any source connected to the critical output bus of the system is occurring. One such condition could be a result of a shorted SCR.

h. Static Switch: For parallel systems, static switch design shall be distributed/integral type. External static switch cabinets shall not be necessary.

3. DISPLAY AND CONTROLS

a. Control Logic: The UPS shall be controlled by two fully redundant, Authority-replaceable and hot-swappable intelligence modules (IM). These modules shall have separate, optically isolated, communication paths to the power and static switch modules. Logic power for the control modules shall be derived from redundant power supplies, each having a separate AC and DC input and output. The communication of the control modules shall be of controller area network (CAN Bus) and EIA485. All control functions such as start-up, transfer to bypass, and all parameter changes shall be accessible from the touch screen user interface. Operations such as start-up will have step by step instructions from the user interface to ensure correct sequencing of operations. To further minimize user error, the touch screen shall highlight, in green, all functions that have been completed. The current step in the process shall also be outlined to ensure easy operation. Each UPS system shall have one such user interface.

b. Graphical User Interface: A microprocessor-controlled user interface/display unit shall be located on the front of the system. The display shall consist of a 10.4 inch (264 mm) multicolor graphical display with 800 x 600 resolution.

c. Metered Data: The following data shall be available on the graphical user interface/display:
   1) Input\output voltages, currents, frequencies.
   2) Breaker and switch status.
   3) Battery status.
   4) Event log.
   5) Energy measurements.

d. Event Log: The display unit shall allow the Authority to display a time and date stamped log. The event log shall be capable of holding 1500 entries. The default event log size shall be 400 entries.

e. Alarms: The display unit shall allow the Authority to display a log of active alarms. The following minimum set of alarm conditions shall be available:
   1) Input frequency outside configured range.
   2) AC adequate for UPS but not for bypass.
   3) Low/no AC input, startup on battery.
   4) Intelligence module inserted.
   5) Intelligence module removed.
   6) Redundant intelligence module inserted.
   7) Redundant intelligence module removed.
   8) Number of batteries changed since last on.
   9) Number of power modules changed since last on.
   10) Number of batteries increased.
   11) Number of batteries decreased.
   12) Number of power modules increased.
   13) Number of power modules decreased.
   14) Number of external battery cabinets increased.
   15) Number of external battery cabinets decreased.

16) Redundancy restored.
17) Need battery replacement.
18) The redundant intelligence module is in control.
19) UPS fault.
20) On battery.
21) Shutdown or unable to transfer to battery due to overload.
22) Load shutdown from bypass. input frequency, volts outside limits.
23) Fault, internal temperature exceeded system normal limits.
24) Input circuit breaker open.
25) System level fan failed.
26) Bad battery module.
27) Bad power module.
28) Intelligence module installed and failed.
29) Redundant intelligence module installed and failed.
30) Redundancy lost.
31) Redundancy below alarm threshold.
32) Runtime below alarm threshold.
33) Load above alarm threshold.
34) Sub feed breaker above critical level
35) Load no longer above alarm threshold.
36) Minimum runtime restored.
37) Bypass not in range (either frequency or voltage).
38) Back-feed contactor stuck in off position.
39) Back-feed contactor stuck in on position.
40) UPS in bypass due to internal fault.
41) UPS in bypass due to overload.
42) System in forced bypass.
43) Fault bypass relay malfunction.
44) Q001 open/closed.
45) Q002 open/closed.
46) Q003 open/closed.
47) Q005 open/closed.
48) High DC warning.
49) High DC shutdown.
50) Low battery shutdown.
51) Low battery warning.
52) MBwD door open.
53) Parallel communication error

f. Controls: The following controls or programming functions shall be accomplished by the use of the user interface/display unit. The touch screen display shall facilitate these operations:
1) Silence audible alarm.
2) Display or set the date and time.
3) Enable or disable the automatic restart feature.
4) Transfer critical load to and from static bypass.
5) Test battery condition on demand.
6) Set intervals for automatic battery tests.
7) Adjust set points for different alarms.
8) Adjustable ramp-in times from 1 to 40 seconds.
9) Potential free (dry) contacts.

g. Free Contacts: The following potential free contacts shall be available on the relay interface board:
   1) Normal operation.
   2) Battery operation.
   3) Bypass operation.
   4) Common fault.
   5) Low battery.
   6) UPS off.

h. Communication Interface Board: A communication interface board shall provide the following communication ports which shall be able to be used simultaneously:
   1) Ethernet.
   2) Ethernet interface port for a remote display.
   3) Modbus RS485

i. Emergency power off (EPO) (Note: The EPO pushbutton shall include a protective cover to prevent unintentional operation).

4. BATTERY
   a. The UPS battery shall support an optional battery plant of modular construction made up of Authority-replaceable, hot-swappable, fused, battery modules. Each battery module shall be monitored for voltage and temperature for use by the UPS battery diagnostic. Battery charging current shall be temperature compensated.
   b. The battery jars housed within each removable battery module shall be of the valve regulated lead acid (VRLA) type.
   c. The UPS shall incorporate a battery management system to continuously monitor the status of each removable battery module. This system shall notify the Authority in the event a failed or weak battery module is found.
   d. The batteries shall be long life batteries (5 to 8 years) and the battery casing shall be flame retardant type.
   e. The UPS shall incorporate a battery capacity test that will be capable of determining available runtimes.
5. ACCESSORIES
   a. Maintenance Bypass Cabinet (MBwD): The MBwD shall provide power to the critical load bus from the bypass source, during times where maintenance or service of the UPS is required. The MBwD shall provide a mechanical means of complete isolation of the UPS from the electrical wiring of the installation and shall be mounted to the systems I/O frame. As a minimum, the MBwD shall contain the following features and accessories:
      1) Subfeed circuit breakers of the appropriate size, withstand rating (see table), and trip rating for the system.

Breaker size	Interrupt rating
60-100A	22,000AIC
125-400A	25,000AIC

      2) Minimum 1A/1B auxiliary contacts for the purpose of relaying status information of each circuit breaker/switch actuator to the UPS and static bypass.
      3) Plated copper bus bar (where applicable), braced for the appropriate withstand rating (50 kAIC rating) of the system.
      4) A load test port (not breaker protected)

5) Field configurable such that the MBwD can be located on the left or right side of the system Input / output cabinet
6) The following minimum options shall also be available for the MBwD:
    a) Mimic label with light indications for power flow.
7) The MBwD shall carry one of the following agency listings:
    a) UL 891.
    b) UL 1558.
    c) UL 1778.
    d) UL 60950.

b. Remote Batteries: The modular batteries shall have the capability to be located remote to the UPS. In such installations, an optional side car shall be used to connect the batteries by cables to the UPS. The battery side car shall accommodate top or bottom cable entry. The side car shall have overcurrent fuses to protect the cables. The fuse status shall be monitored by the UPS.

c. Relay Board: Relay boards shall be provided for Authority connections to external alarms or to activate external Authority circuits.

d. Software and Connectivity:
1) Network Adaptor: The ethernet web/SNMP adaptor shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base (MIB) shall be provided in DOS and UNIX "tar" formats.
2) Unattended Shutdown: The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems during when the UPS is operation from the battery.

e. Remote UPS Monitoring: The following methods of remote UPS monitoring shall be available:
1) Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.
2) Simple Network Management Protocol (SNMP): Remote UPS monitoring shall be possible through a standard MIB II compliant platform.

f. Software Compatibility: The UPS manufacturer shall have available software to support remote monitoring and initiate the graceful shutdown for the following systems:
1) Microsoft Windows Vista
2) Microsoft Windows 7
3) Microsoft Windows 95/98/XP.
4) Microsoft Windows NT 4.0 SP6/2000.
5) OS/2.
6) Netware 3.2 – 5.1.
7) MAC OS 9.04, 9.22, 10.
8) Digital Unix/True 64.
9) SGI 6.0-6.5.
10) SCO UNIX.
11) SVR4 2.3, 2.41.
12) SCO Unix Ware 7.0 - 7.11.
13) SUN Solaris 2.6-2.8.
14) SUN OS 4.13, 4.14.
15) IBM AIX 4.3x-4.33g, 5.1.

16) HP-UX 9.x-11.i.

D. ACCEPTABLE MANUFACTURERS
   1. Basis of Design: Product specified is “APC Symmetra PX 250kW” as manufactured by APC by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance.
   2. Or Approved Equal.

2.02 BUILDING A & C

A. INPUT PFC POWER STAGE
   1. The input PFC power stage (converters) of the UPS shall constantly rectify the power imported from the mains input of the system, converting the input mains AC power to DC power for precise regulation of the DC bus voltage, battery charging, and output power stage (inverters) regulated output power.
   2. Input Current Total Harmonic Distortion: The input current THD_I shall be held to 8.5% or less at full system load, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting loads of both a linear or non-linear type. This shall be accomplished with no additional filters, magnetic devices, or other components.
   3. Input Current Limit:
      a. The input PFC converters shall control and limit the input current draw from utility to 150% of the UPS output. During conditions where input current limit is active, the UPS shall be able to support 100% load, charge batteries at 10% of the UPS output rating, and provide voltage regulation with mains deviation of up to +/-20% of the nominal input voltage.
      b.
      c. In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100% of UPS capacity, input current shall not exceed 130% of UPS output current, while providing full battery recharge power and importing necessary power for system losses.

B. Charging:
   1. The battery charging shall maintain the DC bus float voltage of 218.4V, +/-1% at the nominal temperature of 25°C (77°F)
   2. The battery charging circuit shall contain a temperature monitoring circuit, which will regulate the battery float voltage to optimize battery life.
   3. The battery charging circuit shall remain active when in automatic Bypass and in Normal Operation.
   4. The battery charger shall have a charge capacity of 350W.

C. Output Power Stage (Inverters)
   1. The UPS output power stage (inverters) shall constantly recreate the UPS output voltage waveforms by converting the DC bus voltage to AC voltage through a set of IGBT switches. In both online operation and battery operation, the output power stage (inverters) shall create output voltage waveforms independent of the mains input voltage waveforms. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal

nature of the recreated output voltage sine waves of the output power stage (inverters).

2. Overload Capability: The output power stage (inverters) shall be capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 104% load for an indefinite length of time. The system shall transfer to bypass if the overload persist and then return back on-line when the overload is removed.
3. Battery Protection: The UPS shall have monitoring and control circuits to limit the level of discharge on the battery system.

D. Automatic Bypass
   1. As part of the UPS, system automatic bypass relays shall be provided. The system automatic bypass shall provide a transfer of the critical load from the Inverter outputs to the automatic bypass input sources during times when the inverters cannot support the load. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS shall constantly monitor the output currents, as well as the bypass source voltages, and inhibit potentially unsuccessful transfers to automatic bypass from taking place.
   2. The design of the automatic bypass switch power path shall consist of two electromechanical relays.
   3. Automatic Transfers: An automatic transfer of load to bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from bypass back to normal operation takes place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to bypass shall also take place if for any reason the UPS cannot support the critical bus.
   4. Manual Load Transfers: Manually initiated transfers to and from bypass may be initiated through the UPS computer interfaces (serial or network communications) or by engaging the bypass switch on the rear panel of the unit.

E. Display and Controls
   1. Control Logic: The UPS shall be controlled by an embedded DSP which performs the following functions:
      a. Monitoring quality of input, bypass and output voltages;
      b. Monitoring vital parameters of the UPS;
      c. Executing the state machine;
      d. Intelligent battery management;
      e. Controlling the input and output power stage;
      f. Remaining runtime calculation;
      g. Self-diagnostics, self-test and proactive fault detection;
      h. Communication to the host server via serial port;
      i. Communication to the Network Interface Card or another SmartSlot accessory card if equipped.

F. Display/Control Unit: A display/control comprising of 16 LED and 2 pushbutton switches shall be located at the front of the UPS. The display/control panel shall be capable of being turned 90 degrees clockwise or counterclockwise to accommodate the orientation of the UPS, in either a tower or rack-mounted configuration.

G. Display/Control Unit pushbutton: The following controls functions shall be actionable by the use of the pushbutton switches located at the Display/Control Unit:

1. Turn the UPS on;
2. Turn the UPS off;
3. Initiate self-test in order to test battery condition;
4. Silence audible alarm;
5. Cold start.
6. Displaying input RMS voltage on the battery capacity LED bar graph.

H. Manual Bypass switch: A switch shall be provided on the rear of the UPS such that when it is engaged it forces the UPS into the bypass state, provided the input voltage and frequency are within acceptable limits.

I. EPO terminal: The UPS is equipped with Emergency Power Off (EPO) terminal which can be wired so as to provide means to instantaneously de-energize the UPS and its load from a remote location in case of emergency.

J. Data displayed on the Display/Control Unit: The following indicators shall be available on the Display/Control Unit via LED indicators:
1. The UPS load LED bar;
2. The UPS is online;
3. The UPS is on battery;
4. The UPS is in bypass;
5. The UPS is overloaded;
6. The UPS is in fault state;
7. The battery needs to be replaced;
8. The battery capacity/utility voltage LED bar

K. Audible Alarms: Using audio signal, the UPS will notify the user about important events. The following is the list of distinct audio alarms:
1. The UPS is online.
2. The UPS is on battery.
3. The UPS is in bypass.
4. The UPS has an internal fault.
5. The UPS is overloaded.
6. The UPS battery is disconnected or must be replaced;

L. Communication Interface: Communication interfaces shall be provided as follows:
1. RJ-45 Serial Port connector, for interfacing with terminal emulation software.
2. RJ-45 Ethernet connection, on installed Network Management Card.

M. Battery
1. The UPS battery system shall comprise of user replaceable, hot swappable, battery modules.
2. The battery blocks housed within each removable battery module shall be of the Valve Regulated Lead Acid (VRLA) type, with a design life of 3 – 5 years.
3. The UPS shall incorporate an Intelligent Battery Management system to continuously monitor the health of the battery system and notify the user if that system is weak or needs replacing.
4. It shall be possible to add additional battery modules to increase runtime. These modules shall be hot-pluggable, allowing for easy and quick installation or

replacement without the need for electrical wiring, electrician services or powering down of the UPS.

5. Each UPS Battery Module shall have a means of DC disconnect for transportation and to disconnect the battery module completely from the internal bus while installed in the UPS system.
6. Charging:
    a. The intelligent battery management system shall contain a temperature monitoring circuit and compensation algorithm that regulates the battery charging voltage so as to optimize battery life.
    b. The battery charging circuit shall remain active when in bypass or on-line modes of operation.

N. The UPS shall be shipped with battery modules preinstalled but disconnected.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment with skilled mechanical erection labor in accordance with manufacturer's instructions.

B. Clearances and Protection: Maintain all clearances around UPS to adjacent electrical equipment and wall surfaces.

C. Factory-Assisted Start-Up: If a factory-assisted UPS start-up is requested, factory-trained service personnel shall perform the following inspections, test procedures, and on-site training:
1. Visual Inspection:
    a. Inspect equipment for signs of damage.
    b. Verify installation per manufacturer's instructions.
    c. Inspect cabinets for foreign objects.
    d. Inspect battery units.
    e. Inspect power modules.

D. Mechanical Inspection:
1. Check UPS and external maintenance bypass cabinet internal control wiring connections.
2. Check UPS and external maintenance bypass cabinet internal power wiring connections.
3. Check UPS and external maintenance bypass cabinet terminal screws, nuts, and/or spade lugs for tightness.

E. Electrical Inspection:
1. Verify correct input and bypass voltage.
2. Verify correct phase rotation of mains connections.
3. Verify correct UPS control wiring and terminations.
4. Verify voltage of battery modules.
5. Verify neutral and ground conductors are properly landed.
6. Inspect external maintenance bypass switch for proper terminations and phasing.

F. Site Testing:
   1. Ensure proper system start-up.
   2. Verify proper firmware control functions.
   3. Verify proper firmware bypass operation.
   4. Verify proper maintenance bypass switch operation.
   5. Verify system set points.
   6. Verify proper inverter operation and regulation circuits.
   7. Simulate utility power failure.
   8. Verify proper charger operation.
   9. Document, sign, and date test results.

G. On-Site Operational Training: During the factory-assisted start-up, operational training for site personnel shall include, but shall not be limited to, key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

3.02 FIELD QUALITY CONTROL

A. Factory Testing: Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification. These tests shall include operational discharge and recharge tests on at least a one-minute battery plant to assure guaranteed rated performance.

B. Unit Start-Up and Site Testing: Site testing shall be provided by the manufacturer's field service personnel. Site testing shall consist of a complete test of the UPS system and the associated accessories supplied by the manufacturer in accordance with NETA ATS 1. A full load power test including a partial battery discharge test shall be provided as part of the standard start-up procedure. This shall be accomplished without disturbing user wiring and completed prior to operation of the site critical load from the UPS output. The test procedure shall be used to verify the capability of the UPS output waveform with its load. The engineer shall be informed immediately of any test failures.

3.03 WARRANTY

A. UPS: The UPS warranty shall be in effect for no less than one year after initial start-up or eighteen months after shipment, whichever period expires first.

B. Battery: The battery manufacturer's standard warranty shall be passed through to the end user.

3.04 INSTALLATION AND OPERATION DATA

A. The specified UPS system shall be supplied with five copies of Operation and Maintenance (O & M) Manuals.

3.05 FIELD ENGINEERING SUPPORT

A. The UPS manufacturer shall have field service organization staffed by factory trained field service engineers dedicated to the startup, maintenance, and repair of UPS

equipment. The organization shall consist of regional and local offices, managed on a regional basis.

END OF SECTION

SECTION 26 36 00

TRANSFER SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for automatic transfer switches and related installation.

B. Related Sections:
1. Section 26 05 00 Common Work Results for Electrical
2. Section 26 05 63 Acceptance of Electrical Systems
3. Section 26 32 13.13 Diesel Engine Driven Generator Set

1.02 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. NFPA 70: National Electrical Code (NEC).

C. Underwriters Laboratories (UL):
1. UL 1008: Automatic Transfer Switches.

1.03 SUBMITTALS

A. General: Include shop drawings, manufacturer's descriptive literature and published details with performance/capacity rating schedules or charts as applicable, and where required by the cited referenced standards.

B. Shop Drawings: All mechanical and electrical equipment and components specified herein must be included to be considered a complete shop drawing.
1. Product Data: For each mechanical and electrical component, include manufacturers descriptive literature; product specifications; published details; technical bulletins; performance and capacity rating curves, charts, and schedules; catalogue data sheets; and other submittal materials as required to verify that the proposed products conform to the quality and function ability of the specified products.
a. Identification - Clearly indicate by an arrow on submissions covering more than one product type or style exactly which product is being submitted for approval.
b. Manufacturer - Include the catalogue name, company name, address, and telephone number for each product submitted.

2. Equipment Drawings: Submit completely dimensioned plan, elevations, and cross-sections of system equipment and sub-assemblies. Shop drawings clearly indicate enclosure size, gutter space, and withstand current rating and continuous ampere rating of switch.
3. Details: Provide detail drawings of the automatic transfer switch equipment as specified in this Section. Submit complete detail drawings of all sub-assemblies.
4. Product List: Provide a list of equipment and components on all drawings with each product identified by legend reference. Include product name, manufacturer, and model number.
5. Wiring Diagrams: Submit wiring diagrams for electrical apparatus showing numbered wiring terminals where applicable. In addition, submittal to contain detailed three- line diagrams and assembly wiring diagrams. Submit control diagrams indicating control devices mounted in automatic transfer switch, interconnecting wiring, and remote control devices, if any.
6. Provide from manufacturer a notarized letter certifying compliance with the requirements of the specification. The certification will also identify by serial number(s) the equipment involved. No exceptions to the specifications, other than those stipulated at time of submittal to be included in the certification.

C. Submit Operation and Maintenance (O & M) Manuals, which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures, and operating instructions.

1.04 SHORT CIRCUIT, ARC-FLASH, AND PROTECTIVE DEVICE COORDINATION STUDY

A. The computerized short-circuit, arc-flash, and protective coordination study will be performed and submitted as outlined in Section 26 05 00 of these specifications.

B. The Contractor is responsible for supplying the necessary and required information in order that this study may be completed and submitted at least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.

1.05 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. 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) unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are for the location installed and listed and labeled or approved as indicated and specified for the short circuit currents, voltages, and currents applied and listed and labeled or approved for the applications the items are intended.

C. Conform all work to NFPA 70, National Electrical Code.

D. Perform all electrical work under the supervision of a licensed electrician.

1.06 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 manufacturers 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.

1.07 DESIGN CRITERIA

A. System Voltage: 480/277 Volts, three-phase, four-wire, grounded

B. System Frequency: 60 Hertz

C. Continuous Current: As indicated on the drawings

D. All components in the system shall have adequate capacity, capability and bracing for the fault current as follows:
   1. Current Limiting Class L Fuse: 200,000 Amperes
   2. 3 cycle "Any Breaker": 50,000 Amperes
   3. 18 cycle "Any Breaker": 36,000 Amperes

1.08 FACTORY TESTS

A. Upon receipt of all approved shop drawings for the switchboards, the manufacturer shall fabricate and factory test the equipment in question.

B. Upon completion of the factory tests, and prior to shipment, forward the following to the Engineer for review and comments.
   1. Certified test report, or in lieu thereof a certified letter, ascertaining that the equipment in question was tested in strict conformance with all applicable Standards, and that the equipment met or exceeded all tests requirements.

2. A certified quality control report indicating the items checked, the date when checked and initialed by the individual performing the quality control.
3. Provide as part of this submittal the Operational and Maintenance Manuals for the referenced equipment as specified herein in this Section of the Specifications.

C. Equipment not accepted at the job site without prior receipt of the associated certified test report or the certified letter and the certified quality control report referenced to above.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Refer to Procurement Documents.

B. Furnish all items of the materials, design, sizes and ratings shown on the Drawings and herein specified.

C. Furnish materials and equipment bearing evidence of UL listing where UL standards exist and manufacturer identification and customary size or rating data.

D. Provide products that are free from defects impairing performance, durability, or appearance, and of the commercial quality best suited for the purpose shown on the Drawings or specified herein.

2.02 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Provide Products such as conduit, wireways, wire and connectors, cable, support devices, fasteners, and similar devices, as required for Work of this Section as specified in the various Sections of the Division 26 Specifications.

2.03 AUTOMATIC TRANSFER SWITCHES

A. Provide automatic transfer switches rated for continuous duty in an unventilated NEMA 1 sheet metal enclosure. Enclosure shall be UL listed. The cabinet door shall be key-locking. Controls on cabinet door shall be key-operated. The cabinet shall provide required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles or non-key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

B. All poles of transfer switch shall be mechanically held in both normal and emergency positions. All switches shall be double throw having electrically operated normal-emergency positions, inherently interlocked both mechanically and electrically so that all main contacts move simultaneously on the same shaft, without the utilization of multiple snap-action devices.

C. The electrical operator shall be a single mechanism, comprised of a minimum number of operating parts, a service handle designed for one hand operation shall be provided for manual service operation. All main contacts shall be silver alloy wiping action type and be protected by separately removal arching contacts. Transfer switches with main and/or arcing contacts that weld in the event of a fault current as indicated by UL or independent test lab reports will not be acceptable. Main contacts shall transfer in 1/6 of a second or less.

D. All switch and relay contacts, coils, springs and control elements shall be conveniently removable from the front of the transfer switch without use of special tools, or removal of the switch panels from the enclosure and without major disassembly or disconnection of drive linkages or power conductors. Sensing and control relays shall be continuous duty industrial control type with minimum contact rating of 10 amperes. Sensing relays shall operate without contact chatter or false response when voltage is slowly varied to drop out and pick up levels.

E. The continuous duty rating of the automatic transfer switch shall be capable of handling all classes of loads on a make, carry and break basis per UL 1008. Certified test data shall be available to verify that a withstand test has been conducted in accordance with UL-1008, Sections 25 and 26. The switch must be capable of surviving in operable condition the maximum short circuit fault current available at the load side of the overcurrent device indicated on the Drawings.

F. The transfer switches shall be specifically designed for 4 pole application. Transfer switches utilizing adapted devices such as molded case circuit breakers, or circuit breaker parts, disconnect switches, etc., which have not been intended to repeatedly open and close load currents are not acceptable. UL approval on individual power switch devices alone is not sufficient. Transfer switches shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar.

G. The transfer switch shall obtain its operating voltage from the source to which it will transfer.

H. Failure of any coil or disarrangement of any part shall not permit the transfer switch to assume a neutral position.

I. Operation: The automatic transfer switch control panel shall utilize solid-state sensing on normal and emergency for automatic, positive operation. The following shall be provided:
   1. All phases of the normal source voltage shall be monitored line-to-line. Close differential voltage sensing shall be provided on all phases. The pickup voltage shall be adjustable from 85% to 100% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value. The transfer to emergency will be initiated upon reduction of normal source to 85% of nominal voltage and retransfer to normal shall occur when normal source returns to 90% of nominal.
   2. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. The time delay shall be field adjustable from 0.5 to 6 seconds and factory set at 1 second.

3. A time delay on retransfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and factory set at 30 minutes.
4. An unloaded running time delay for emergency generator cool down. The time delay shall be field adjustable from 0 to 5 minutes and factory set at 5 minutes.
5. A time delay on transfer to emergency. Initially set at zero but field adjustable up to 1 minute for controlled timing of load transfer to emergency.
6. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 100% of nominal. Pickup frequency shall be adjustable from 90% to 100% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal and frequency is 95% or more of nominal.

J. Auxiliary Contacts, Indicating Lights, Control Switches: The following shall be provided:
1. A contact that closes when normal source fails for initiating engine starting, rated 10 amps, 32VDC. Contacts to be gold plated for low voltage service.
2. A contact that opens when normal source fails for initiating engine starting, rated 10 amps, 32VDC. Contacts to be gold plated for low voltage service.
3. Two auxiliary contacts that are closed when automatic transfer switch is connected to normal source and two auxiliary contacts that are closed when automatic transfer switch is connected to emergency source. Rated 10 amps, 480 VAC.
4. One auxiliary contact that is closed when normal source is available and one auxiliary contact that is closed when emergency source is available. Rated 10 amps, 480 VAC.
5. A green signal light to indicate when the automatic transfer switch is connected to the normal source. A red signal light to indicate when the automatic transfer switch is connected to the emergency source.
6. A white signal light to indicate when the normal source is available. A white signal light to indicate when the emergency source is available.
7. A test switch to momentarily simulate normal source failure.
8. A key-operated switch with standby and normal positions to manually switch between the standby and normal source.
9. A solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. A with/without load selector switch for the exercise period.
10. A "Emergency Generator Shutdown" push-pull (maintained position) pushbutton with red mushroom head.

K. Transfer switches shall be equipped with a field adjustable controls to allow the operator to control the transfer switch operating time during switching in both directions. The controls shall control the time the load is isolated from both power sources, to allow load residual voltage to decay before closure to the opposite source. The transfer switch operating speed control feature shall have an adjustable range of 0 to 7.5 seconds.

L. Acceptable Manufacturers:
1. Cummins Model OTPCE (Basis of Design)
2. Or Approved Equal

PART 3 EXECUTION

3.01 INSTALLATION

A. Products shall be installed, connected, and interconnected, where indicated, and in accordance with the manufacturer's printed instructions, as specified herein and as indicated on the Drawings. Connections shall be made in a manner, which will insure electrical continuity and operability of the products. Verify the Work of other trades is complete to the extent that substrates on which electrical apparatus is to be installed is ready to receive same.

B. Protect the equipment against foreign matter and moisture during installation.

3.02 TESTING

A. Consult Section 26 05 63 for requirements for field inspection and testing of the automatic transfer switches.

END OF SECTION

SECTION 26 41 00

LIGHTNING PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for an exterior, building lightning protection system, including equipment and related installations.

B. Related Sections:
   1. Refer to Procurement Documents.
   2. Refer to Procurement Documents.
   3. Section 26 05 33.13: Conduit for Electrical Systems.

1.02 REFERENCES

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

B. Lightning Protection Institute (LPI):
   1. LPI 175, Lightning Protection Institute Installation Code.

C. National Fire Protection Association (NFPA):
   1. NFPA 780, Lightning Protection Systems.

D. Underwriters Laboratories (UL):
   1. UL 96, Lightning Protection Components.
   2. UL 96A, Installation Requirements for Lightning Protection Systems.

E. American Society for Testing and Materials (ASTM):
   1. ASTM D5, Standard Test Method for Penetration of Bituminous Materials.
   2. ASTM D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
   3. ASTM D257, Test Methods for DC Resistance or Conductance of Insulating Materials.
   4. ASTM D570, Standard Test Method for Water Absorption of Plastics.

1.03 PERFORMANCE REQUIREMENTS

A. Provide a complete, functional, and unobtrusive lightning protection system as specified herein for Building B as approved by the Engineer.
   1. Provide the standard product of a manufacturer regularly engaged in the production of lightning protection systems.
      a. Provide the manufacturer's latest approved design.

2. Observe the limitations on areas of usage for aluminum cables and for copper and aluminum materials together as outlined in NFPA 780 and LPI 175.
3. Install all systems in conformance with UL 96A requirements.
4. Protect equipment on stacks and chimneys from corrosion, and size the equipment in accordance with LPI and UL requirements.

B. Provide all equipment, labor, materials, and items of service required for the performance of the Work of this Section.

C. Install all equipment in a neat workmanlike manner in the most inconspicuous manner possible.

1.04 SUBMITTALS

A. Prior to the start of the work of this Section, submit the following information in accordance with the requirements of Procurement Documents:
1. Product data for the materials and equipment used as a part the work of this Section.
2. Shop drawings showing the type, size, and locations of all equipment, grounds, cable routings, and other items required to provide a complete and operational lightning protection system.
3. Lightning protection system manufacturer’s qualifications.
4. Lightning protection system installer’s qualifications.

B. Certification: The Contractor will provide written certification that products to be provided under this section meet the requirements of 49 CFR 661 Buy America Act.

C. Upon completion of the installation, submit the following information in accordance with the requirements of Procurement Documents:
1. As-built shop drawings for the lightning protections system.
2. The LPI Certified System Application form.

1.05 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. Provide a lightning protection system that conforms to the requirements of the Lightning Protection Institute and Underwriter’s Laboratories Standards for lightning protection systems.
1. Provide LPI System Certification.
2. Provide Underwriters' Laboratories, Inc. inspected, approved, and properly labeled equipment; and furnish a UL Master Label for the system.

C. Provide a complete lightning protection system composed of new equipment, the product of a single manufacturer who is qualified as specified in Paragraph 1.06C, and of a design and construction to suit its application in accordance with accepted

industry standards, UL requirements, LPI requirements, and NFPA Code requirements.

D. Lightning Protection System Manufacturer's Qualifications:
   1. Provide products for the system from a manufacturer regularly engaged in the production of lightning protection systems.
   2. The system manufacturer must be a UL listed and approved manufacturer.
   3. The system manufacturer must be a fully certified manufacturer member in good standing of the Lightning Protection Institute.
   4. The system design and installation shall be performed under the direct supervision of a Master Installer Designer, certified by LPI.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide lightning protection equipment manufactured by the one of the following manufacturers:
   1. Thompson Lightning Protection, Inc. (Basis of Design)
   2. Harger Lightning Protection, Inc.
   3. Heary Brothers Lightning Protection Co., Inc.
   4. East Coast Lightning Equipment, Inc.
   5. Or Approved Equal.

2.02 MATERIALS

A. Provide copper or aluminum materials as described herein that conform to the requirements of UL 96; and of the size, weight, and construction to suit the application indicated in accordance with LPI and NFPA Code requirements for Class I structures.

B. Conductors:
   1. Roof Conductors: Provide UL listed conductors consisting of 28 strands of 14 gauge aluminum wire weighing 114 pounds (51kg) per 1,000 feet (300m).
   2. Downlead Conductors from Roof to Ground: Provide conductors 28 strands or 14 gauge aluminum wire, minimum.

C. Air Terminals:
   1. Perimeter or Roof Ridge Air Terminals: 1/2 inch (13mm) by 18 inch (450mm) solid aluminum.
   2. Roof Center Area Air Terminals: 2 inch (13mm) by 48 inch (1.25m) solid aluminum with an approved brace.
   3. Air Terminal Bases: Cast aluminum with bolt pressure cable connections.
      a. Crimp type connectors are not acceptable.
      b. Surface Contact Area: 18.5 square inches (120 square cm) minimum.
   4. Air Terminal Flexible Springs: Provide flexible safety springs at the base of all air terminals per drawing details.
   5. Air Terminal Personnel Protectors: Provide "safety tops" for air terminals. Protectors shall utilize a durable UV resistant material.

D. Copper Ground Rods: Provide 3/4 inch (19mm) diameter by 10'-0" long rods, minimum.

E. Hardware:
   1. Conductor Fasteners: Provide an approved type of non-corrosive metal fasteners having ample strength to support the conductors.
   2. Bonding Devices, Cable Splicers, and Miscellaneous Connectors: Provide cast aluminum devices with bolt pressure connections to cable.
      a. Cast or stamped crimp fittings are not acceptable.
   3. Miscellaneous Fasteners: Provide stainless steel bolts, nuts and screws.

F. Bimetal Transition Fittings: Provide an approved bimetal fitting to be used minimum of 12" above grade for transitioning from aluminum conductor to copper cable.

G. Conduit and Conduit Fittings: Provide Schedule 40 PVC conduit conforming to NEMA TC-2, with fittings conforming to NEMA TC-3, and both conforming to the requirements of Section 26 05 33.13.

H. Exo-Thermionic Welded Connectors:
   1. Provide molds, thermite packages, and other material for exo-thermionic welds that are full-rated to carry 100 percent of cable rating and which are letter-coded exo-thermionic welded type.
      a. Provide the molds, thermite packages, and other material from a single manufacturer throughout the project.
      b. Acceptable manufacturers, are as follows:
         1) Cadweld.
         2) Thermoweld.
         3) Or Approved Equal.
   2. Provide items for connections of cable to ground-rod.

I. Provide additional materials to complete a functional system per the lightning protection system manufacturer's recommendations.

2.03 FINISHES

A. Coating/Covering Material for the Grounding Clamps and Connectors:
   1. Provide a black, rubber based compound coating/covering material for the grounding clamps and connectors that is permanently pliable, moldable and un-backed, not less than 1/8 inch (3mm) thick, and which has the following properties:
      a. Solids/Density: 100 percent/12 pounds per gallon. (1.5kg per 1 liter).
      b. Penetration: 90-130 inches (2.3 - 3.3m) in accordance with ASTM D5.
      c. Water Absorption: 0.10 percent maximum in accordance with ASTM D570.
      d. Dielectric Strength: 500 volts/mil (19,685 volts/mm) in accordance with ASTM D149.
      e. Volume Resistivity: 2000 megohms-inches in accordance with ASTM D257, and 5000 megohms-CM in accordance with ASTM D257.

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. Employ an experienced installer who is a Certified Master Installer recognized by UL and the LPI, or working under the direct supervision of an LPI manufacturer as listed above, or his authorized LPI Certified Master Installer representative.

3.02 INSTALLATION

A. Air Terminal Installation:
   1. Locate and space air terminals according to LPI and NFPA requirements.
      a. Do not space air terminals more than 20 feet (6m) apart around the outside perimeter or the ridge of the roof, and not over 50 feet (15m) apart through the center of flat roof areas unless approved by the Engineer.
   2. Extend air terminals at least 18 inches (450mm) above the object to be protected.
   3. Securely mount air terminal bases with stainless steel screws or bolts, except secure all air terminal bases in flat roof areas with adhesive in accordance with the roofing manufacturer's recommendations.

B. Conductor Installation:
   1. Install conductors in accordance with the UL Code.
   2. Install a perimeter cable around the entire main roof.
   3. Connect each perimeter cable to at least two down leads to provide a two way path to ground from each air terminal.
   4. Interconnect all center roof air terminals with conductors to the outside perimeter cable.
   5. Conductors on flat roof areas may be run exposed.
   6. Make ground connections both around the perimeter of each roof and to the main down conductor at 100'-0" (30m) on center, maximum.
   7. Install conductor fasteners spaced not to exceed 3 feet (91cm) on center.
   8. Conceal all down leads in 1-1/2 inch (4cm) Schedule 40 PVC conduit.
   9. Seal all conduit openings with duct seal.
   10. To run downlead cables through the roof, use through-roof connectors with solid rods or conduit through pitch pockets.
      a. Do not run downlead cables directly through the roof.
   11. Enclose single ground wires in conduit and conduit fittings without other circuit conductors:

C. Bond all metallic objects on the roof to the lightning protection system as required by NFPA 780.

D. Aluminum to Copper Downlead Connections:
   1. Provide an approved transition bimetal fitting at the roof level to transition from aluminum roof conductor to copper downlead cable.

E. Ground Terminal Installation:
   1. Locate grounding terminals at the base of the structure.

2. Check ground rod locations to verify that the following conditions have been met; and correct all discrepancies which may include relocating the ground rods if necessary:
    a. Adequate compaction of soil.
    b. Freedom from stones, organic-material, debris rubble, and corrosive material.
    c. Adequate clearance from buildings, other work, and utility lines.
        1) Adequate clearance requires separation of 2'-6" (76cm), minimum, unless otherwise indicated.
    d. Adequate distance between rods and other ground systems.
        1) Adequate distance requires separation of 6'-6" (198cm), minimum, unless otherwise indicated.
3. Make ground connections around the perimeter of the structure, but do not allow the average spacing between grounding terminals to exceed 100 feet (30m).
4. Drive ground terminals to a depth of 10 feet (3m), minimum; drive the terminals deeper if necessary to reach permanent moisture.

F. Ground Wire to Ground Rod Connections:
1. Exothermically weld ground wires to ground rods.
2. Coat connections and the area around the connections with coating compound.
3. Assure freedom from pin-holes and holidays in coating.

G. Ground Wire to Equipment Connections:
1. Connect ground wires to equipment using two-hole compression type lugs.
2. On ground lugs and studs, clean all paint, grease, and other similar insulating materials from contact points.
3. Clean all wires to a bright finish prior to connection.

3.03 INTERFACE WITH OTHER WORK

A. Coordinate installation of the lightning protection with other trades to insure a correct, neat, and unobtrusive installation.

B. Verify that a sound bond to the main water service has been achieved, and that interconnection with other building ground systems, including both telephone and electrical grounding systems, has been properly made.

3.04 FIELD QUALITY CONTROL

A. Secure and deliver the LPI System Certification to the Engineer upon completion of the installation.

B. Furnish Underwriters Laboratories, Inc. Master Label as evidence that the installation has met with UL 96A code requirements.

END OF SECTION

SECTION 26 43 13

SURGE PROTECTIVE DEVICES FOR LOW VOLTAGE ELECTRIC POWER CIRCUITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of materials for furnishing, installing, connecting, energizing, testing, cleaning and protecting enclosed surge protective devices.

B. Related Sections:

1.	Section 26 05 00	Common Work Results for Electrical
2.	Section 26 05 26	Grounding and Bonding for Electrical Systems
3.	Section 26 05 28	Hangers and Supports for Electrical Systems
4.	Section 26 05 63	Acceptance of Electrical Systems
5.	Section 26 25 19	Low Voltage Electrical power Conductors and Cables
6.	Section 26 05 33.13	Conduits for Electrical Systems

1.02 REFERENCES

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

B. American National Standards Institute/Underwriters Laboratories (ANSI/UL):
1. ANSI/UL 1449 Third Edition (2009) – Safety for Surge Protective Devices.

C. National Fire Protection Association (NFPA):

1.	NFPA 70	National Electrical Code (NEC) Article 285.

D. Institute of Electrical and Electronic Engineers/American National Standards Institute (IEEE/ANSI):

1.	ANSI/IEEE C62.41	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2.	ANSI/IEEE C62.45	IEEE Guide on Surge Testing Equipment Connected to Low-Voltage AC Power Circuits.

1.03 SUBMITTALS

A. Make all submittals in accordance with Section 26 05 00.

B. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Authority and the Engineer.

C. Product Data and Catalog Cuts: Provide product data within 60 days of contract award for all products provided.

D. Shop Drawings: Submit shop drawings for all Surge Protective Devices.

E. Provide manufacturer's instructions for all Surge Protective Devices.

F. Project Record Documents: Record actual installed elevation and locations of equipment and wiring on record contract and shop drawings as specified in Section 26 05 00.

G. Project Closeout: Include record drawings, shop drawings and product data with Installation and Maintenance Manuals and submit at project closeout in accordance with Section 26 05 00.

1.04 SHORT CIRCUIT, ARC-FLASH, AND PROTECTIVE DEVICE COORDINATION STUDY

A. The computerized short-circuit, arc-flash, and protective coordination study will be performed and submitted as outlined in Section 26 05 00 of these specifications.

B. The Contractor is responsible for supplying the necessary and required information in order that this study may be completed and submitted at least two full calendar weeks prior to submitting Shop Drawings for equipment included the respective studies, submit the preliminary studies and corresponding computer printouts and annotated one-line distribution diagram to the Engineer for review and comment.

1.05 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. Conform all quality control work to Section 26 05 00.

C. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual or certified as meeting the standards of United Laboratories by the Electrical Testing Laboratory 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.

D. Unless products meeting the requirements of nationally recognized testing laboratories are not readily available for a category of products, provide products that are:
   1. Listed and labeled by Underwriters Laboratory.
   2. Approved by Factory Mutual.
   3. Certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory.

E. Conform all work to regulatory requirements of all state, local, and national governing codes and requirements, NFPA 70, National Electrical Code, and the requirements of Section 26 05 00.

F. Installer Qualifications: Firm specializing in installing work of this Section with minimum three years documented experience.

G. Install work by or under supervision of licensed electricians.

1.06 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 manufacturers 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.

1.07 DELIVERY, STORAGE AND HANDLING

A. Protect items from damage during delivery, storage and handling in accordance with Section 26 05 00 and as detailed below.

B. Store all products indoors in heated warehouses on blocking or pallets.

1.08 WARRANTY

A. SPD shall have a ten-year warranty. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

PART 2 PRODUCTS

2.01 SURGE PROTECTIVE DEVICES EQUIPMENT

A. General Requirements (Refer to Procurement Documents):
   1. Provide only products satisfying the applicable requirements for testing and reporting as established herein. Devices proposed for use on this project shall be

tested in accordance with ANSI/UL 1449 Third Edition, as prescribed by ANSI/IEEE C62.45. The residual or "clamping" voltages shall be recorded for all applicable mode of operation and for each of the test standard waveforms referenced. The results of these tests shall be submitted to the Engineer with the product data sheets as outlined under in this Section.

2. Products furnished for use on this project are to incorporate protective elements in all applicable modes, unless specifically indicated otherwise.
3. Install SPD equipment where so indicated on the Drawings. Voltage class and type of unit to be compatible with distribution voltage being protected.

B. Integral Surge Protective Devices (Service Entrance/Switchboard):
1. SPD shall be Component Recognized in accordance with ANSI/UL 1449 Third Edition, Standard for Safety, Surge Protective Devices.
2. SPD shall be installed by and shipped from the electrical distribution equipment manufacturer's factory, or field installed integral to provision space within equipment when previously approved by the Engineer.
3. SPD shall be modular in design. Each protection element shall be a user replaceable surge current diversion module (MOV based). Each surge current diversion module shall be fused with 200 kAIC rated fuses. Each surge current diversion module shall include solid state status indicator lights.
4. SPD shall provide redundant surge current diversion modules for each mode of Protection. Modes of Protection shall be L-N, L-G, N-G in grounded systems, and L-L, L-G in un-grounded systems.
5. SPD shall incorporate copper bus bars for the surge current path. Small gauge round wiring or plug-in connections shall not be used in the path for surge current diversion. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
6. Nominal Discharge Current (In) – SPD applied to the distribution system shall have a 20kA In rating.
7. 250 kA SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C (Type 1) environments.
8. SPD shall meet or exceed the following criteria:
   a. Minimum surge current rating per mode shall be:

L-N	125 kA
L-G	125 kA
N-G	125 kA
Per phase	250 kA

   b. UL 1449 Third Edition component recognized voltage protection ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L
480Y/277	1200V	1200V	1200V	2000V
208Y/120	600V	700V	600V	1000V

9. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
10. SPD shall be equipped with onboard visual and audible diagnostic monitoring. Red and green indicator lights shall provide full time visual diagnostic monitoring of the operational status of each phase as well as each surge current diversion module. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided.

The SPD diagnostic monitoring devices shall be mounted on the front of the switchboard enclosure. The diagnostic monitoring circuits shall continually monitor the operational status of the surge current diversion modules. No other test equipment shall be required for SPD monitoring or testing before or after installation.

11. SPD shall have a response time no greater than 1 nanosecond for any of the individual Protection modes.
12. SPD shall be mounted integral to the distribution equipment and connected to the power bus through a dedicated circuit breaker or disconnect.
13. SPD shall include Form C dry contacts to monitor the performance of each phase and provide a summary alarm.
14. SPD shall include an event surge counter. The counter shall be equipped with a manual reset and a battery or flash memory to retain memory upon loss of AC power. The surge counter display and reset switch shall be mounted on the front of the switchboard enclosure.
15. Acceptable Manufacturers:
    a. Eaton Electric (Basis of Design)
    b. Square D Company
    c. General Electric
    d. Siemens
    e. ABB
    f. Advanced Protection Technologies Inc.
    g. LEA International

C. Integral Surge Protective Devices (Distribution/Panelboard):
1. SPD shall be Component Recognized in accordance with ANSI/UL 1449 Third Edition, Standard for Safety of Surge Protective Devices.
2. SPD installed on Distribution equipment the line side of the service entrance disconnect shall be Type 2 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 2 or Type 2 SPDs.
3. SPD shall be installed by and shipped from the electrical distribution equipment manufacturer's factory.
4. SPD shall be modular in design. Each protection element shall be a user replaceable surge current diversion module (MOV based). Each surge current diversion module shall be fused with 200 kAIC rated fuses. Each surge current diversion module shall include solid state status indicator lights.
5. SPD shall provide redundant surge current diversion modules for each mode of Protection. Modes of Protection shall be L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.
6. SPD shall incorporate copper bus bars for the surge current path. Small gauge round wiring or plug-in connections shall not be used in the path for surge current diversion. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
7. Nominal Discharge Current (In) –SPD applied to the distribution system shall have a 20kA In rating.
8. 120 kA SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B (Type 2) environments.
9. SPD shall meet or exceed the following criteria:
    a. Minimum surge current rating per mode shall be:
        L-N 60 kA

L-G	60 kA
N-G	60 kA
Per phase	120 kA

b. UL 1449 Third Edition component recognized voltage protection ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L
480Y/277	1200V	1200V	1200V	2000V
208Y/120	500V	600V	500V	800V

10. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 125% of nominal RMS voltage.
11. SPD shall be equipped with onboard visual and audible diagnostic monitoring. Red and green indicator lights shall provide full time visual diagnostic monitoring of the operational status of each phase. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided. The SPD diagnostic monitoring devices shall be mounted on the front of the panelboard enclosure. The diagnostic monitoring circuits shall continually monitor the operational status of the surge current diversion modules. No other test equipment shall be required for SPD monitoring or testing before or after installation.
12. SPD shall have a response time no greater than 1 nanosecond for any of the individual Protection modes.
13. SPD shall be mounted integral to the distribution equipment and connected to the power bus through a dedicated circuit breaker or disconnect.
14. SPD shall include Form C dry contacts to monitor the performance of each phase and provide a summary alarm.
15. SPD shall include an event surge counter. The counter shall be equipped with a manual reset and a battery or flash memory to retain memory upon loss of AC power. The surge counter display and reset switch shall be mounted on the front of the panelboard enclosure.
16. Acceptable Manufacturers:
    a. Eaton Electric (Basis of Design)
    b. Square D Company
    c. General Electric
    d. Siemens
    e. ABB
    f. Advanced Protection Technologies Inc.
    g. LEA International

D. External Surge Protective Devices (Distribution):
1. SPD shall be UL Listed in accordance with ANSI/UL 1449 Third Edition, Standard for Safety, Surge Protective Devices, and UL 1283, Electromagnetic Interference Filters.
2. SPD shall be modular in design. Each protection element shall be a user replaceable surge current diversion module (MOV based). Each surge current

diversion module shall be fused with 200 kAIC rated fuses. Each surge current diversion module shall include solid state status indicator lights.

3. SPD shall provide redundant surge current diversion modules for each mode of Protection. Modes of Protection shall be L-N, L-G, N-G in WYE systems, and L-L, L-G in DELTA systems.
4. SPD shall incorporate copper bus bars for the surge current path. Small gauge round wiring or plug-in connections shall not be used in the path for surge current diversion. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
5. Nominal Discharge Current (In) –SPD applied to the distribution system shall have a 20kA In rating.
6. 120kA SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B (Type 2) environments.
7. SPD shall meet or exceed the following criteria:
   a. Minimum surge current rating per mode shall be:

L-N	60 kA
L-G	60 kA
N-G	60 kA
Per phase	120 kA

   b. ANSI/UL 1449 Third Edition component recognized voltage protection ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L
480Y/277	1200V	1200V	1200V	2000V
208Y/120	500V	600V	500V	800V

8. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 125% of nominal RMS voltage.
9. SPD shall be equipped with onboard visual and audible diagnostic monitoring. Red and green indicator lights shall provide full time visual diagnostic monitoring of the operational status of each phase as well as each surge current diversion module. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided. The SPD diagnostic monitoring devices shall be mounted on the front cover of the enclosure. The diagnostic monitoring circuits shall continually monitor the operational status of the surge current diversion modules. No other test equipment shall be required for SPD monitoring or testing before or after installation.
10. SPD shall have a response time no greater than 1 nanosecond for any of the individual Protection modes.
11. SPD shall be mounted in a NEMA 12 enclosure, unless noted otherwise.
12. SPD shall include Form C dry contacts to monitor the performance of each phase and provide a summary alarm.
13. SPD shall include an event surge counter. The counter shall be equipped with a manual reset and a battery or flash memory to retain memory upon loss of AC power. The surge counter display and reset switch shall be mounted on the front cover of the enclosure.
14. Acceptable Manufacturers:
    a. Eaton Electric (Basis of Design)
    b. Square D Company
    c. General Electric

d. Siemens
e. ABB
f. Advanced Protection Technologies Inc.
g. LEA International

2.02 MATERIALS

A. Grounding Materials: Conform to Section 26 05 26

B. Steel Supports and Anchors: Conform to Section 26 05 28

C. Wiring, External to Equipment and Connectors: Conform to Section 26 05 19

D. Conduit Materials: Conform to Section 26 05 33.13

PART 3 EXECUTION

3.01 PREPARATION

A. Painted surfaces, which will be covered by items of this Section, shall have a prime and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

3.02 INSTALLATION

A. Space enclosures out from surfaces mounted on 1/4-inch spacers or u-channel supports. Provide supports as specified in Section 26 05 28.

B. Install all Surge Protective Devices in accordance with the manufacturer's instructions.

C. Ground all Surge Protective Devices in accordance with Section 26 05 26, and the manufacturer's instructions using wire as specified in Section 26 05 19, of size No. 6 AWG or larger if otherwise indicated, recommended, or specified.

D. Connect all Surge Protective Devices in accordance with Section 26 05 19 and the manufacturer's instructions. For service, Surge Protective Devices use No. 4 AWG or larger if otherwise indicated or recommended. For branch circuit Surge Protective Devices use No. 6 AWG or larger if otherwise indicated on the drawings, recommended, or specified. For instrument, communication, and data and telephone unit protectors use wire sized the same as the circuit, data-line that the Surge Protective Devices is connected to or larger if otherwise indicated, recommended, or specified.

E. Install all SPD's with the shortest practical lead length.

F. Set enclosure top 6-feet 6-inches above finished floor or grade unless otherwise indicated or specified. If other equipment is installed in an area, the top of the units may be set lower then 6-feet 6-inches but in no case set the bottom of the enclosure lower than 12-inches above the finish floor or grade.

G. Make all holes for conduit entries with punches.

H. In all areas except dry areas install conduit drain-fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

I. Interface with other work:
   1. Connect conduits to enclosure with watertight hubs except in damp locations on the bottom of enclosures. A sealing locknut may be used in place of watertight hubs and in dry locations two locknuts and bushings may be used.
   2. Connect wiring to line and load terminals with lugs provided or approved by manufacturer in conformance with Section 26 05 19. Remove interior or protect interior components during wire pulling.
   3. Connect to conduit systems in conformance with Section 26 05 33.13.
   4. Connect to wiring systems in conformance with Section 26 05 19.

3.03 FIELD QUALITY CONTROL

A. Site Testing:
   1. Prior to energizing:
      a. Have insulation testing and setting made in conformance of Section 26 05 63.
      b. Ensure that all load-side wiring is clear of shorts and has received and passed the insulation tests of Section 26 05 63.
      c. Energize in presence of Authority and close circuit breaker for first time in presence of Authority.
      d. Final testing after energizing:
         1) Perform thermographic test and record circuit parameters in conformity with Section 26 05 63.

3.04 PROTECTION

A. During painting mask all nameplates, all plastic parts, pushbuttons, operating shafts and all items not to be painted.

B. Protect all items during work of other trades including welding and cutting.

C. Protect Surge Protective Devices against short circuits and improper operation.

END OF SECTION

SECTION 26 50 00

LIGHTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Requirements for general and emergency egress lighting equipment, components, and related installation.

B. Related Sections:
1. Section 26 05 26 Grounding and Bonding for Electrical Systems
2. Section 26 05 28 Hangers and Supports for Electrical Systems
3. Section 26 05 63 Acceptance of Electrical Systems
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 05 33.23 Boxes for Electrical Systems
7. Section 26 27 26 Wiring Devices

1.02 REFERENCES

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

B. The Aluminum Association, Inc. (AA):
1. DAF-45, Designation System for Aluminum Finishes.

C. American National Standards Institute (ANSI).
1. ANSI C81.64, Guidelines and General Information for Electrical Lamp Bases, Lampholders and Gauges.
2. ANSI C81.64a, Electric Lamp Bases and Holders - Guidelines and General Information for Electrical Lamp Bases, Lampholders and Gauges.
3. ANSI C82.1, Specifications for Fluorescent Lamp Ballasts.
4. ANSI C82.1d, Electric Lamps – Paragraphs 5.3.3 and 5.5.3: Compact Fluorescent Lamp Ballasts.
5. ANSI C82.1e, Fluorescent Lamps – Specifications for Fluorescent Lamp Ballasts.
6. ANSI C82.2, Fluorescent Lamp Ballasts, Methods of Measurement of.
7. ANSI C82.2a, Fluorescent Lamps - Methods of Measurement.
8. ANSI C82.3, Fluorescent Lamp Reference Ballasts, Specifications for.
9. ANSI C82.4, Ballasts - for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
10. ANSI C82.5, Reference Ballasts - High-Intensity-Discharge and Low-Pressure Sodium Lamps.
11. ANSI C82.6, Reference Ballasts for High-Intensity-Discharge Lamps – Methods of Measurement.

12. ANSI C82.6a, Reference Ballasts for High-Intensity-Discharge Lamps – Methods of Measurement.
13. ANSI C82.8, Lamp Transformers – Incandescent Filament Lamp Transformers - Constant Current (Series) Supply Type.
14. ANSI C82.9, High-Intensity-Discharge and Low-Pressure Sodium Lamps, Ballasts and Transformers - Definitions.
15. ANSI C82.9b, Electric Lamp Ballasts - High-Intensity-Discharge and Low-Pressure Sodium Lamps, Ballasts and Transformers - Definitions.
16. ANSI C82.11, High-Frequency Fluorescent Lamp Ballasts.
17. ANSI C82.11a, Lamp Ballasts - Specifications for High-Frequency Fluorescent Lamp Ballasts - Distance to Grounded Starting Aid.
18. ANSI C82.11b, Lamp Ballasts - Specifications for High-Frequency Fluorescent Lamp Ballasts - Line Transient Requirements.
19. ANSI C82.11c, Normative Annex A: Specifications for Low Voltage Control Interface for Controllable Ballasts and Informative Index B: Specification for Nomenclature for Controllable Ballasts.
20. ANSI C82.12, Lamp Ballasts - Ballasted Adaptors.
21. ANSI C82.13, Fluorescent Lamps and Ballasts - Definitions.
22. ANSI C82.77, Lamp Ballasts - Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment.

D. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. ANSI/IEEE C62.41; Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

E. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250, Enclosures for Electrical Equipment.

F. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).

G. Underwriter's Laboratories, Inc. (UL):
   1. UL 496, Lampholders.
   2. UL 542, Fluorescent Lamp Starters.
   3. UL 924, Standard for Emergency Lighting and Power Equipment.
   4. UL 935, Standard for Fluorescent-Lamp Ballasts.
   5. UL 1029, Standard for High-Intensity-Discharge Lamp Ballasts.
   6. UL 1574, Standard for Track Lighting Systems.
   7. UL 1598, Luminaires.
   8. UL 1598B, Standard for Supplemental Requirements for Luminaire Reflector Kits for Installation on Previously Installed Fluorescent Luminaires.
   9. UL 1993, Standard for Safety for Self-Ballasted Lamps and Lamp Adapters.
   10. UL 1994, Standard for Luminous Egress Path Marking Systems.
   11. UL 2108, Standard for Low Voltage Lighting Systems.

H. U. S. Government:
   1. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910 Occupational Health and Safety Standards.
      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):
   a. The Energy Policy and Conservation Act (EPCA) of 1975, Public Law 94-163, and all amendments thereto:
      1) The National Energy Conservation Policy Act, Public Law 95-619.
      2) The National Appliance Energy Conservation Act, Public Law 100-12.
      3) The National Appliance Energy Amendments of 1988, Public Law 100-357.
      4) The Energy Policy Act of 1992, Public Law 102-486.
      5) The Energy Policy of 2005, Public Law 109-58.

1.03 DEFINITIONS

A. HID - An acronym for “High Intensity Discharge” used to indicate lamps that produce light by passing a current through a metal vapor.
   1. Free electrons from the current collide with some of the electrons of the metal vapor atoms and momentarily knock some electrons in the vapor’s atoms into a higher orbit or quantum energy level; when these displaced electrons fall back to their former energy level, a quantum of visible radiation is emitted by each.
   2. The wavelength of the radiation depends on the energy zone of the disturbed electron and on the type of metal vapor used in the lamp’s arc tube.

1.04 DESIGN REQUIREMENTS

A. Design Criteria:
   1. The Lighting Fixture Schedule 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 Fixture Schedule includes the lighting fixture descriptions, fixture manufacturers, and corresponding model numbers.
      b. 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 (i.e. ballast capacitor igniter, and other similar item descriptions).
         3) 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 in the Lighting Fixture Schedule 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, direct/indirect and indirect 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.
      b. For exterior roadway, area, or floodlighting luminaires, photometric data shall include isocandela charts, coefficient of utilization, IES roadway distribution classification (where applicable), and isofootcandle plots for the specific mounting heights, lamps, and conditions of the project.
   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.

1.05 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. 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.
   2. Comply with the requirements of the Energy Policy and Conservation Act (EPCA) of 1975 and all amendments thereto, especially including the National Appliance Energy Conservation Act of 1988, the Energy Policy Act of 1992, and the Energy Policy of 2005.

C. 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.
   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".
   3. Provide lighting fixture ballasts certified by the Certified Ballast Manufacturers Association (CBM) or its successor organization to be in accordance with standard ballast specifications established by ANSI as listed in Paragraph 1.02.A.

1.06 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 manufacturers 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.

1.07 SUBMITTALS

A. Submit the following information for approval in accordance with the requirements of the Procurement Document:
   1. Product Data:
      a. Manufacturer's catalog cuts.
      b. Manufacturer's photometric data, distribution curves, isolux charts, glare factor data, and coefficients of utilization.
   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.
         2) Ballast certifications.
      c. Manufacturer's Instructions:
         1) Manufacturer's installation instructions.

1.08 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 re-lamping 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 Authority.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The manufacturers of the fixtures that were used as the basis for the lighting design for this Contract are listed in the Lighting Fixture Schedule on the Contract Drawings.
   1. The manufacturers' fixture descriptions and corresponding fixture model numbers are also listed in the Lighting Fixture Schedule.
   2. 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 approval of the Engineer prior to being substituted for the listed manufacturers.

B. Fluorescent Fixture Ballast Manufacturers:
   1. Acceptable manufacturers of fluorescent fixture ballasts include the following:

a. Advance Electric.
b. Magnetek, Inc.
c. Approved equal.

C. Dimming Fluorescent Fixture Ballast Manufacturers:
1. Acceptable manufacturers of dimming fluorescent fixture ballasts include the following:
a. Lutron (Eco-10 series for 100% - 10% dimming range and Hi-Lume series for 100% - 1% dimming range)
b. Advance Electric
c. Approved Equal.

D. HID Fixture Ballast Manufacturers:
1. Acceptable manufacturers of HID fixture ballasts include the following:
a. Advance Electric.
b. Magnetek, Inc.
c. Approved equal.

E. Lighting Contactor Manufacturers
1. Acceptable manufacturers of lighting contactors include the following:
a. Square D, a brand of Schneider Electric.
b. Cutler-Hammer Group, Eaton Corporation.
c. Allen-Bradley, a brand of Rockwell Automation.
d. Approved equal.

2.02 MATERIALS

A. Conduit and Raceway:
1. Provide electrical conduit and raceway in accordance with the requirements of Sections 26 05 33.13 and 26 05 33.23 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.

2.03 MANUFACTURED UNITS

A. Light Fixtures:
1. Provide those fixtures indicated on the Lighting Fixture Schedule on the Contract Drawings or approved substitutions.

2. Fixture Grounding Device and Conductor:
    a. Provide the housing of each fixture with a separate, factory-installed grounding device and ground conductor.
3. Exterior Fixtures:
    a. Factory-equip fixtures intended for exterior installation with waterproof gaskets and anodized aluminum frames unless indicated otherwise on the Contract Drawings.
        1) Provide outlet boxes, neoprene gaskets, and stainless steel hardware to render the exterior fixture installation waterproof.
    b. Finish:
        1) Provide fixtures for exterior installation with a finish free of scratches and other surface blemishes.
        2) Provide fixtures for exterior installation with an AA-M12C22A42, Dark Bronze Anodized final finish as specified in DAF-45.
    c. Brackets:
        1) Provide brackets of the type and style indicated or scheduled on the Contract Drawings and color matched to the light fixture.

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. Match the voltages of fluorescent and HID lamps to installed fixtures.
    b. Provide lamps having the proper type of sockets to suit the fixtures provided.
2. If fluorescent lamps are required, provide the energy saving type unless otherwise indicated on the Contract Drawings.

C. Lighting Fixture Ballasts:
1. Provide UL listed and certified lighting fixture ballasts that meet the requirements of the National Appliance Energy Conservation Act of 1988 and all amendments thereto.
2. Provide lighting fixture ballasts in accordance with the requirements of the standard ballast specifications established by ANSI.
    a. Fluorescent Ballasts:
        1) Provide lighting fixtures equipped with electronic program rapid start type ballasts.
        2) Ballasts to be UL listed, Class P, program rapid start, input current total harmonic distortion not to exceed 10 percent, be of the low noise level, multi-lamp capacity, to have an average lamp current crest factor of 1.7, a power factor of 90 percent or above, to have a frequency of operation of 42 KHz or greater and be stroboscopic corrected.
        3) Ballasts shall comply with ANSI C62.41 Category A for transient protection.
        4) Ground ballasts in accordance with NEC and provide in-fixture automatic resetting thermal protection for ballasts and capacitors.
        5) Ballast shall provide lamp end of life protection circuit which meets NEMA recommendations.
    b. Fluorescent Dimming Ballasts: Those dimming ballasts as indicated on the Lighting Fixture Schedule of the Drawings.
        1) Multiple control input fluorescent dimming ballasts as listed on the fixture schedule.

2) Remaining dimming ballasts shall be as indicated on the Lighting Fixture Schedule, approved for use with the dimming controller as specified in this Section and provide 3-wire line voltage control.
   a) Electronic dimming ballast shall have an architectural dimming range of 100% - 10% or 100% - 1% as indicated on the light fixture schedule.
   b) Dimming ballasts shall provide dimming to the specified level without flicker.
   c) Dimming ballast shall maintain constant light output of ± 2% over a line voltage variation of ±10%.
   d) Dimming ballasts shall have the following characteristics:
   e) Power Factor - greater than 95%
   f) THD - less than 10% at full light output
   g) Third Harmonic Distortion - less than 10%
   h) Lamp Current Crest Factor - less than 1.7
   i) Ballast Factor - 0.85
   j) Dimming ballast shall be a rapid start type and preheat lamp cathodes before applying arc voltage to ensure rated lamp life is not diminished.
   k) Dimming ballasts shall be manufactured by Lutron (Eco-10 series for 100% - 10% dimming range and Hi-Lume series for 100% - 1% dimming range), Advance or as approved.

c. Metal Halide Ballasts:
   1) Provide light fixtures equipped with pulse start igniter and an encapsulated core & coil ballast.
   2) Ballasts shall be designed with class “H” or higher insulation system and vacuum-pressure impregnated with a silica-filled polyester resin.
   3) All coils shall be precision wound.
   4) Ballasts shall be designed to operate for 60,000 hours of continuous operation at their maximum rated temperature.
   5) Ballasts and starter combinations shall be designed to provide a reliable lamp starting down to -30 degrees Celsius at nominal line voltage of plus or minus 10%.
   6) Ballasts shall have a nominal ballast factor of 1.0.
   7) Ballasts shall contain no live parts.
   8) Ballasts shall be UL component recognized.

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. Luminaire Poles
   1. Comply with AASHTO LTS-3 for pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.
   2. Wind-Load Strength of Total Support Assembly: Adequate to carry support assembly plus luminaires at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 90 mph with a gust factor of

1.3. Support assembly includes pole or other support structures, brackets, arms, appurtenances, base, and anchorage and foundation.

3. Strength Analysis: For each pole type and luminaire combination, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
4. Aluminum Poles: Fabricated from seamless, extruded structural tube complying with ASTM B 429, 6063-T6 alloy with access handhole in pole wall.
5. Metal Pole Brackets: Match pole metal. Provide cantilever brackets without underbrace, in sizes and styles indicated, with straight tubular end section to accommodate luminaire.
6. Finish: Match finish of pole/support structure for arm, bracket, and tenon mount materials.

F. Luminaire Pole Foundations
1. Pole/Support Structure Bases: Anchor type with hold-down or anchor bolts, leveling nuts, and bolt covers.
2. Embedded type with underground conduit/cable entry.
3. Comply with Specification Section 03300- Cast-in-Place Concrete.
4. Design Strength: 3000-psig (20.7-MPa), 28-day compressive strength.

G. Boxes, Gaskets, Hardware, and Support Devices:
1. Provide outlet boxes, neoprene gaskets, and stainless steel hardware to render the installation of the lighting waterproof.
   a. Provide waterproof splice kits where required as specified in Section 26 05 19.
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.

2.04 CEILING MOUNT OCCUPANCY SENSORS

A. One Way Directional Occupancy Sensor:
1. Occupancy sensor shall combine both ultrasonic and passive infrared sensing.
2. Occupancy sensor shall operate on 24VDC.
3. Occupancy shall have automatic timer and sensitivity features to prevent “false-offs” and “false ons”.
4. Occupancy sensor shall cover 1,000 square foot.
5. Occupancy sensor shall be provided with a mask to eliminate the coverage area for applications not requiring the full field of view of 360 degrees.

B. Multi-Directional Occupancy Sensor:
1. Occupancy sensor shall combine both ultrasonic and passive infrared sensing.
2. Occupancy sensor shall operate on 24VDC.
3. Occupancy shall have automatic timer and sensitivity features to prevent “false-offs” and “false ons”.
4. Occupancy sensor shall cover 2,000 square foot.

5. Occupancy sensor shall be provided with a mask to eliminate the coverage area for applications not requiring the full field of view of 360 degrees.

C. Power Pack for Occupancy Sensors:
   1. Power Pack shall have a high impact, UL rated 94 – 5 V plastic construction case.
   2. Power Pack shall be plenum rated.
   3. Power Pack shall have a 120V or 208V primary input and a 24 VDC, 100 mA nominal, full-wave rectified and filtered output.
   4. Power Pack shall have two isolated relays for the control of two circuits. Contact ratings shall be 20A for fluorescent ballasts and 1 HP for motor load.

2.05 WALL SWITCH WITH SELF-CONTAINED OCCUPANCY SENSOR

A. Wall Switch with Self-Contained Occupancy Sensor:
   1. Single gang, gangable device designed to fit behind a standard decorator switch plate.
   2. Dual element, infrared detector behind a fresnel lens.
   3. Detection Range:
      a. 8 to 14 micrometer frequency spectrum of bodily emitted infrared radiation.
      b. 180 degree sensing field.
      c. 40 foot sensing distance.
   4. Adjustable Ambient Override: 7 foot candles to full daylight.
   5. An adjustable time delay from 30 seconds to 30 minutes.
   6. Fully adjustable sensitivity.
   7. Operate on 277V.

PART 3 EXECUTION

3.01 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.

3.02 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. Recessed Fixture Installation:
   1. Support recessed fixtures on the ceiling system's structural elements rather than its surface materials such as tiles, plaster, drywall, or similar surfaces.
      a. Use the mounting yokes furnished with the fixtures and, where required, the supports specified in Section 26 05 28.
   2. If the fixture is to be installed in modular tile ceilings, locate the fixture in the center of the ceiling panel unless indicated otherwise.
      a. Refer to the Architectural Reflected Ceiling Plan included in the Contract Drawings for modular tile ceiling layouts.
   3. If light leaks through gaps between the recessed fixture trim and the adjacent surface, install suitable sealing gaskets.

C. 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.
   2. Exit Fixture Installation:
      a. Install exit fixtures for doors directly over the doorways as indicated on the Contract Drawings
      b. Center the fixtures over the doorways, and install the fixtures to clear the door and associated hardware.

D. Poles
   1. Use web fabric slings (not chain or cable) to raise and set poles.
   2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   3. Secure poles level, plumb, and square.
   4. Grout void between pole base and foundation. Use nonshrinking or expanding concrete grout firmly packed in entire void space.
   5. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.03 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.

3.04 FIELD QUALITY CONTROL

A. Inspect, test, and certify lighting and the associated electrical distribution system and equipment in accordance with the requirements of Section 26 05 63.

3.05 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.

3.06 AIMING AND FOCUSING

A. Contractor shall notify the Authority 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 relamping and normal maintenance.

END OF SECTION

SECTION 27 00 00

COMMUNICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of materials for furnishing, installing connecting, energizing, testing, cleaning and protecting a structured wiring system for voice and data.

B. Related Section:

1. Section 26 05 00 - Common Work Results for Electrical
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems
3. Section 26 05 28.33 - Conduits and Backboxes for Electrical Systems
4. Section 26 05 28.36 - Cable Trays for Electrical Systems
5. Section 26 05 53 - Identification for Electrical Systems
6. Section 27 05 13.43 - Cable Services
7. Section 27 08 00 - Commissioning of Communications
8. Section 27 11 00 - Communications Equipment Room Fittings
9.
10.
11.
12.
13. Section 27 32 43 - Radio Communications Equipment
14. Section 27 51 16 - Public Address and Mass Notification Systems
15. Section 33 82 13 - Copper Communications Distribution Cabling
16. Section 33 82 23 - Optical Fiber Communications Distribution Cabling

1.02 REFERENCES

A. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronics Industry Alliance (EIA):

1. EIA-455-21A FOTP-21 Mating Durability of Fiber Optic Interconnecting Devices
2. ANSI/TIA/EIA-526-7 OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
3. ANSI/TIA/EIA-526-14A OFSTP-14A Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
4. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements
5. ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
6. ANSI/TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard

7. ANSI/TIA/EIA-569-A — Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA/EIA-606 — Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
9. ANSI/TIA/EIA-607 — Commercial Building Grounding and Bonding Requirements for Telecommunications

B. Institute of Electrical and Electronic Engineers (IEEE):
1. IEEE 802.3ab — Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T

C. Insulated Cable Engineers Association (ICEA):
1. ANSI/ICEA S-80-576 — Communication Wire and Cable for Wiring of Premises

D. National Electrical Manufacturers Association (NEMA):
1. NEMA WC 63.1 — Telecommunications Cables

E. Underwriters Laboratories (UL):
1. UL 444 — Communications Cables
2. UL 467 — Grounding and Bonding Equipment
3. UL 1863 — UL Standard for Safety for Communications-Circuit Accessories

F. National Fire Protection Association (NFPA):
1. NFPA 70 — National Electrical Code (NEC)

1.03 GENERAL REQUIREMENTS

A. Provide a completely cabled and terminated communication system (voice/data/fiber) in a star topology.

B. Communications system cabling, raceways, pathways, and spaces shall at minimum comply with ANSI/TIA/EIA-568-B.1, -568-B.2, -568-B.3, -569-A and -607.

C. All multi-mode and single-mode fibers shall be industry rated, best performing design.

D. Provide grounding and bonding per, at minimum, ANSI/TIA/EIA-607, NFPA 70 and UL 467.

1.04 SUBMITTALS

A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Engineer.

B. Third Party Performance Testing: Provide with all product data evidence of third party performance testing by a Nationally Recognized Independent Testing Laboratory.

C. Product Data and Catalog Cuts: Submit product data for all products provided. Indicate clearly the usage of each product.

D. Shop Drawings:
   1. Telecommunications Drawings: Provide registered communications distribution designer (RCDD) approved drawings complete with wiring diagrams and details required to prove that the distribution system shall properly support connectivity from the telecommunications equipment room to telecommunications work area outlets. Show the entrance facility and layout of cabling and pathway runs, cross connect points, MDF, BDF, IDF, grounding system, terminating block arrangements and type. Drawings shall depict final telecommunications cabling configuration, including location, color coding, gauge, pair assignment, polarization, and terminating blocks layout at cross connect points and patch panels after telecommunications cable installation. Provide a plastic laminated schematic of telecommunications cable system showing cabling, BDF's, IDF's, MDF's, and equipment rooms keyed to floor plans by room number.
   2. Distribution Frames: Provide shop drawing showing layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks and equipment spaces and racks.

E. Installer Qualifications: Prior to installation, submit data of installer's experience and qualifications. Installers shall be a Building Industry Consulting Service International (BICSI) Registered Cabling Installation Technician or have experience that shall include 3 years on projects of similar complexity. Include names and locations of two projects successfully completed using optical fiber and copper communications cabling systems. Include written certification from users that systems have performed satisfactorily for not less than 18 months. Include specific experience in installing and testing structured telecommunications distribution systems using optical fiber, Category 3 and Category 6 cabling systems.

F. Test Plan: Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the UTP and optical fiber components and accessories. Include procedures for certification, validation, and testing.

G. Submit Operation and Maintenance (O & M) Manuals which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures, and operating instructions. Submittal shall include the requirements of paragraph entitled “Telecommunications Drawings.

H. Test Reports: Furnish factory reel tests for optical fiber cables.

1.05 QUALITY ASSURANCE

A. 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 unless products meeting the requirements of these testing laboratories are

not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.

B. Provide products that have been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Test results shall be provided upon request of the Engineer.

C. Manufacturer Qualifications: Firm specializing in installing work of this Section with minimum five years documented experience in construction of similar equipment.

D. Conform all work to NFPA 70, National Electrical Code.

E. Installer Qualifications: Firm specializing in installing work of this Section with minimum three years documented experience.

F. Install work under supervision of skilled licensed electricians.

PART 2 EXECUTION

2.01 PREPARATION

A. Ensure that painted surfaces that will be covered by items of this Section have a prime and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

2.02 INSTALLATION

A. Outside wire and cable shall be installed in ducts conforming to Section 33 71 19. Inside wire and cable shall be installed in conduit conforming to Section 26 05 28.33 or cable tray conforming to Section 26 05 28.36. Use of cable tray limited to equipment rooms and as indicated on the drawings.

B. Cable Installation in Conduits and Ducts: During the installation of cables in conduits and ducts, the cable manufacturer's recommended pulling tension shall not be exceeded. A suitable lubricating medium, harmless to the cable jacket, shall be used when pulling cables into conduits, pipes or duct banks. No oil or grease substances not specifically manufactured for cable installation will be permitted for such use on this project.

C. Cable Attachment and Support: Lengths of cables which are not installed in conduits and are run inside equipment rooms shall be secured to cable trays or cable ladders using nylon cable ties and attached to walls and backboards using nylon cable clamps or hangers or using a plastic wiring system such as manufactured by Panduit, or Approved Equal. Cables shall be attached or otherwise supported at intervals not to exceed 457 mm [18 in].

D. Strain Relief: Provide sufficient strain relief (slack) in all cables, cable conductors, and wiring to avoid stress on all cables, wires, and wiring connections.

E. Bends: Cables shall not be bent to a radius less than ten (10) times the diameter of the cable, or less than the manufacturer's recommended minimum bending radius, during installation or as finally installed.

F. Continuous Cable Sections: All cable runs shall be continuous without splices between cable terminating locations.

G. Conduit/Cable Entrances to Facilities: All conduit and cable entrance openings into equipment rooms and huts shall be sealed with a pliable sealing compound after the cable is in place. Sealing compounds for rooms, huts, walls, or other partitions shall be fire retardant per ASTM E 814. Sealing compound shall be used to seal the area around the cable where the cable emerges from the end of a conduit, pipe, or ductbank. All spare conduits shall be sealed or plugged in an approved manner.

H. Fire retardant pliable sealing compound shall be an intumescent firestop putty, reusable and repenetrable, conforming to ASTM E 814 and UL 1479, Nelson FSP Firestop Putty, or Approved Equal.

I. Conduit Bushings: At all transition points where a cable runs from inside a conduit into a cable trough; or onto a cable tray or plywood backboard, the end of the conduit shall be fitted with a plastic bushing to prevent abrasive damage to the cable.

J. Cable Dress: Cable installed in trays or troughs shall be laid therein and not pulled in place. Cables installed in trays and troughs shall have a minimum amount of crossover and shall not be pulled tightly around bends.

K. Protection of Cables: Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions, such as sharp corners on equipment. Cables damaged due to neglect by the Contractor, during installation, shall be replaced by the Contractor, at no additional cost to the Owner.

L. Cable Continuity and Integrity: All cables shall be continuous and without splices between the specified termination locations. The cable termination points shall be located within communication interface cabinets, equipment enclosures, splice cases, and equipment termination boxes as shown on the Drawings and as described in the Specifications.

M. Cable Shield Continuity and Integrity: The shield of each section of communication cable shall be electrically continuous for the entire cable length.

N. Cable and Wiring Identification: All cables shall be terminated in standard order, according to the EIA/TIA and ICEA color codes. Individual cables shall be identified at each cable termination with self-adhesive labels. All spare pairs in each cable shall be terminated and identified.

O. All voice/data/fiber wires and cables shall be installed in raceways or cable trays as specified in Section 26 05 28.33 and Section 26 05 28.36 respectively.

P. Provide pull rope in all empty conduit runs with not less than 12 inches (30 cm) of slack both ends.

Q. Conduits shall be restricted to no more than two 90-degree bends or equivalent without a pull box.

R. Maintain minimum bending radius of changes in direction as follows:
   1. 10 times diameter of 4” (100 mm) and larger conduits.
   2. 6 times diameter of smaller conduits.

S. Avoid bends in conduits from pull boxes.

T. Except as noted hereinafter for telecommunications cabling and pathways with copper media, keep conduit and cable tray minimum 6 inches (150 mm) away from parallel runs of electrical power equipment, flues, steam, and hot water pipes.

U. Telecommunications cabling and pathways with copper media shall be installed in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment.
   1. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling.
   2. Pathways shall be installed in accordance with the following minimum clearance distances of 4 feet (1.2 meters) from motors, generators, frequency converters, transformers, x-ray equipment or uninterruptible power system, 12 inches (300 mm) from power conduits and cable systems, 5 inches (125 mm) from fluorescent or high frequency lighting system fixtures.

V. Install voice, data and fiber telecommunications cabling and pathway system as detailed in ANSI/TIA/EIA-568-B and -569-A. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not untwist Category 6 UTP cables more than one half inch (12 mm) from the point of termination to maintain cable geometry. Provide service loop on each end of the cable, 10 ft (3 m) in the telecommunications closet, 3.3 ft (1 m) in the work area outlet for optical fiber and 12 inches (30 cm) for UTP. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds (110 N) pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable bend radii shall not be less than four times the cable diameter.

W. All communications cables for the inside plant shall be terminated. Segregate voice, data and fiber terminations. Provide service loops for all voice (telephone) backbone cables. Provide excess cable at both ends of horizontal cable to facilitate future re-termination. Provide all cross-connecting hardware and jumper cables, including 100% connection capability of all patch cords.
   1. All telephone/voice cabling shall be punched down on 110 type punch-down blocks located on telephone backboards. Height of highest punch-down block shall not exceed 78 inches (1980 mm) above floor. Use C-4 clips for horizontal cable terminations and C-5 clips for riser/backbone cable terminations. All

cabling shall be punched down and cross connected. Telephone outlets shall be activated with cross-connect jumper cables between the backbone cable punch-down blocks and the horizontal cable punch-down blocks.

2. Terminate all copper data cabling on Category 6 type data patch panels with jacks. Terminate all fiber optic cabling using ST connectors on data patch panels. Data outlets shall be activated with cross-connect jumper cables between the backbone cable patch panels and the horizontal cable patch panels. Patch panels and equipment shall be rack mounted. Racks shall have a minimum of 39 inches (1 meter) clearance at front and back. Racks shall be permanently bolt anchored to the floor per manufacturer's recommendations.

X. Provide outlet box and jack at each voice/data/fiber outlet. Depth of outlet boxes shall be sufficient to allow manufacturer's recommended conductor bend radii.
   1. Terminate UTP cable in accordance with ANSI/TIA/EIA-568-B and wiring configuration as specified.

Y. Terminate UTP cable in accordance with ANSI/TIA/EIA-568-B and wiring configuration as specified.

Z. Telecommunications Grounding: Provide per ANSI/TIA/EIA-607. Run grounding conductors with the backbone cable plant. Bond racks, conduits, raceways cable trays, etc. in accordance with ANSI/TIA/EIA standards, NFPA 70 and Section 26 05 26. Grounding conductors shall be compatible with raceways. Protect all grounding and bonding conductors from physical damage. Contractor shall individually and properly ground all relay racks, ladder rack, equipment cabinets and inside and outside plant cable shields, wherever the cables leave the sheaths, to ground bars shown on Contract Drawings. Contractor shall individually and properly ground all voice punch-down cable frames and other supplied hardware to the ground bars shown on the Contract Drawings. Daisy-chaining of equipment grounding is not permitted. Grounding shall conform to EIA/TIA 607 and NEC articles 250 and 800.

AA. Provide identification and labeling of communications cables, outlets and equipment per ANSI/TIA/EIA-606.
   1. All cables shall be labeled at least at each end of each cable section, using cable tags or labels. Inside plant cables shall be labeled using self adhesive waterproof labels; outside plant cables shall be labeled using approved waterproof cable tags.
   2. Proposed Plan
      a. Each work area outlet shall be labeled with the Rack, Patch Panel, Port Number (i.e. Rack No. 01, Patch Panel No. 03, Port No. 14 would be labeled as 01-03-14)
      b. Each Patch Panel port shall be labeled with the Room and Jack Number (i.e. Room 127, Jack Number 016 would be labeled as 127-016)
   3. A cable labeling table shall be developed based on this project. The table shall be submitted for approval by the Owner prior to cable installation.
   4. Cable Tags
      a. Attach to cable using two nylon cable ties through holes in the tag.
      b. Use pre-printed plastic tags marked with a durable, abrasion resistant, waterproof ink.

2.03 CLEANING

A. After wiring, vacuum out interior and wipe clean of all foreign material.

B. After painting in areas, remove all over paint, drips and splashes.

2.04 FIELD QUALITY CONTROL

A. Perform telecommunications cabling inspection, verification, and performance tests in accordance with ANSI/TIA/EIA-568-B.

B. Inspection: Visually inspect cabling jacket materials for UL or third party certification markings. Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for tip and ring pin assignments, and inspect cabling connections to confirm compliance with ANSI/TIA/EIA-568-B. Visually confirm Category 6 marking of outlets, wallplates, connectors, and patch panels.

C. Prior to installing optical fiber cable, perform end-to-end attenuation tests using an OTDR while cable is on the reel at the jobsite.

D. Perform testing after cables are terminated, but not cross connected.

E. Verification Tests:
   1. UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after terminated but not cross connected. Perform 1MHz to 100MHz scan attenuation test for Category 6 systems installations.
   2. Perform optical fiber end-to-end attenuation tests in both directions using a power meter and light source, testing at both operational windows for both multi-mode and single-mode, and manufacturer's recommended test procedures. Perform tests in accordance with ANSI/TIA/EIA-526-14A, Method B for horizontal, multimode optical fiber and ANSI/TIA/EIA-526-7, Method B for horizontal, single mode optical fiber. Perform verification acceptance tests and factory reel tests.

F. Performance Tests:
   1. Category 6 Links (Voice, Data): Perform UTP permanent link tests in accordance with ANSI/TIA/EIA-568-B. Tests shall include wire map, length, attenuation, NEXT, Power Sum NEXT, ELFEXT, Power Sum ELFEXT, return loss, propagation delay and delay skew. Each and every link shall be tested and shall pass the requirements of ANSI/TIA/EIA-568-B for Category 6. Any failing link shall be diagnosed and corrected. The corrective action shall be followed by a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation.

2. Voice Links: In addition to Category 6 tests, test each pair for short circuit, continuity, short to ground, crosses, and reversed polarity. Include operational and ringback, and dial tone tests.
3. Optical Fiber Links: Perform optical fiber end-to-end attenuation tests in both directions and reel tests at jobsite.

2.05 PROTECTION

A. During painting, mask all nameplates, all plastic parts, and all items not to be painted.

B. Protect all items during work of other trades including welding and cutting.

END OF SECTION

Appendix A

Ortronics/Berk-Tek
Certified Installers

Building Infrastructure Group
14310 Sullyfield Circle
Ste 400
Chantilly VA 20151
Attn: Pat Barron
pbarron@biggp.com
(703) 752-7605

Vision Technologies, Inc.
14140 Parke Long Ct., Ste E
Chantilly, VA 20151-1649
Attn: Melvin Thomas
mthomas@visiontech.biz
(703) 439-1487

Net100, Ltd.
14120-H Sullyfield Circle
Chantilly, VA 20151
Attn: Kevin Sisk
KSisk@Net100Ltd.com
(703) 995-5228

Quality Communications
44645 Guilford Drive
Ste 204
Ashburn, VA 20147
Attn: Pattye Roubo
PRoubo@aol.com
(703) 729-2300

AVA Electric
1410 Marblewood Avenue
Capitol Heights, MD 20743
(301) 386-8839 Office
(240) 417-6668 Cell
Derrick Moore
dmoore@avaservices.com

DCI (Dynamic Concepts Inc.)
1730 17th St, NE
Washington, DC 20002

202-944-8787 Office
Ronald Watkins
rwatkins@dcihq.com

Information Innovators, Inc. (III)

7400 Fullerton Road
Suite 210
Springfield, VA 22153
703.635.7088
Steve Ikert
sikert@iiinfo.com

National Fiber and Copper, Inc.

PO Box 118
Lisbon, MD 21765
301-514-8961 Cell
Andy Langley
ralnfc@aol.com

Netcom Technologies, Inc.

7423 Lindbergh Drive
Gaithersburg, MD 20879
(301) 670-0486 x101 Office
(301) 252-6332 Cell
Roy Rea
royrea@netcomtec.com

Teldata Communications, Inc.

19211-A Chennault Way
Gaithersburg, MD 20879
301-670-0122 Office
Robert Knoll
bknoll@teldata.net

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
DEPARTMENT OF INFORMATION TECHNOLOGY
NETWORK & COMMUNICATIONS SERVICES

Appendix B Approved Materials

Item Description	Manufacturer	Part Number
Copper Cable and Connectivity		
Lanmark-1000 Four Pair Category 6 UTP - Plenum Green	BerkTek	10065428
Lanmark-1000 Four Pair Category 6 UTP- Plenum Blue	BerkTek	10065423
Lanmark-1000 Four Pair Category 6 UTP - Plenum Yellow- WAP	BerkTek	10065427
Lanmark-1000 Four Pair Category 6 UTP - Plenum Violet - Special Circuits	BerkTek	10083461
Single Gang Faceplate, Fog White	Ortronics	OR40300158
Dual Gang Faceplate, Fog White	Ortronics	OR-40300159
Single Category 6, RJ-45 568B, Coupler	Ortronics	OR-S21600
Dual Category 6, RJ-45 568B, Coupler	Ortronics	OR-S22600
Faceplate Blank Insert	Ortronics	OR-40300164
Faceplate Blank Insert -package of 10	Ortronics	OR-40300191
Single Gang Surface Mount Wallbox, Standard Depth - Fog White	Ortronics	OR-40300061
Single Gang Surface Mount Wallbox, Deep - Fog White	Ortronics	OR-40300185
Surface Monut Wallbox Magnet	Ortronics	OR-70900020
Clarity Category 6 110 Block-100 pair	Ortronics	OR-110ABC6100
Clarity Category 6 110 Block-300 pair	Ortronics	OR-110ABC6300
Patch Panel Bezel Kit 24 Module	Ortronics	OR-401045286
Patch Panel Bezel Kit 12 Module	Ortronics	OR-401045284
Clarity High Density Patch Panel 24 Port (straight)	Ortronics	OR-PHD66U24
Clarity High Density Patch Panel 48 Port(straight)	Ortronics	OR-PHD66U48
Clarity High Density Patch Panel 96 Port(straight)	Ortronics	OR-PHD66U96
Clarity Patch Panel 24 Port (Angled)	Ortronics	OR-PHA66U24
Clarity Patch Panel 48 Port (Angled)	Ortronics	OR-PHA66U48
Clarity Patch Panel 24 Port (Curved)	Ortronics	OR-PHC66U24
Clarity Patch Panel 48 Port (Curved)	Ortronics	OR-PHC66U48
Clarity Mod Cord Cat 6 3 ft	Ortronics	OR-MC603-06
Clarity Mod Cord Cat 6 5 ft	Ortronics	OR-MC605-06
Clarity Mod Cord Cat 6 7 ft	Ortronics	OR-MC607-06
Clarity Mod Cord Cat 6 9 ft	Ortronics	OR-MC609-06
Clarity Mod Cord Cat 6 15 ft	Ortronics	OR-MC615-06
Clarity Mod Cord Cat 6 20 ft	Ortronics	OR-MC620-06
Clarity Mod Cord Cat 6 25 ft	Ortronics	OR-MC625-06

Fiber Optic Cable and Connectivity

Multimode Armor Rated Premises Distribution Plenum 50/125 um-GIGAlite-10XB		
6 Strand	BerkTek	PDPK006XB3010/X5
8 Strand	BerkTek	PDPK008XB3010/X5
12 Strand	BerkTek	PDPK012XB3010/X5
24 Strand	BerkTek	PDPK024XB3010/X5
48 Strand	BerkTek	PDPK12B048XB3010/X5

Multimode Premises Distribution Plenum Rated 50/125 um-GIGAlite-10XB		
6 Strand	BerkTek	PDP006XB3010/X5
12 Strand	BerkTek	PDP012XB3010/X5
24 Strand	BerkTek	PDP024XB3010/X5
48 Strand	BerkTek	PDP12B048XB3010/X5
72 Strand	BerkTek	PDP12B072XB3010/X5
96 Strand	BerkTek	PDP12B096XB3010/X5

144 Strand	BerkTek	PDP12B144XB3010/X5

Multimode Premises Distribution Riser Rated 50/125 um-GIGAlite-10XB		
6 strand	BerkTek	PDR006XB3010/X5
12 Strand	BerkTek	PDR012XB3010/X5
24 Strand	BerkTek	PDR024XB3010/X5
48 Strand	BerkTek	PDR12B048XB3010/X5
72 Strand	BerkTek	PDR12B072XB3010/X5
96 Strand	BerkTek	PDR12B096XB3010/X5
144 Strand	BerkTek	PDR12B144XB3010/X5

Multimode Premises Distribution Plenum Rated 62.5/125 um		
6 Strand	BerkTek	PDP006CB3510/25
12 Strand	BerkTek	PDP012CB3510/25
24 Strand	BerkTek	PDP024CB3510/25
48 Strand	BerkTek	PDP12B048CB3510/25
72 Strand	BerkTek	PDP12B072CB3510/25
96 Strand	BerkTek	PDP12B096CB3510/25
144 Strand	BerkTek	PDP12B144CB3510/25

Multimode Premises Distribution Riser Rated 62.5/125 um		
6 strand	BerkTek	PDR006CB3510/25
12 Strand	BerkTek	PDR012CB3510/25
24 Strand	BerkTek	PDR024CB3510/25
48 Strand	BerkTek	PDR12B048CB3510/25
72 Strand	BerkTek	PDR12B072CB3510/25
96 Strand	BerkTek	PDR12B096CB3510/25
144 Strand	BerkTek	PDR12B144CB3510/25

Fiber Optic Connectors		
ST Multimode	Corning	95-000-51
ST Singlemode	Corning	95-200-51
SC Multimode Unicam 62.5 Micron	Corning	95-000-40
SC Multimode Unicam 50 Micron	Corning	95-050-40
SC Singlemode Unicam	Corning	95-200-41
ST Faceplate Coupler	Ortronics	OR-60900324
SC Faceplate Coupler	Ortronics	OR-60900328
Fiber Optic Splice Enclosures		
Wall Mount Fusion Splice Enclosure (8"-Tray)	Ortronics	OR-62600003
12 Strand Fusion Splice Tray	Ortronics	OR-FST2-F012
Heat Shrink Fusion Splice Protective Sleeve (50 pk)	Ortronics	OR-20500043
Fiber Optic Termination Enclosures		
Three Slot Rack Mount Enclosure; 1RU patching only	Ortronics	OR-FC01U-P
Three Slot Rack Mount Enclosure; 1RU patching & Splice (2 splice trays)	Ortronics	OR-FC01U-C
Six Slot Rack Mount Enclosure; 2RU patching only	Ortronics	OR-FC02U-P
Six Slot Rack Mount Enclosure; 2RU patching & splice (6 splice trays)	Ortronics	OR-FC02U-C
Nine Slot Rack Mount Enclosure, 3RU patch only	Ortronics	OR-FC03U-P
Nine Slot Rack Mount Enclosure, 3RU patch & splice (11 splice trays)	Ortronics	OR-FC03U-C
12 Slot Rack Mount Enclosure, 4RU patch only	Ortronics	OR-FC04U-P
12 Slot Rack Mount Enclosure, 4RU patch & splice (holds 16 splice trays)	Ortronics	OR-FC04U-C
Patch Cabinet	Ortronics	OR615SMFC-12P
Patch Cabinet	Ortronics	OR615SMFC-LX-12
Patch Cabinet	Ortronics	OR-615SMFC-24P
Patch Cabinet	Ortronics	OR-615SMFC-24P/S

Patch Cabinet	Ortronics	OR-615SMFC-48P
Patch Cabinet	Ortronics	OR-615SMFC-48P/S
Patch Cabinet	Ortronics	OR-615SMFC-96P
Six Port ST Coupler Panel, Multimode	Ortronics	OR-OFP-STS06NB
12 Port ST Coupler Panel, Multimode, 50 micron	Ortronics	OR-OFP-STD12LC
Six Port ST Coupler Panel, Singlemode	Ortronics	OR-OFP-STS06NC
12 Port ST Coupler Panel, Singlemode	Ortronics	OR-OFP-STD12AC
Six Port SC Coupler Panel, Multimode, 50 micron	Ortronics	OR-OFP-SCD06LC
Six Port SC Coupler Panel, Multimode,	Ortronics	OR-OFP-SCS06MB
12 Port SC Coupler Panel, Multimode	Ortronics	OR-OFP-SCD12MB
12 Port SC Coupler Panel, Multimode, 50 micron	Ortronics	OR-OFP-SCD12LC
Six Port SC Coupler Panel, Singlemode	Ortronics	OR-OFP-SCD06AC
12 Port SC Coupler Panel, Singlemode	Ortronics	OR-OFP-SCD12AC
Grounding Kits	Ortronics	OR-40500140
Raised Floor Enclosure 6" deep	Ortronics	REF-25256
Raised Floor Enclosure 8" deep	Ortronics	REF-25257RB
Raised Floor Enclosure 14" deep	Ortronics	REF-242412
Mighty Mo Cable Management Cabinet 32" x 32" x 7', 42 RU	Ortronics	OR-40500106
Innerduct		
1-1/4" Plenum Innerduct		
1-1/2" Plenum Innerduct		
2" Plenum Innerduct		
1-1/4" PVC Innerduct	Carlon	DG4x1C
1-1/2" PVC Innerduct	Carlon	DH4x1C
2" PVC Innerduct	Carlon	DJ4x1C
1-1/4" Outside Plant Innerduct	Endot	Endocor 1250
1-1/2" Outside Plant Innerduct	Endot	Endocor 1500
2" Outside Plant Innerduct	Endot	Endocor 2000
Equipment Rack and Hardware		
Standard 19 x 84" Open Relay Rack	Ortronics	OR-604004600
Mighty Mo6 19" x 86" Equipment Rack, 6.5" Channel	Ortronics	OR-MM6706
Mighty Mo6 19" x 86" Equipment Rack, 16.25" Channel	Ortronics	OR-MM6716
Mighty Mo 10 Server Relay Rack 7'	Ortronics	OR-MM107SVR
19" x 38" Wall Mount Equipment Rack	Ortronics	OR-604045450
Wire Distribution Spool	Ortronics	OR-60400013
6" Vertical Wire Management (Mighty Mo 6)	Ortronics	OR-MM6VMD706
10" Vertical Wire Management (Mighty Mo III)	Ortronics	OR-MM6VMD710
3/4" Latchduct, 6' Section	Panduit	LD-5EI6-A
1.5" Latchduct, 6' Section	Panduit	LD-10EI6-A
3/4" Latchduct Fittings	Panduit	xx-5EI-E
1.5" Latchduct Fittings	Panduit	xx-10EI-E
Single Gang Faceplate Extension Ring	Ortronics	OR-40300010
12" x 10' Ladder Rack	CPI	10250-712
12" Ladder Rack Coupler Kit	CPI	11301-001
12" End Angle Bracket	CPI	11421-712
12" Triangle Bracket	CPI	11746-712
12" x 10' Cable Tray	Cablofil	CF54/300EZ
12" Cable Tray Splice (50 pk)	Cablofil	EDRNEZ

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY
DEPARTMENT OF INFORMATION TECHNOLOGY
NETWORK & COMMUNICATIONS SERVICES

Appendix B Approved Materials

Item Description	Manufacturer	Part Number
Copper Cable and Connectivity		
Lanmark-1000 Four Pair Category 6 UTP - Plenum Green	BerkTek	10065428
Lanmark-1000 Four Pair Category 6 UTP- Plenum Blue	BerkTek	10065423
Lanmark-1000 Four Pair Category 6 UTP - Plenum Yellow- WAP	BerkTek	10065427
Lanmark-1000 Four Pair Category 6 UTP - Plenum Violet - Special Circuits	BerkTek	10083461
Single Gang Faceplate, Fog White	Ortronics	OR40300158
Dual Gang Faceplate, Fog White	Ortronics	OR-40300159
Single Category 6, RJ-45 568B, Coupler	Ortronics	OR-S21600
Dual Category 6, RJ-45 568B, Coupler	Ortronics	OR-S22600
Faceplate Blank Insert	Ortronics	OR-40300164
Faceplate Blank Insert -package of 10	Ortronics	OR-40300191
Single Gang Surface Mount Wallbox, Standard Depth - Fog White	Ortronics	OR-40300061
Single Gang Surface Mount Wallbox, Deep - Fog White	Ortronics	OR-40300185
Surface Monut Wallbox Magnet	Ortronics	OR-70900020
Clarity Category 6 110 Block-100 pair	Ortronics	OR-110ABC6100
Clarity Category 6 110 Block-300 pair	Ortronics	OR-110ABC6300
Patch Panel Bezel Kit 24 Module	Ortronics	OR-401045286
Patch Panel Bezel Kit 12 Module	Ortronics	OR-401045284
Clarity High Density Patch Panel 24 Port (straight)	Ortronics	OR-PHD66U24
Clarity High Density Patch Panel 48 Port(straight)	Ortronics	OR-PHD66U48
Clarity High Density Patch Panel 96 Port(straight)	Ortronics	OR-PHD66U96
Clarity Patch Panel 24 Port (Angled)	Ortronics	OR-PHA66U24
Clarity Patch Panel 48 Port (Angled)	Ortronics	OR-PHA66U48
Clarity Patch Panel 24 Port (Curved)	Ortronics	OR-PHC66U24
Clarity Patch Panel 48 Port (Curved)	Ortronics	OR-PHC66U48
Clarity Mod Cord Cat 6 3 ft	Ortronics	OR-MC603-06
Clarity Mod Cord Cat 6 5 ft	Ortronics	OR-MC605-06
Clarity Mod Cord Cat 6 7 ft	Ortronics	OR-MC607-06
Clarity Mod Cord Cat 6 9 ft	Ortronics	OR-MC609-06
Clarity Mod Cord Cat 6 15 ft	Ortronics	OR-MC615-06
Clarity Mod Cord Cat 6 20 ft	Ortronics	OR-MC620-06
Clarity Mod Cord Cat 6 25 ft	Ortronics	OR-MC625-06

Fiber Optic Cable and Connectivity

Multimode Armor Rated Premises Distribution Plenum 50/125 um-GIGAlite-10XB		
6 Strand	BerkTek	PDPK006XB3010/X5
8 Strand	BerkTek	PDPK008XB3010/X5
12 Strand	BerkTek	PDPK012XB3010/X5
24 Strand	BerkTek	PDPK024XB3010/X5
48 Strand	BerkTek	PDPK12B048XB3010/X5

Multimode Premises Distribution Plenum Rated 50/125 um-GIGAlite-10XB		
6 Strand	BerkTek	PDP006XB3010/X5
12 Strand	BerkTek	PDP012XB3010/X5
24 Strand	BerkTek	PDP024XB3010/X5
48 Strand	BerkTek	PDP12B048XB3010/X5
72 Strand	BerkTek	PDP12B072XB3010/X5
96 Strand	BerkTek	PDP12B096XB3010/X5

144 Strand	BerkTek	PDP12B144XB3010/X5

Multimode Premises Distribution Riser Rated 50/125 um-GIGAlite-10XB		
6 strand	BerkTek	PDR006XB3010/X5
12 Strand	BerkTek	PDR012XB3010/X5
24 Strand	BerkTek	PDR024XB3010/X5
48 Strand	BerkTek	PDR12B048XB3010/X5
72 Strand	BerkTek	PDR12B072XB3010/X5
96 Strand	BerkTek	PDR12B096XB3010/X5
144 Strand	BerkTek	PDR12B144XB3010/X5

Multimode Premises Distribution Plenum Rated 62.5/125 um		
6 Strand	BerkTek	PDP006CB3510/25
12 Strand	BerkTek	PDP012CB3510/25
24 Strand	BerkTek	PDP024CB3510/25
48 Strand	BerkTek	PDP12B048CB3510/25
72 Strand	BerkTek	PDP12B072CB3510/25
96 Strand	BerkTek	PDP12B096CB3510/25
144 Strand	BerkTek	PDP12B144CB3510/25

Multimode Premises Distribution Riser Rated 62.5/125 um		
6 strand	BerkTek	PDR006CB3510/25
12 Strand	BerkTek	PDR012CB3510/25
24 Strand	BerkTek	PDR024CB3510/25
48 Strand	BerkTek	PDR12B048CB3510/25
72 Strand	BerkTek	PDR12B072CB3510/25
96 Strand	BerkTek	PDR12B096CB3510/25
144 Strand	BerkTek	PDR12B144CB3510/25

Fiber Optic Connectors		
ST Multimode	Corning	95-000-51
ST Singlemode	Corning	95-200-51
SC Multimode Unicam 62.5 Micron	Corning	95-000-40
SC Multimode Unicam 50 Micron	Corning	95-050-40
SC Singlemode Unicam	Corning	95-200-41
ST Faceplate Coupler	Ortronics	OR-60900324
SC Faceplate Coupler	Ortronics	OR-60900328
Fiber Optic Splice Enclosures		
Wall Mount Fusion Splice Enclosure (8"-Tray)	Ortronics	OR-62600003
12 Strand Fusion Splice Tray	Ortronics	OR-FST2-F012
Heat Shrink Fusion Splice Protective Sleeve (50 pk)	Ortronics	OR-20500043
Fiber Optic Termination Enclosures		
Three Slot Rack Mount Enclosure; 1RU patching only	Ortronics	OR-FC01U-P
Three Slot Rack Mount Enclosure; 1RU patching & Splice (2 splice trays)	Ortronics	OR-FC01U-C
Six Slot Rack Mount Enclosure; 2RU patching only	Ortronics	OR-FC02U-P
Six Slot Rack Mount Enclosure; 2RU patching & splice (6 splice trays)	Ortronics	OR-FC02U-C
Nine Slot Rack Mount Enclosure, 3RU patch only	Ortronics	OR-FC03U-P
Nine Slot Rack Mount Enclosure, 3RU patch & splice (11 splice trays)	Ortronics	OR-FC03U-C
12 Slot Rack Mount Enclosure, 4RU patch only	Ortronics	OR-FC04U-P
12 Slot Rack Mount Enclosure, 4RU patch & splice (holds 16 splice trays)	Ortronics	OR-FC04U-C
Patch Cabinet	Ortronics	OR615SMFC-12P
Patch Cabinet	Ortronics	OR615SMFC-LX-12
Patch Cabinet	Ortronics	OR-615SMFC-24P
Patch Cabinet	Ortronics	OR-615SMFC-24P/S

Patch Cabinet	Ortronics	OR-615SMFC-48P
Patch Cabinet	Ortronics	OR-615SMFC-48P/S
Patch Cabinet	Ortronics	OR-615SMFC-96P
Six Port ST Coupler Panel, Multimode	Ortronics	OR-OFP-STS06NB
12 Port ST Coupler Panel, Multimode, 50 micron	Ortronics	OR-OFP-STD12LC
Six Port ST Coupler Panel, Singlemode	Ortronics	OR-OFP-STS06NC
12 Port ST Coupler Panel, Singlemode	Ortronics	OR-OFP-STD12AC
Six Port SC Coupler Panel, Multimode, 50 micron	Ortronics	OR-OFP-SCD06LC
Six Port SC Coupler Panel, Multimode,	Ortronics	OR-OFP-SCS06MB
12 Port SC Coupler Panel, Multimode	Ortronics	OR-OFP-SCD12MB
12 Port SC Coupler Panel, Multimode, 50 micron	Ortronics	OR-OFP-SCD12LC
Six Port SC Coupler Panel, Singlemode	Ortronics	OR-OFP-SCD06AC
12 Port SC Coupler Panel, Singlemode	Ortronics	OR-OFP-SCD12AC
Grounding Kits	Ortronics	OR-40500140
Raised Floor Enclosure 6" deep	Ortronics	REF-25256
Raised Floor Enclosure 8" deep	Ortronics	REF-25257RB
Raised Floor Enclosure 14" deep	Ortronics	REF-242412
Mighty Mo Cable Management Cabinet 32" x 32" x 7', 42 RU	Ortronics	OR-40500106
Innerduct		
1-1/4" Plenum Innerduct		
1-1/2" Plenum Innerduct		
2" Plenum Innerduct		
1-1/4" PVC Innerduct	Carlon	DG4x1C
1-1/2" PVC Innerduct	Carlon	DH4x1C
2" PVC Innerduct	Carlon	DJ4x1C
1-1/4" Outside Plant Innerduct	Endot	Endocor 1250
1-1/2" Outside Plant Innerduct	Endot	Endocor 1500
2" Outside Plant Innerduct	Endot	Endocor 2000
Equipment Rack and Hardware		
Standard 19 x 84" Open Relay Rack	Ortronics	OR-604004600
Mighty Mo6 19" x 86" Equipment Rack, 6.5" Channel	Ortronics	OR-MM6706
Mighty Mo6 19" x 86" Equipment Rack, 16.25" Channel	Ortronics	OR-MM6716
Mighty Mo 10 Server Relay Rack 7'	Ortronics	OR-MM107SVR
19" x 38" Wall Mount Equipment Rack	Ortronics	OR-604045450
Wire Distribution Spool	Ortronics	OR-60400013
6" Vertical Wire Management (Mighty Mo 6)	Ortronics	OR-MM6VMD706
10" Vertical Wire Management (Mighty Mo III)	Ortronics	OR-MM6VMD710
3/4" Latchduct, 6' Section	Panduit	LD-5EI6-A
1.5" Latchduct, 6' Section	Panduit	LD-10EI6-A
3/4" Latchduct Fittings	Panduit	xx-5EI-E
1.5" Latchduct Fittings	Panduit	xx-10EI-E
Single Gang Faceplate Extension Ring	Ortronics	OR-40300010
12" x 10' Ladder Rack	CPI	10250-712
12" Ladder Rack Coupler Kit	CPI	11301-001
12" End Angle Bracket	CPI	11421-712
12" Triangle Bracket	CPI	11746-712
12" x 10' Cable Tray	Cablofil	CF54/300EZ
12" Cable Tray Splice (50 pk)	Cablofil	EDRNEZ

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF
INFORMATION TECHNOLOGY
NETWORK & COMMUNICATIONS SERVICES

INFRASTRUCTURE DESIGN & WIRING STANDARDS

Table of Contents

PART 1 - GENERAL SPECIFICATIONS

1.1 SCOPE

This document describes the standards, products and execution requirements relating to furnishing and installing Telecommunications Cabling at new or remodeled buildings for the Washington Metropolitan Area Transit Authority, herein after called WMATA. These standards are provided for use in planning spaces, budgeting for communications infrastructure, and as a technical description suitable for use in Requests for Proposals.

These standards, used in conjunction with published current ANSI/EIA/TIA standards represent a structured communications wiring system which will accommodate technological developments over the next several years. As technology changes this document will be amended to provide the most current and effective information available. Any aspects of communications wiring or design which are not sufficiently addressed in this document shall be brought to the attention of the manager of Network Technology Operations & Infrastructure Design in the department of Information Technology, Network and Communications Services.

1. Backbone and horizontal cabling comprised of copper and fiber cabling, and support systems are covered under this document.

2. The Horizontal (workstation) Cabling System shall consist of a minimum of two (2) 4-pair Unshielded Twisted Pair (UTP) Copper Cables to each work area outlet unless otherwise noted for specific locations. The cables shall be installed from the Work Area Outlet to the Telecommunications Room (TR) located on the same floor, and routed to the appropriate rack serving that area and terminated as specified in this document.

3. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Telecommunications contractor/installer as detailed in this document unless otherwise noted.

4. Product specifications, general design considerations, and installation guidelines are provided in this document. Typical installation details, cable routing and outlet types will be provided as an attachment to this document. If bid documents are in conflict, this specification shall take precedence. The contractor/installer shall meet or exceed all requirements for the cable system described in this document.

1.2 REGULATORY REFERENCES:

All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the local Electrical Code and present manufacturing standards.

All materials shall be UL Listed and shall be marked as such. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.

The cabling system described in this document is derived from the recommendations made in recognized telecommunications industry standards. The following documents are incorporated by reference:

1. TIA/EIA - 568-B.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements, January, 2006

2. TIA/EIA - 568-B.2, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components, February, 2007

3. TIA/EIA - 568-B.3, Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Components, April, 2002

4. TIA/EIA – 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, October, 2004

5. TIA-526-7, Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant, February, 2002

6. TIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant, August, 1998

7. TIA-598-C, Optical Fiber Cable color Coding, January, 2005

8. TIA/EIA – 570-B, Residential Telecommunications Infrastructure Standard, April 2004

9. TIA/EIA – 606 - A, Administration Standard for Commercial Telecommunications Infrastructure May, 2002 and Errata

10. J-STD- 607-A - Commercial Building Grounding and Bonding Requirements for Telecommunications, October, 2002

11. TIA/EIA – 758-A, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, August 2004

12. BICSI - TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM) – 11th Edition, 2006

13. National Fire Protection Agency (NFPA – 70),

14. National Electrical Code (NEC) -2005

15. National Fire Protection Agency (NFPA-130) Standard for Fixed Guideway Transit and Passenger Rail Systems, 2007

If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The contractor/installer has the responsibility to determine and adhere to the most recent release when installing or designing for installation.

This document does not replace any code, either partially or wholly. The contractor/installer must be aware of local codes which may have an impact on the design or installation of any cabling.

1.3 APPROVED CONTRACTOR

The Telecommunications contractor must be an approved Ortronics Certified Installer at a Plus tier (CIP, CIP-GOLD, CIP-PLATINUM, and multi-site/national contractor) and/or Berk-Tek Certified OASIS Integrator. A copy of certification documents must be submitted initially to this office. The Telecommunications contractor/installer is responsible for workmanship and installation practices in accordance with the Ortronics CI/CIP Program and Berk-Tek OASIS Program. Ortronics/Berk-Tek will extend a NetClear 25-year Static, Dynamic and Applications Warranty to the end user once the Telecommunications contractor/installer fulfills all requirements under Ortronics CI/CIP and/or Berk-Tek OASIS Program. At least 30 percent of the copper installation and termination crew must be certified by BICSI, Berk-Tek, or Ortronics with a Technicians Level of Training. Also, at least 10 percent of the optical fiber installation and termination crew must be certified by Berk-Tek or Ortronics or other approved organizations in Optical Fiber installation and termination practices. **See Appendix A, BerkTek / Ortronics Certified Installation Contractors.**

1.4 APPROVED PRODUCTS

See Appendix B, Approved Materials Berk-Tec and Ortronics have been listed here as a WMATA preferred solution, however any other manufacture's solution meeting or exceeding the listed criteria may be submitted for review and approval. Any solution submitted must also be capable of providing a manufacturers warrantee equal to, or greater than the preferred Berk-Tec/Ortronics solution.

1.5 WORK INCLUDED

The work included under this design standard consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The Telecommunications contractor/installer will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

The work shall include, but not be limited to the following:

- Furnish and install a complete telecommunications wiring infrastructure
- Furnish, install, and terminate all UTP and Optical Fiber cable
- Furnish and install all wall plates, jacks, patch panels, and patch cords
- Furnish and install all required cabinets and/or racks as required and as indicated
- Furnish any other material required to form a complete system
- Perform link or channel testing (100% of horizontal and/or backbone links/channels) and certification of all components
- Furnish test results of all cabling to the owner on compact disk and paper format, listed by each closet, then by workstation ID
- Adhere and comply with all requirements of Ortronics Certification and Berk-Tek OASIS programs
- Provide owner training and documentation. (Testing documentation and As-built drawings)

1.6 SUBMITTALS

Under the provisions of this design and wiring standard, prior to the start of work the telecommunications contractor/installer shall:

- Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this design and installation standard.
- Submit proof from manufacturer of contractor's good standing in manufacturer's program. This certification must be completed annually and submitted to this office.
- Submit appropriate cut sheets and samples for all products, hardware and cabling.
- Work shall not proceed without the Owner's approval of the submitted items.
- The telecommunications contractor/installer shall receive approval from the Owners on all substitutions of material. No substituted materials shall be installed except by written approval from the Owner and this office.

1.7 QUALITY ASSURANCE

The Ortronics CIP / Berk-Tek OASIS telecommunications contractor/installer shall be a company specializing in communication cabling installation. At least 30 percent of the copper installation and termination crew must be certified by BICSI, Berk-Tek or Ortronics with a Technicians Level of Training. At least 10 percent of the optical fiber installation and termination crew must be certified by BICSI Berk-Tek, or Ortronics in optical fiber installation and termination practices.

IT/NCS Cable Installation Quality Control Process

1. QA Phase 1
    - IT/NCS Cable Installation Practices. Inspections will ensure the following conform to TIA/EIA, WMATA Design & Wiring Standards, and all Local codes
    - Cable bend radius
    - Cable support in ceiling (Hangers/J hooks/ladder racks)
    - Cable slack at the work area and the TR
    - TR Configuration (Proper cable placement based on scope of work)

2. QA Phase 2
    - IT/NCS Cable Termination Practices. Inspections will ensure the following conform to TIA/EIA, WMATA Design & Wiring Standards, and all Local codes
    - Correct type, style and color of work area outlet
    - Correct jack pin out configuration
    - Correct TR termination: Pin out, Hardware and placement
    - Correct backbone termination

3. QA Phase 3
    - IT/NCS Cable Installation Practices. Inspections will ensure the following conform to TIA/EIA, WMATA Design & Wiring Standards, and all Local codes
    - Final check of horizontal / Backbone cable route
    - Correct racks/enclosure installation. Type and placement
    - Overall progress

4. QA Phase 4 (Final)
    - IT/NCS Final Testing and Inspection. Inspections will ensure the following conform to TIA/EIA, WMATA Design &Wiring Standards, and all Local codes
    - Complete work area installation, including work area outlets, face plates and label
    - Complete TR installation. Hardware installation, correct labeling, installation, type and the complete installation of all wire management
    - Complete Backbone cable installation, termination and labeling
    - View a percentage of the actual field testing to ensure correct procedures are being adhered to and the proper test equipment is being used

Final sign off: IT/NCS will sign a document provided by the telecommunications contractor/installer approving the installation process and materials demonstrated in this project.

1.8 DELIVERY, STORAGE AND HANDLING

- Delivery and receipt of products shall be at the contractor's main place of business/office.
- WMATA will not be responsible for the acceptance or delivery of any materials.
- Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable shall be stored off site at the contractor's expense.
- If the telecommunications contractor/installer wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.

1.9 DRAWINGS

- It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the telecommunications contractor/installer in bidding the job. The telecommunications contractor/installer shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.
- The telecommunications contractor/installer shall verify all dimensions at the site and be responsible for their accuracy.
- Prior to submission of any bid package, the telecommunications contractor/installer shall call to the attention of the Engineer of any materials or apparatus the telecommunications contractor/installer believes to be inadequate and to any necessary items of work omitted.

PART 2 – PRODUCTS

2.1 EQUIVALENT PRODUCTS

Due to the nature and type of communications, all products including but not limited to faceplates, jacks, patch panels, racks, 110 blocks, and patch cords, for the purpose of this document, shall be manufactured by Ortronics. All copper and optical fiber cable products shall be manufactured by Berk-Tek. There will be no substitutions allowed.

2.2 WORK AREA OUTLETS

Work area cables shall each be terminated at their designated work area location in the connector types described in section 1.4, Approved Products.

The Telecommunications Outlet Assembly shall accommodate:

- A minimum of two (2) modular jacks
- Additional accommodations for specific locations as noted in the plans for optical fiber and/or additional copper cables as necessary.
- A blank filler will be installed when extra ports are not used.
- A dust cap shall be provided on all modular jacks with the circuit number on the identifier strip.
- Multiple jacks that are identified in close proximity on the drawings (but not separated by a physical barrier) may not be combined in a single assembly unless pre-approved through the use of a Request for Information (ROI). The telecommunications contractor/installer shall be responsible for determining the optimum compliant configuration based on the products proposed.
- The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the telecommunications contractor shall submit the proposed configuration for each outlet assembly for review by the Owner.
- The modular jack shall incorporate printed label strip on the dust cap module for the purpose of identifying the outlet. Printed labels shall be permanent and compliant with ANSI/TIA/EIA–606-A standard specifications. Labels shall be printed using Ortronics label program (LabelMo) or using a printer such as a Brady hand held printer. Hand printed labels shall not be accepted.

Faceplates: The faceplates shall:

- Be as described in section 1.4, Approved Products
- Be UL listed and CSA certified
- Be constructed of high impact, ABS plastic UL 94V-0 construction (except where noted otherwise)
- Shall match the faceplate color used for other utilities in the building or match the color of the raceway if installed in surface raceway
- Be compliant with the above requirements along with the following when incorporating optical fiber
- Be a low profile assembly
- Incorporate a mechanism for storage of cable and fiber slack needed for termination
- Position the fiber optic couplings to face downward or at a downward angle to prevent contamination
- Incorporate a shroud that protects the optical couplings from impact damage
- Be available as single-gang or dual-gang
- Shall provide easy access for adds, moves, and changes by front removal of jack modules

- Possess recessed designation windows to facilitate labeling and identification
- Shall include a clear plastic cover to protect labels in the designation window
- Have mounting screws located under recessed designation windows
- Comply with ANSI/TIA/EIA-606-A work area labeling standard
- Allow for the UTP modules to be inverted in place for termination purposes

Voice / Data Jacks/Outlets

- Voice/Data jacks shall be 8-position modular jacks and shall be Category 6 performance as defined by the references in this document including ANSI/TIA/EIA-568-B.2-1. All pair combinations must be considered, with the worst-case measurement being the basis for compliance
- Be as described in section 1.4, Approved Products
- The modular jack shall be backwards compatible to Category 3, 5, and 5e\

2.3 110 COPPER TERMINATION BLOCK

The voice cross connect shall be a passive connection between the horizontal termination blocks and the backbone termination blocks. The wall mount frames shall be field terminated kits including all blocks, connecting blocks, and designation strips. Management rings shall be mounted between vertical columns of blocks to provide management of cross-connect wire. Backbone and horizontal blocks shall use 4-pair connecting blocks. Blocks shall be oriented so that backbone terminations are located on the left and horizontal frames are located on the right of the termination field when facing the frame assembly.

110 Block Kits shall

- Include both the wiring block in a 50, 100 and 300 pair footprint and the connecting block C6110C4
- Be OR-110ABC6050, OR-110ABC6100 AND OR-110ABC6300
- Be as described in section 1.4, Approved Products
- Support termination of 22-24 AWG solid conductor
- Wiring block shall contain back openings for the feed through of cable
- Meet category 6 component compliance
- Have color-coded tips on the wiring block and color coding on the connector blocks for installation identification
- Shall use standard termination practice requiring a single conductor 110 impact tool
- Termination hardware shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires
- Be backwards compatible to category 3, 5 and 5e
- Be labeled in compliance with ANSI/TIA/EIA-606-A labeling specifications using permanent labels and LabelMo software (or other labeling software/printer)

110 Cross-Connect System Backboard Channels Shall

- Be available in 300 and 900 pair sizes
- Allow the mounting of 110 100-pair blocks without legs
- Include bottom trough and grounding bar
- Be wall mountable

110 Wall Mount Vertical Trough Shall

- Be available in single channel or dual channel configurations

- Be in dual channel configuration shall be used to provide separation for different wiring media
- Be available in 300 pair and 900 pair sizes
- Be wall mountable
- Be used with wall mountable backboard channels. Acceptable configurations include a 300 pair and a 900 pair

2.4 MODULAR PATCH PANELS

- The Modular Patch Panels shall
- Meet category 6 component compliance
- Be as described in section 1.4, Approved Products
- Require standard termination practices using a 110 impact tool
- Use a single piece IDC housing designed to accept larger Category 6 conductors
- Support both T568B and T568A wiring
- Include easy to follow wiring labels
- Include label fields
- Allow for the use of icons
- Include full length metal rear cable management
- Be available in standard or high density
- Be backward compatible to category 3, 5 and 5e

2.5 RACKS

All racks and wire management shall be Ortronics specific. The equipment rack shall provide vertical cable management and support for the patch cords at the front of the rack and wire management, support, and protection for the horizontal cables inside the legs of the rack. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels for protection and to maintain proper bend radius and cable support. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Rack shall be black in color to match the patch panels and cable management.

Free-Standing Rack

Free-standing rack shall:

- Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B
- Have top cable trough with waterfall and built in patch/horizontal cable distribution separator
- Have EIA hole pattern on front and rear
- Be available with a 6.5” (165 mm) channel depth
- Be available with hook and loop straps for securing bulk cables inside the vertical U-channels
- Assemble as 19” (483 mm) or 23” (584 mm) with no additional hardware
- Be available with three styles of vertical patch cord management: interbay with latches, cable management rings, or fingerduct with covers
- Provide floor and ceiling access for cable management and distribution
- Provide pre-drilled base for floor attachment of rack

Wall Mounted Rack

Wall mount rack shall:

- Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B
- Have top cable trough to route patch and distribution cables between racks
- Have EIA hole pattern on front and rear
- Rack height shall be specified as 7 ft / 2.13 m (44 rack units) or 4.0 ft/1.22 m (22 rack units)
- Be available with a 6.5" (165 mm) or 14" (356 mm) channel depth
- Be available with hook and loop straps for securing cables inside the vertical U-channels
- Be available with vertical cable management rings for cord routing organization and strain relief
- Be available with vertical U-channels to protect and conceal distribution cables
- Provide floor and ceiling access for cable management and distribution
- Have wall mount braces with locator posts for easy wall mounting
- Have side access points that allow for access to manage/install distribution cables in the vertical channels

2.6 HORIZONTAL DISTRIBUTION CABLE

All horizontal data station cable and voice cable shall terminate on modular patch panels (copper or fiber), 110 cross-connecting blocks (copper), or patch/splice cabinets (fiber) in their respective Telecommunications Room or Equipment Room as specified on the drawings.

100 OHM Category 6 UNSHIELDED TWISTED PAIR CABLE (UTP)

Physical Characteristics:

- (For Plenum) shall be plenum rated and meet applicable requirements of ANSI/ICEA S-80-576. All 4 pairs must be insulated with F.E.P. No 2x2 or 3x1 constructions will be allowed.
- Be as described in section 1.4, Approved Products
- All 4 pairs must be insulated with 100 % DuPont Teflon.
- The outer jacket shall be SmokeGuard FP with Teflon.
- Shall be suitable for the environment in which they are to be installed.

The color coding of pairs shall be:

Pair 1	Pair 2	Pair 3	Pair 4
W-BL; BL	W-O; O	W-G; G	W-BR; BR

Transmission Characteristics:

- DC resistance of any conductor shall not exceed 9.38 Ohms per 100m max. at 20°C. Measured in accordance with ASTM D 4566.
- The mutual capacitance of any pair at 1 kHz for 100m of cable shall not exceed 4.4 nF .
- DC resistance unbalance between any two conductors of any pair shall not exceed 3% when measured at or corrected to 20°C in accordance with ASTM D 4566.
- The capacitance unbalance to ground at 1 kHz of any pair shall not exceed 330 pF per 100m.
- Performance values are worst pair or minimum performance guaranteed.

- Structural return loss swept measurement for 100m or longer shall be meet or exceed the following:

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	155	200	250	350	500	550
Max. SRL(dB)	26.0	26.0	26.0	26.0	26.0	25.0	23.5	22.5	21.6	21.0	20.5	19.8	19.0	18.8

- The maximum insertion loss of any pair shall be less than the following:

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	155	200	250	350	500	550
Max. Attenuation (dB)	2.0	3.8	5.9	7.5	8.4	10.6	15.3	19.7	25.0	28.8	32.6	39.5	48.6	51.4

- The NEXT coupling loss between pairs in a cable shall be greater than or equal to the following:

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	155	200	250	350	500	550
NEXT Loss Worst Pair (dB)	79.3	70.3	64.3	61.3	59.8	56.9	52.4	49.3	46.4	44.8	433	41	388	38.2

- The PSNEXT loss @ 20 degrees Celsius + 3 degrees (68 degrees F + 5.5 degrees) between pairs in a cable for a length of 100m (328ft) shall be greater than or equal to the following:

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	155	200	250	350	500	550
PSNEXT Loss Worst Pair (dB)	77.3	68.3	62.3	59.3	57.8	54.9	504	473	444	42.8	41.3	392	36.8	36.2

- The ELFEXT loss @ 20 degrees Celsius + 3 degrees (68 degrees F + 5.5 degrees) between pairs in a cable for a length of 100m (328ft) shall be greater than or equal to the following:

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	155	200	250	350	500	550
ELFEXT Loss Worst Pair (dB)	72.8	60.7	52.8	48.7	46.7	42.9	36.8	32.8	28.9	26.7	24.8	21.9	18.8	17.9

- The PSELFEXT loss @ 20 degrees Celsius + 3 degrees (68 degrees F + 5.5 degrees) between pairs in a cable for a length of 100m (328ft) shall be greater than or equal to the following:

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	155	200	250	350	500	550
PS-ELFEXT Loss Worst Pair (dB)	69.8	57.7	49.8	45.7	43.7	39.9	33.8	29.8	25.9	23.7	21.8	18.9	15.8	14.9

- The return loss @ 20 degrees Celsius + 3 degrees (68 degrees F + 5.5 degrees) between pairs in a cable for a length of 100m (328ft) shall meet or exceed the following

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	155	200	250	350	500	550
Min. RL (dB)	20.0	23.6	26.0	26.0	26.0	25.0	23.5	22.5	21.6	21.0	20.5	19.8	19.0	18.8

- Minimum longitudinal and transverse conversion loss (LCL & TCL) @ 20 degrees Celsius + 3 degrees (68 degrees F + 5.5 degrees) shall meet or exceed the following

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	200	250	350	500	550
LCL & TCL (dB)	50.0	44.0	40.0	38.0	37.0	35.1	32.0	30.0	27.0	26.0	24.6	23.0	22.6

- Minimum equal level transverse conversion loss (EL TCTL) @ 20 degrees Celsius + 3 degrees (68 degrees F + 5.5 degrees) for a length of 100m (328ft) shall meet or exceed the following

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	30.0
EL TCTL (dB)	35.0	23.0	15.0	10.9	9.0	5.5

- The propagation delay of any pair at from 1 to 250 MHz @ 20 degrees Celsius + 3 degrees (68 degrees F + 5.5 degrees) for a length of 100m (328ft) shall meet or exceed the following

Frequency (MHz)	1.0	4.0	10.0	16.0	20.0	31.25	62.5	100	200	250
Propagation Delay (ns)	570	552	545	543	542	540	539	538	537	536

2.7 BACKBONE CABLE

Indoor/Outdoor Optical Fiber Non-Conductive Plenum (OFNP) Loose Tube With Laser Optimized 50/125 Optical Fibers

Each Multimode Fiber shall be:

- Graded-index optical fiber wave-guide with nominal 50/125nm-core/cladding diameter.
- Be as described in section 1.4, Approved Products
- Shall comply with the latest revision of ANSI/EIA/TIA-492AAAB.

- Attenuation shall be measured in accordance with ANSI/EIA/TIA-455-78.
- Information transmission capacity shall be measured in accordance with the latest revision of ANSI/EIA/TIA-455-204 or –455-220.
- Maximum attenuation dB/Km @ 850/1300 nm: Per manufacturer's specifications

Physical Characteristics:

- Shall be suitable for use in both outdoor and indoor applications without the use of a transition at the building entrance.
- Shall be suitable for use in risers, plenums and horizontal applications.
- Shall have a dry water blocking system for cable core and buffer tubes.
- Shall be available with a fiber strand count range from 6 to 144.
- Shall have a 3.0 mm sub-unit diameter.
- Shall have and be marked with an UL-OFNP and OFN FT6 Flame Rating.
- Shall comply with the requirements of ICEA S-83-596 & ANSI/ICEA S-87-640.
- Strength members shall be dielectric and may be either fiberglass or aramid yarn.
- Suitable for underground or above ground conduits.
- Loose Tube fibers shall be color coded in accordance with EIA/TIA-598 with an overall blue jacket.
- Suitable for operation between -40°C to +75°C
- Shall be UV resistant

Indoor/Outdoor Optical Fiber Non-Conductive Plenum (OFNP) Loose Tube With Enhanced (Low Water Peak) Single-mode Optical Fibers

Each Single-mode Fiber shall be:

- Class IVa dispersion - unshifted single mode optical fibers with Low Water Peak complying with ANSI/EIA/TIA-492CAAB-2000.
- Be as described in section 1.4, Approved Products
- The zero dispersion wavelength shall be between 1300 nm and 1320 nm. The ANSI/EIA/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.090 ps/km-nm2. Dispersion measurements shall be made in accordance with ANSI/EIA/TIA-455-169 or ANSI/EIA/TIA-455-175-B.

Transmission Characteristics:

- Maximum cabled attenuation dB/km @ 1310/1550 nm: 0.5/0.4
- The cabled cutoff wavelength shall be ≤1260 nm when measured in accordance with ANSI/EIA/TIA-455-80-C

Physical Characteristics:

- Shall be suitable for use in both outdoor and indoor applications without the use of a transition at the building entrance.
- Shall be suitable for use in risers, plenums and horizontal applications.
- Shall have a dry water blocking system for cable core and buffer tubes.
- Shall be available with a fiber strand count range from 6 to 144.
- Shall have a 3.0 mm sub-unit diameter.
- Shall have and be marked with an OFNP and OFNP FT-6 Flame Rating.
- Shall comply with ANSI/ICEA S-83-596, ANSI/ICEA S-87-640, and ANSI/ICEA S-104-696.
- Strength members shall be FGE/Aramid/yarn.
- Suitable for underground or above ground conduits.
- Loose Tube fibers shall be color coded in accordance with EIA/TIA-598 with an overall blue jacket.

- Shall have a ripcord for overall jacket.
- Suitable for operation between -40oC to +75o C
- Shall be UV resistant

2.8 FIBER OPTIC CONNECTORS

Fiber Optic Connectors
Each Fiber Connector shall:

- WMATA's standard multimode and singlemode fiber optic connector is the SC style connector
- Be available in singlemode and multimode versions
- Be as described in section 1.4, Approved Products
- Accept a nominal fiber diameter of 125 micrometers
- Have a typical insertion loss of 0.3 dB for multimode and 0.2 dB for singlemode
- Be stable over an operating range of –40C to +75 degrees C.

2.9 COPPER CABLE PROTECTION UNITS

All copper circuits shall be provided with protection between each building with an entrance cable protector panel. See section 2.11 for additional requirements. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TC ground point. Approved manufacturer of protection units is Porta Systems.

2.10 PATCH CORDS

The contractor shall provide factory terminated and tested UTP and optical fiber patch cords and equipment cords for the complete cabling system. The UTP patch cables shall meet the requirements of ANSI/TIA/EIA-568-B for patch cord testing.

Copper (UTP) patch cords shall:

- Be as described in section 1.4, Approved Products
- Be an Ortronics category 6 Clarity patch cord with Paralign 2 Plug Design.
- Use 8 position connector with impedance matched contacts and designed using dual reactance.
- Be constructed of 100 ohm, 4 pair, 24 AWG, stranded conductor, unshielded twisted pair copper per the requirements of the ANSI/TIA/EIA-568-B.2 and ANSI/TIA/EIA-568-B.2–1 standard.
- Meet TIA category 6 component specifications in ANSI/TIA/EIA-568-B.2-1
- 100% factory tested to meet category 6 performance
- Be capable of universal T568A or T568B wiring schemes.
- Modular connector shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.
- Have a performance marking indelibly labeled on the jacket (by the manufacturer).
- Have the ability to accept color-coded labels and icons to comply with ANSI/TIA/EIA-606-A labeling specifications.
- have "snagless" protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief
- Be backwards compatible to Category 3, 5 and 5e

Optical Fiber patch cords shall:

- Contain two (2) optical fibers.
- Be as described in section 1.4, Approved Products
- Include listing of actual loss of patchcord when packaged

2.11 GROUNDING AND BONDING

The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.

- The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding bus bar (TMGB).
- Each telecommunications room shall be provided with a telecommunications ground bus bar (TGB).
- The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.
- All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.
- All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape.
- All cables and bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.

2.12 FIRESTOP

A firestop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.

- All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly firestopped.
- Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed.
- A drawing showing the proposed firestop system, stamped/embossed by the PE shall be provided to the Owner's Technical Representative prior to installing the firestop system(s).

PART 3- EXECUTION

3.1 WORK AREA OUTLETS

Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

- Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B.1 document, manufacturer's recommendations and best industry practices.
- Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- Bend radius of the horizontal cable shall not be less than 4 times the outside diameter of the cable.
- The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- Data jacks, unless otherwise noted in drawings, shall be located in the bottom position(s) of each faceplate. Data jacks in horizontally oriented faceplates shall occupy the right-most position(s).
- Voice jacks shall occupy the top position(s) on the faceplate. Voice jacks in horizontally oriented faceplates shall occupy the left-most position(s).

All Work Area design and installation practices should adhere to the BICSI TDMM 11 Chapter 3.

3.2 TELECOMMUNICATIONS SPACES

Telecommunications spaces are defined as:

- Telecommunications enclosure (TE)
- Telecommunications room (TR)
- Equipment room (ER)
- Entrance facility (EF)

Conduit Pathways between any of these spaces must be at minimum 4in (EMT) in size. The amount of these conduits must be calculated using a 40% fill ratio and maintaining at least 50% vacancy after completion.

All design and installation practices should adhere to the BICSI TDMM 11 Chapter 6. This should include but is not limited to location, sizing, conditioning, fire protection, flood protection, floor loading, grounding, lighting, physical protection & EMI.

3.3 HORIZONTAL DISTRIBUTION SYSTEMS

The horizontal distribution system consists of two basic elements—the horizontal pathways and related spaces, and the horizontal cabling system.

Horizontal pathways include:

- Physical pathways (e.g., conduit and cable tray) used for containment of telecommunications cabling.
- Nonphysical pathways (e.g., the space between open-top cable supports [J-hooks]) through which cable is placed between physical support or containment components.

Horizontal pathways consist of structures that conceal, protect, support, and provide access to horizontal cables between the telecommunications outlet/connector used to connect work area equipment at the work area and HC (FD) in the serving TR or TE.

All horizontal distribution systems design and installation practices should adhere to the BICSI TDMM 11 Chapter 4.

3.4 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

- Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
- A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-A maximum fill for the particular raceway type or 40%.
- Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- The cable's minimum bend radius and maximum pulling tension shall not be exceeded.
- If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
- Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor/installer shall install appropriate carriers to support the cabling.
- Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
- Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
- Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
- Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.

All horizontal distribution systems design and installation practices should adhere to the BICSI TDMM 11 Chapter 4 & BICSI ITISM Chapter 4.

3.5 HORIZONTAL CROSS CONNECT INSTALLATION

- Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard, manufacturer's recommendations and best industry practices.
- Pair untwist at the termination shall not exceed 13 mm (0.5 inch).
- Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- The cable jacket shall be maintained as close as possible to the termination point.
- Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

All horizontal distribution systems design and installation practices should adhere to the BICSI TDMM 11 Chapter 4.

3.6 OPTICAL FIBER TERMINATION HARDWARE

- Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.
- Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
- A maximum of 12 strands of fiber shall be spliced in each tray
- All spare strands shall be installed into spare splice trays.

All fiber optic termination practices should adhere to the BICSI ITSIM Chapter 6.

3.7 BACKBONE CABLE INSTALLATION

- Backbone cables shall be installed separately from horizontal distribution cables
- A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
- Where backbone cables are installed in an air return plenum, riser rated cable shall be installed in metallic conduit.
- Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- All backbone cables shall be securely fastened to the sidewall of the TR on each floor.

- Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
- Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
- Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

All backbone distribution systems design and installation practices should adhere to the BICSI TDMM 11 Chapter 5.

3.8 COPPER TERMINATION HARDWARE

- Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard, manufacturer's recommendations and best industry practice.
- Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- The cable jacket shall be maintained to within 25 mm (one inch) of the termination point.
- Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

All copper cable termination practices should adhere to the BICSI ITSIM Chapter 6.

3.9 RACKS

- Racks shall be securely attached to the concrete floor using a minimum ½ ” hardware or as required by local codes.
- Racks shall be placed with a minimum of 36 inch clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.
- All racks shall be grounded to the telecommunications ground bus bar in accordance with Section 2.11 of this document.
- Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- Wall mounted termination block fields shall be mounted on 4’ x 8’ x .75” void free plywood. The plywood shall be mounted vertically 12” above the finished floor. The plywood shall be painted with two coats of white fire retardant paint.
- Wall mounted termination block fields shall be installed with the highest point not to exceed 5’6” above the finished floor and with the lowest edge of the mounting frame 18” from the finished floor.

3.10 FIRESTOP SYSTEM

- All firestop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

All fire stopping practices should adhere to the (BICSI) (TDMM 11th edition) Chapter 7 & (BICSI) (ITSIM) Chapter 5.

3.11 GROUNDING SYSTEM

- The TBB shall be designed and/or approved by a qualified PE, licensed in the state that the work is to be performed. The TBB shall adhere to the recommendations of the ANSI/TIA/EIA-607 standard, and shall be installed in accordance with best industry practice.
- Installation and termination of the main bonding conductor to the building service entrance ground shall be performed by a licensed electrical contractor.

All Bonding and Grounding design and installation practices should adhere to the BICSI TDMM 11 Chapter 8.

3.12 IDENDIFICAITON AND LABELING

- The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme in conjunction with the installer/contractor.
- At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets.
- The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system.
- Racks and patch panels shall be labeled to identify the location within the cable system infrastructure.
- All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.
- Labeling shall follow the guidelines of ANSI/TIA/EIA-606-A.
- All label printing will be machine generated by Ortronics LabelMo software using indelible ink ribbons or cartridges or equivalent.
- Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.
- Outlet, patch panel and wiring block labels shall be installed on or in the space provided on the device.

All identification and labeling practices should adhere to the BICSI TDMM 11 Chapter 10.

3.13 TESTING AND ACCEPTANCE

General

- All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B.
- All pairs of each installed cable shall be verified prior to system acceptance.
- Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, the Ortronics Certification Program Information Manual and best industry practice. If any of these are in conflict, the Contractor/Installer shall bring any discrepancies to the attention of this office for clarification and resolution.

Copper Channel Testing

- All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance.
- Horizontal cabling shall be tested using a Level III test unit for category 6 performance compliance.
- The basic tests required are:
  Wire Map
  Length
  Attenuation
  NEXT (Near end crosstalk)
  Return Loss
  ELFEXT Loss
  Propagation Delay
  Delay skew
  PSNEXT (Power sum near-end crosstalk loss)
  PSELFEXT (Power sum equal level far-end crosstalk loss)

Continuity

- Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs.
- Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests.
- The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number.
- Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

Length

- Each installed cable link shall be tested for installed length using a TDR type device.
- The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate.
- The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B Standard.

- Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number.
- For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

Category 6 Performance

Shall meet the channel requirements outlined below for a 100-meter, 4-connector channel.

Frequency (MHz)	Maximum Insertion Loss (dB)	Minimum NEXT (dB)	Minimum PSNEXT (dB)	Minimum ELFEXT (dB)	Minimum PSELFEXT (dB)	Minimum Return Loss (dB)
1.0	2.1	70.0	67.0	68.3	65.3	24.0
4.0	4.0	68.0	65.5	56.2	53.2	24.0
10.0	6.3	61.6	59.0	48.3	45.3	24.0
20.0	9.0	56.6	54.0	42.2	39.2	24.0
31.25	11.3	53.4	50.7	38.4	35.4	22.1
62.5	16.4	48.4	45.6	32.3	29.3	19.1
100.0	21.2	44.9	42.1	28.3	25.3	17.0
155.0	26.6	41.7	38.8	24.4	21.4	15.1
200.0	31.5	39.8	36.9	22.2	19.2	14.0
250.0	36.0	38.1	35.2	20.3	17.3	13.0

Fiber Testing

- All fiber testing shall be performed on all fibers in the completed end to end system.
- There shall be no splices unless clearly defined in an RFI.
- Testing shall be conducted in accordance with TIA/EIA-526-7, Method B for singlemode fibers.
- Test shall be conducted in accordance with ANSI/EIA/TIA-526-14 Standard for multimode fibers.
- System loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers and 1310 and/or 1550 nanometers for single mode fibers.
- These tests also include continuity checking of each fiber.
- Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for singlemode) in both directions.
- Where links are combined to complete a circuit between devices, the Contractor/Installer shall test each link from end to end to ensure the performance of the system. ONLY LINK TEST IS REQUIRED.
- The contractor/installer can optionally install patch cords to complete the circuit and then test the entire channel.
- The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.
- Attenuation testing shall be performed with an approved hand held tester from an industry recognized test equipment manufacturer.

All field testing practices should adhere to the BICSI, TDMM11; Chapter 11

3.14 SYSTEM DOCUMENTATION

- Upon completion of the installation, the telecommunications contractor/installer shall provide three (3) full documentation sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.
- Manufacturer's original certificate of origin with each fiber's factory attenuation results must be submitted. In the event the "birth certificate" was destroyed or lost the contractor/installer is responsible for contacting the factory of origin for a certified duplicate copy.
- Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test result and draft as-built drawings.
- Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.
- At the request of the Engineer, the telecommunications contractor/installer shall provide copies of the original test results.
- The Engineer may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings.
- Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.15 TEST RESULTS

- Test documentation shall be provided on compact disk within three weeks after the completion of the project.
- The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year).
- The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s).
- The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation.
- The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-B including applicable TSB's and amendments.
- The appropriate Level III tester shall be used to verify Category 6 cabling systems.
- Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package.
- The telecommunications contractor/installer must furnish this information in electronic form (CD-ROM).
- When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

3.16 AS-BUILT DRAWINGS

- The drawings are to include cable routes and outlet locations.
- Outlet locations shall be identified by their sequential number as defined elsewhere in this document.
- Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.
- The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added.
- These documents will be modified accordingly by the telecommunications contractor/installer to denote as-built information as defined above and returned to the Owner.
- The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (AutoCAD rel. 14) form.

PART 4 -WARRANTY AND SERVICES

Warranty
The NetClear Warranty combines a 25-year extended product warranty with a 25-year applications assurance warranty. Berk-Tek and Ortronics (Manufacturer) provides the warranty directly to the end-user.

- An Extended Product Warranty shall be provided which warrants functionality of all components used in the system for 25 years from the date of registration. The Extended Product Warranty shall warrant the installed horizontal and/or backbone copper, and both the horizontal and the backbone optical fiber portions of the cabling system.
- The Application Assurance Warranty shall cover the failure of the wiring system to support the applications that are designed for the link/channel specifications of ANSI/TIA/EIA–568-B.1. These applications include, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, and 155 Mb/s ATM.
- The contractor/installer shall provide a warranty on the physical installation.

Final Acceptance & System Certification

- Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two week period will constitute acceptance of the system.
- Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a numbered certificate, from Ortronics or Berk-Tek, registering the installation.

PART 5 - INSTALLATION AND DSIGN PRACTICES

All installation practices will adhere to the Building Industry Consulting Service International (BISCI) Telecommunications Distribution Methods Manual (TDMM) Eleventh edition, as well as the Information Transport Systems Installation Manual (ITSIM) & Outside Plant Design Reference Manual (OPDRM). These BISCI manuals shall take precedence in any situation regarding design and installation practices.

PART 6 - SAFETY

It is the responsibility of the user of this document to determine the use of applicable safety and health practices (e.g., Occupational Safety and Health Administration [OSHA], *National Electrical Code*® [*NEC*®], *National Electrical Safety Code*® [*NESC*®]) associated with telecommunications systems installation and design practices. No project is so important nor any completion deadline so critical to justify nonconformance to industry standards.

SECTION 27 05 13.43

CABLE SERVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Cable Communication Services

B. Related Section:
   1. Section 27 00 00 - Communications

1.02 REFERENCES

1.03 SUBMITTALS

A. Product Services: Submit service contract data for all products provided. Indicate clearly the services provided for each service.

1.04 QUALITY ASSURANCE

PART 2 PRODUCTS

END OF SECTION

SECTION 27 08 00

COMMISSIONING OF COMMUNICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Commissioning of items common to Division 27

B. Related Documents:
   1. Commissioning Plan

C. Related Section:
   1. Section 27 00 00 - Communications

1.02 REFERENCES

A.

1.03 COMMISSIONING DESCRIPTION

A. Communications commissioning process includes the following tasks:
   1. Installation Observation.
   2. Testing and startup of Communications equipment and systems.
   3. Equipment and system verification checks.
   4. Functional performance testing to verify equipment and system performance.
   5. Provide qualified personnel to assist in commissioning tests.
   6. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
   7. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
   8. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
   9. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
   10. Provide training for systems specified in this Section with coordination by Commissioning Authority.

1.04 EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

A. Communications
   1. Cable Systems
      a. Fiber Optic cables systems
      b. Cat 6 cable systems
      c. Cat 3 Cable systems

B. Rack Systems

C. Phone System

D. Public Address and Mass Notification Systems

E. Radio Communications Equipment

1.05 COMMISSIONING SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist.

B. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified.

C. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

1.06 CLOSEOUT SUBMITTALS

A. Commissioning Report

B. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.

C. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.07 QUALITY ASSURANCE

A. Perform Work in accordance with requirements of other Sections of this Contract.

1.08 COMMISSIONING RESPONSIBILITIES

A. Commissioning Authority is provided as work of the Contractor.

B. Equipment or System Installer Commissioning Responsibilities:
   1. Attend commissioning meetings.
   2. Ensure Testing Laboratory performs assigned commissioning responsibilities as specified.
   3. Provide instructions and demonstrations for Owner's personnel.
   4. Ensure subcontractors perform assigned commissioning responsibilities.
   5. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
   6. Develop startup and initial checkout plan using manufacturer’s startup procedures and functional performance checklists for equipment and systems to be commissioned.
   7. During verification check and startup process, execute Communications related portions of checklists for equipment and systems to be commissioned.
   8. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.

9. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem solving.
10. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
11. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
12. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
13. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
14. Perform verification checks and startup on equipment and systems as specified.
15. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
16. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
17. Conduct Communications system orientation and inspection.

C. Equipment Manufacturers Commissioning Responsibilities:
   1. Attend the initial commissioning meeting.
   2. Review design for ability of systems to be controlled including the following:
      a. Confirm proper hardware requirements exist to perform functional performance testing.
      b. Confirm sensors selected are within device ranges.
      c. Review sequences of operation and obtain clarification from Architect/Engineer.
   3. Inspect check and confirm correct installation and operation of systems as required in Section 16080.
   4. Perform training sessions to instruct Owner's personnel in equipment operation, in accordance with each respective equipment Specification Section.
   5. Demonstrate system performance and operation to Commissioning Authority during functional performance tests.
   6. Provide manufacturers equipment system technician to assist during Commissioning Authority verification check and functional performance testing.
   7. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

D. Testing Laboratory Commissioning Responsibilities:
   1. Attend the initial commissioning meeting.
   2. Participate in testing procedures in accordance with Section 16080.

1.09 COMMISSIONING MEETINGS

A. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.10 SCHEDULING

A. Prepare schedule indicating anticipated start dates for the following:
   1. Cable Systems
      a. Fiber Optic cable systems
      b. Cat 6 cable systems
      c. Cat 3 Cable systems
   2. Rack Systems
   3. Phone System
   4. Public Address and Mass Notification Systems
   5. Radio Communications Equipment

1.11 COORDINATION

A. Notify Commissioning Authority minimum of four weeks in advance of the following:
   1. Scheduled equipment and system startups
   2. Scheduled start of testing and final inspection work

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. All industry standard test equipment required for performing the specified tests shall be provided by the Commissioning Authority. Any proprietary vendor specific test equipment shall be provided by that vendor or manufacturer.

B. Any portable or handheld setup / calibration devices required to initialize the control system shall be made available by the control vendor (at no cost) to the Commissioning Authority.

C. Instrumentation shall meet the following standards:
   1. Be of sufficient quality and accuracy to test and/or measure system performance within the tolerances required.
   2. Be calibrated at the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument
   3. Be maintained in good repair and operating condition throughout the duration of use on this project.
   4. Be immediately recalibrated or repaired if dropped and/or damaged in any way during use on this project.

PART 3 EXECUTION

3.01 COMMISSIONING PLAN AND SCHEDULE

A. The Commissioning Authority shall develop and submit a schedule for the commissioning process, which is integrated with the construction schedule. Included shall be the required work by all team members (Commissioning Authority, design team, contractors, and the Owner). Overlay with the construction schedule, and include time for test and balance, verification, and functional performance testing.

3.02 CONSTRUCTION OBSERVATION

A. This is an additional and separate activity from that provided by the design team. Construction observation is required as part of the commissioning and coordination process to be provided by the Commissioning Authority.

3.03 VERIFICATION AND FUNCTIONAL PERFORMANCE TEST PROCEDURES

A. Personnel experienced in the technical aspects of each system to be commissioned shall develop and document the commissioning procedure to be used. Include a performance checklist and performance test data sheets for each system based on actual system configuration. The Design Engineers and Commissioning Authority shall review these procedures for technical depth, clarity of documentation and completeness. Special emphasis shall be placed on testing procedures that shall conclusively determine actual system performance and compliance with the design intent.

B. The Commissioning Authority shall determine the acceptance procedures for each system within Divisions 27. The acceptance procedures shall incorporate the commissioning standards and successful testing results as referred to throughout Division 27 specifications.

C. The appropriate contractor and vendor(s) shall be informed of what tests are to be performed and the expected results. Whereas some test results and interpretations may not become evident until the actual tests are performed, all parties shall have a reasonable understanding of the requirements. The Commissioning Plan shall address those requirements and be distributed to all parties involved with that particular system.

D. Acceptance procedures shall confirm the performance of systems to the extent of the design intent. When a system is accepted, the Owner shall be assured that the system is complete, works as intended, is correctly documented, and operator training has been performed.

3.04 FUNCTIONAL PERFORMANCE TESTING OBSERVATION

A. The functional performance testing shall be performed by the installing contractor or equipment manufacturer’s representative. The Commissioning Authority shall direct and witness all of these tests.

B. Tests shall be completed comprehensively and to the extent necessary to enable the Commissioning Authority to assure the Owner and design professional that the systems do perform per the design intent.

3.05 OPERATING AND MAINTENANCE (O&M) MANUALS

A. The Commissioning Authority shall review the draft form of the O&M manuals provided by the Division 27 contractors. The review process shall verify that O&M instructions meet specifications and are included for all equipment furnished by the contractor, and that the instructions and wiring diagrams are specific (edited where necessary) to the actual equipment provide for this project.

1. Published literature shall be specifically oriented to the provided equipment indicating required operation and maintenance procedures, parts lists, assembly / disassembly diagrams, and related information.
2. The contractor shall incorporate the standard technical literature into system specific formats for this facility as designed and as actually installed. The resulting O&M information shall be system specific, concise, to the point, and tailored specifically to this facility. The Commissioning Authority shall review and edit these documents as necessary for final corrections by the contractor.

B. The O&M manual review, and coordination efforts shall be completed prior to Owner training sessions, as these documents are to be utilized in the training sessions.

3.06 TRAINING

A. Schedule and coordinate training sessions for the Owner's staff for each system. Training shall be in a classroom setting with the appropriate schematics, handouts, and visual / audio training aids onsite with equipment.

B. The Commissioning Authority organizes, schedules, and directs the training sessions.

C. The appropriate installing contractors shall provide training on all the major systems per specifications, including peculiarities specific to this project.

D. The equipment vendors shall provide training on the specifics of each major equipment item including philosophy, troubleshooting, and repair techniques.

3.07 RECORD DRAWINGS

A. The Commissioning Authority shall review the record contract documents to verify incorporation of both design changes and record construction details. Discrepancies noted shall be corrected by the appropriate party.

3.08 EXCLUSIONS

A. Responsibility for construction means and methods:
1. The Commissioning Authority is not responsible for construction means, methods, job safety, or any construction management functions on the job site.

B. Hands on work by the Commissioning Authority: The contractors shall provide all services requiring tools or the use of tools to startup, test, adjust, or otherwise bring equipment and systems into a fully operational state. The Commissioning Authority shall coordinate and observe these procedures (and may make minor adjustments), but shall not perform construction or technician services other than verification of testing, adjusting, and control functions.

3.09 INSTALLATION

A. Place Communications systems and equipment into full operation and continue operation during each working day of commissioning.

END OF SECTION

SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS AND APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Equipment to fit out a communications equipment room or space.

B. Related Section:
1. Section 27 00 00 - Communications

1.02 REFERENCES

A. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronics Industry Alliance (EIA):

1.	EIA-455-21A	FOTP-21 Mating Durability of Fiber Optic Interconnecting Devices.
2.	ANSI/TIA/EIA-526-7	OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
3.	ANSI/TIA/EIA-526-14A	OFSTP-14A Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
4.	ANSI/TIA/EIA-568-B.1	Commercial Building Telecommunicatons Cabling Standard – Part 1: General Requirements.
5.	ANSI/TIA/EIA-568-B.2	Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
6.	ANSI/TIA/EIA-568-B.3	Optical Fiber Cabling Components Standard
7.	ANSI/TIA/EIA-569-A	Commercial Building Standard for Telecommunications Pathways and Spaces
8.	ANSI/TIA/EIA-606	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
9.	ANSI/TIA/EIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications

B. Institute of Electrical and Electronic Engineers (IEEE):

1.	IEEE 802.3ab	Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T

C. Insulated Cable Engineers Association (ICEA):

1.	ANSI/ICEA S-80-576	Communication Wire and Cable for Wiring of Premises

D. National Electrical Manufacturers Association (NEMA):

1.	NEMA WC 63.1	Telecommunications Cables

E. Underwriters Laboratories (UL):
   1. UL 444 Communications Cables
   2. UL 467 Grounding and Bonding Equipment
   3. UL 1863 UL Standard for Safety for Communications-Circuit Accessories

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

1.03 SUBMITTALS

A. Product Data and Catalog Cuts: Submit product data for all products provided. Indicate clearly the usage of each product.

B. Shop Drawings:
   1. Distribution Frames: Provide shop drawing showing layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks and equipment spaces and racks.
   2. Product Data: For each device, include manufacturers descriptive literature; product specifications; published details; technical bulletins; performance and capacity rating curves, charts, and schedules; catalogue data sheets; and other submittal materials as required to verify that the proposed products conform to the quality and function ability of the specified products.
   3. Identification: Clearly indicate by an arrow on submissions covering more than one product type or style exactly which product is being submitted for approval.
   4. Equipment Characteristics: Size, location, weight, and electrical requirements.
   5. Manufacturer: Include the catalogue name, company name, address, and telephone number for each product submitted.

1.04 QUALITY ASSURANCE

A. 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 unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.

B. Provide products that have been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Test results shall be provided upon request of the Engineer.

C. Manufacturer Qualifications: Firm specializing in installing work of this Section with minimum five years documented experience in construction of similar equipment.

PART 2 PRODUCTS

2.01 TELEPHONE BACKBOARD

A. See drawings

B. Provide void-free, fire rated interior grade plywood 3/4 inch thick (19 mm), 4 by 8 feet (1200 by 2400 mm). Backboards shall be painted with a gray, nonconductive fire-resistant overcoat. Do not cover the fire stamp on the backboard.

2.02 PUNCH DOWN BLOCKS (VOICE)

A. Termination Fields:
   1. Wall-mount 110 type wiring base with legs, label strip holders, white label strips. Shall conform to Category 6 requirements and be 1000BASE-T compliant.

B. Connector Blocks:
   1. 110 type connector blocks that seat securely on 110 type wiring base providing a gas-tight IDC connection that maintains signal integrity. Four-pair (C-4) or five-pair (C-5) as required by application. Shall conform to Category 6 requirements and be 1000BASE-T compliant.

C. Acceptable Manufacturers:
   1. The Siemon Company.
   2. Leviton Voice and Data Division.
   3. Hubbell Premise Wiring.
   4. Or Approved Equal.

2.03 PATCH PANELS

A. UTP Copper Cable (Data):
   1. See drawings
   2. Panel shall be constructed of 0.09 inch (2.2 mm) minimum aluminum and shall be compatible with an EIA 19 inches (480 mm) equipment rack.
   3. Panel shall be equipped with the indicated quantity of non-keyed, RJ-45 ports, wired to T568B. Patch panels shall terminate the building cabling on 110-style insulation displacement connectors and shall utilize a printed circuit board interface color-coded for both T568A and T568B wiring. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.
   4. The rear of each panel shall have incoming cable strain-relief and routing guides and shall accommodate top, bottom or side cable entry.
   5. Panel shall conform to performance requirements of ANSI/TIA/EIA-568-B for Category 6 and be 1000BASE-T compliant.

B. Fiber Optic:

2.04 FIBER OPTIC PATCH PANELS - INDOOR INDUSTRIAL GRADE WALL MOUNTED

A. See drawings

B. Industrial quality, wall mounted, fiber optic cable connector housing.

C. Steel, with baked on powder coat finish. IP64 / NEMA 12. Padlockable outer door.

D. Housing shall include provisions for strain relief of incoming cables, as well as slack fiber management.

E. Provide splice tray accessories with adequate capacity for the application.

F. Provide conduit adapter accessories and gastight annular sealing bushings on all conduits.

G. Unless noted otherwise, quantity and type of connectors shall be provided for proper termination of all incoming cable fibers, plus 100% spare. Where the drawings indicate two or more cables (not including cross connecting patch cords) entering a single patch panel, separate connectors shall be provided for every fiber from each cable to allow for cross-connecting between the cables via the use of patch cords.

H. Manufacturer
   1. Ortronics

2.05 FIBER OPTIC PATCH PANELS - INDOOR/OUTDOOR ENVIRONMENTAL WALL MOUNTED

A. See drawings

B. Industrial quality, wall mounted, fiber optic cable connector housing.

C. Non-metallic. Sunlight resistant. IP66 / NEMA 4X. Padlockable outer door.

D. Housing shall include provisions for strain relief of incoming cables, as well as slack fiber management.

E. Provide splice tray accessories with adequate capacity for the application.

F. Provide conduit adapter accessories and gastight annular sealing bushings on all conduits.

G. Unless noted otherwise, quantity and type of connectors shall be provided for proper termination of all incoming cable fibers, plus 100% spare. Where the drawings indicate two or more cables (not including cross connecting patch cords) entering a single patch panel, separate connectors shall be provided for every fiber from each cable to allow for cross-connecting between the cables via the use of patch cords.

H. Manufacturer
   1. Ortronics

2.06 FIBER OPTIC PATCH PANELS - INDOOR RACK MOUNTED

A. See drawings

B. Provide rack-mount fiber optic cable connector housing for mounting in a standard 19-inch rack. Provide with compatible mounting brackets for use in a 23-inch or 24-inch or other non-standard rack, if required.

C. Provide housing of metallic construction.

D. Configuration:
   1. Provide 1U and 2U housings with hinged metallic door and slide out connector tray.
   2. Provide 3U and 4U housings with hinged polycarbonate front door.
   3. Housing shall include provisions for strain relief of incoming cables and slack fiber management.

E. Unless noted otherwise, quantity and type of connectors shall be provided for proper termination of all incoming cable fibers, plus 100% spare. Where the drawings indicate two or more cables (not including cross connecting patch cords) entering a single patch panel, separate connectors shall be provided for every fiber from each cable to allow for cross-connecting between the cables via the use of patch cords.

F. Manufacturer
   1. Ortronics

2.07 EQUIPMENT RACKS

A. General
   1. See Drawings
   2. The Rack enclosure shall be an EIA compliant 19" gangable multi-vendor server rack. Useable height shall be 42 rack spaces. Fully welded construction shall provide a static capacity of 10,000 lbs. and UL Listed load capacity of 2,500 lbs. Rack shall be constructed of the following materials: top and bottom shall be 14-gauge steel, horizontal braces shall be 16-gauge steel and all structural elements shall be finished in a durable black powder coat. Top shall include 4" cable pass-throughs with gland grommets. Rack shall have removable split rear knockout panels with 1/2", 3/4" and 1-1/2" electrical knockouts and top BNC knockouts. Grounding and bonding stud shall be 1/4-20 threaded, installed in base of enclosure. Enclosures shall satisfy the 2007 & 2010 CBC; 2006, 2009 & 2012 IBC; ASCE 7-05 (2005 Edition) & ASCE 7-10 (2010 Edition) and the 2006 & 2009 editions of NFPA 5000. Rack shall be UL Listed in the US and Canada.

B. Special Provisions:
   1. None

C. Construction:
   1. Height: 73 inches (42 spaces) minimum
   2. Depth: 39 inches useable depth
   3. Width: 24 inches
   4. Frame: Steel
   5. Door: Perforated door (25% open area minimum) with locking handle
   6. Sides: Solid removable with locking kit
   7. Rear: Split rear door
   8. Top: integrated fan tops (450 CFM minimum) with proportional speed thermostatic fan controller
   9. Base: Platform Base with isolation leveling feet
   10. Accessories: Provide mounting hardware, screws and cage nuts, as required for the system
   11. 20 amp, 20 position power strip w/circuit breaker
   12. Front and Rear Cable Organizers

13. Color: Black

D. Acceptable Manufacturers:
   1. APC

2.08 OUTLETS

A. See Drawings

B. Outlets consisting of box, fiber storage/spacer ring, wallplate and connectors.

C. Outlets shall include provisions for storage and bend radius protection of fiber and copper cabling.

D. Acceptable Manufacturers:
   1. The Siemon Company.
   2. Leviton Voice and Data Division.
   3. Hubbell Premise Wiring.
   4. Or Approved Equal.

2.09 PATCH CORDS

A. UTP Copper Cable (Data):
   1. Provided By Owner
   2. Factory assembled and tested, constructed with stranded wire, equipped with 8-pin modular connectors and strain relief boots, and conforming to Category 6 requirements and be 1000BASE-T compliant. Length as required

B. Fiber Optic:
   1. Provided By Owner
   2. Factory assembled and tested, constructed with 62.5/125 um or 50/125 um multi-mode or single-mode fiber core as required and equipped with ST or SC connectors as required. Patch cords shall meet minimum performance requirements specified in ANSI/TIA/EIA-568-B for cables and hardware specified. Length as required.
   3.

END OF SECTION

SECTION 27 32 43

RADIO COMMUNICATIONS EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

B. Related Section:
   1. Section 27 00 00 - Communications

1.02 REFERENCES

A. Underwriters Laboratories (UL):
   1. UL 444 Communications Cables
   2. UL 467 Grounding and Bonding Equipment
   3. UL 1863 UL Standard for Safety for Communications-Circuit Accessories

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

1.03 SUBMITTALS

A. Product Data and Catalog Cuts: Submit product data for all products provided. Indicate clearly the usage of each product.

B. Shop Drawings:
   1. Product Data: For each device, include manufacturers descriptive literature; product specifications; published details; technical bulletins; performance and capacity rating curves, charts, and schedules; catalogue data sheets; and other submittal materials as required to verify that the proposed products conform to the quality and function ability of the specified products.
   2. Identification: Clearly indicate by an arrow on submissions covering more than one product type or style exactly which product is being submitted for approval.
   3. Equipment Characteristics: Size, location, weight, and electrical requirements.
   4. Manufacturer: Include the catalogue name, company name, address, and telephone number for each product submitted.

1.04 QUALITY ASSURANCE

A. 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 unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.

B. Provide products that have been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Test results shall be provided upon request of the Engineer.

C. Manufacturer Qualifications: Firm specializing in installing work of this Section with minimum five years documented experience in construction of similar equipment.

PART 2 PRODUCTS

2.01 MOTOROLA TRUNKED ANTENNA AND EQUIPMENT

A. Provided by the Owner

2.02 MOTOROLA COVERAGE AUGMENTATION EQUPIMENT

A. Provided by the Owner

2.03 DIGITAL TV ANTENNA

A. See drawings

2.04 ANTANNA MOUNTING HARDWARE, CABLE RACKS AND APPURTENANCES

A. See drawings

PART 3 EXECUTION

3.01 PREPARATION

A. Manufacturer's Instructions:
   1. Follow manufacturer's instructions for surface preparation for all products applied as part of this installation.

B. Protection:
   1. Follow manufacturer's time and temperature instructions for protection of applied products.

3.02 INSTALLATION

A. Install all systems as indicated on the Drawings.

B. Apply finishes, sealants, and tapes in accordance with manufacturers printed instructions and approved submittals.

C. Install all systems in accordance with standard trade practices and applicable regulations of jurisdictional authorities.

D. Install all devices and products plumb, level, square, and free from wrap or twist. Maintain dimensional tolerances and alignment with surrounding construction and adjacent surfaces.
   1. Install pipe hangers and supports in accordance with NEC.

E. Coordinate interconnection with electrical equipment with Division 16 Contractor.

3.03 REPAIR/RESTORATION

A. Repair or restore any materials damaged or disturbed during the course of this installation.

3.04 FIELD QUALITY CONTROL

A. Field Tests:
   1. Perform the following field tests in the presence of the Engineer:
      a. Perform TDR testing to identify point faults. Report in graphical format.
      b. Test all ground system interconnections. Report impedance measurements.
   2. Repair or replace any cables and connectors that do not meet manufacturer's published performance standards. Retest any such cables.

B. Inspection:
   1. Visually inspect all installed system components. Restore or replace all components found to be in less than perfect condition.

3.05 STARTING EQUIPMENT

A. Manufacturer's Field Services:
   1. Provide manufacturer's field representative to prepare and start equipment. Measure utility and power supply voltages as necessary prior to energization of equipment to ensure correct power and wiring.

B. Adjusting:
   1. Make adjustments to power supplies, amplifiers and any other system components to ensure optimized system operation.

3.06 CLEANING AND PROTECTION

A. Clean in accordance with manufacturer's recommendations.

B. Do not use cleaning materials that may damage finish or adjacent surfaces.

3.07 PROTECTION

A. Protect installed work from subsequent construction activities.

END OF SECTION

SECTION 27 41 16.13

AUDIOVISUAL CABLING, CONNECTORS, FACEPLATES & LABELING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Procurement Documents, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Cabling
2. Certified & Specialty Cabling Systems
3. Connectors
4. Faceplates
5. Labeling

B. Related Sections:

1. 26 05 00 Common Work Results for Electrical
2. 26 05 19 Low Voltage Electrical Power Conductors and Cables
3. 26 05 26 Grounding and Bonding for Electrical Systems
4. 26 05 28 Hangers and Supports for Electrical Systems
5. 26 05 33.13 Conduits for Electrical Systems
6. 26 05 33.19 Wireways for Electrical Systems
7. 26 05 33.23 Boxes for Electrical Systems
8. 26 33 53 Static Uninterruptible Power Supplies
9. 26 43 13 Surge Protective Devices for Low Voltage Electric Power Circuits
10. 27 00 00 Communications
11. 27 05 13.43 Cable Services
12. 27 08 00 Commissioning of Communication Systems
13. 27 11 00 Communications Equipment Room Fittings and Appurtenances
14. 27 32 43 Radio Communications Equipment
15. 27 41 16.13 Audiovisual Cabling, Connectors, Faceplates & Labeling
16. 27 41 16.16 Audiovisual HD Digital Transport & Distribution System
17. 27 41 16.19 Integrated Audiovisual System
18. 33 82 13 Copper Communications Distribution Cabling
19. 33 82 23 Fiber Communications Distribution Cabling

1.3 REFERENCES

A. Reference Standards:

1. U.S. Government
    a. Federal Transit Administration
        1) 49 CFR 661 Buy America Requirements

1.4 DESCRIPTION OF WORK

A. Provide audiovisual cabling, connectors, plates, panels, racks and supporting devices as indicated in the specifications and on the drawings.

B. Provide trim rings, flanges, or escutcheon rings around all penetrations through finished construction in exposed, occupied, areas. Provide escutcheon rings at finished ceiling penetrations created by equipment mounts and conduit stubs. The trim rings, flanges, or escutcheon rings color shall match the adjacent finishes and be approved by the AUTHORITY.

C. All individual components required for a fully functioning system may not be shown on equipment lists and schematic diagrams. Provide all components needed for a fully functional audiovisual system. These include but are not limited to:

1. Cabling
2. Panel connectors
3. In-Line connectors
4. Terminal blocks
5. Modular cross-connects
6. Wiring harnesses
7. Cable assemblies
8. Mounting hardware

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. Engage an experienced Installer to perform the work of this Section.

C. All items of equipment including cabling shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

D. The Contractor shall show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor shall maintain at his facility the necessary spare parts in the proper portion as recommended by the manufacturer to maintain and service the equipment being supplied.

E. Pay any and all expenses incurred by these equipment manufacturers' representatives.

F. Electrical Component Standard

1. Provide work complying with applicable requirements of NFPA 70 “National Electrical Code” including but not limited to:

a. Article 250. Grounding.

b. Article 300, Part A. Wiring method.

c. Article 310. Conductors for General Wiring.

d. Article 725. Remote Control, Signaling, Circuits.

e. Article 800. Communication Systems.

1.6 PERFORMANCE OF EQUIPMENT

A. Materials, equipment and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the work in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance and capacity. No approval either written or verbal of any drawings, descriptive data or samples or such material, equipment and/or appurtenance shall relieve the Contractor of his responsibility to turn over the same to the AUTHORITY in optimal working order at the completion of the work.

B. Any material, equipment or appurtenances, the operation, capacity or performance of which does not comply with the drawings and/or specification requirements or which is damaged prior to acceptance by the AUTHORITY shall be held to be defective material and shall be removed and replaced with proper and acceptable materials, equipment and/or appurtenances or put in proper and acceptable working order, satisfactory to the AUTHORITY, without additional claim for payment or cost to the AUTHORITY.

1.7 SUBMITTALS

A. Certification: Provide written certification that products provided under this section meet the requirements of 49 CFR 661 Buy America Act.

B. Product Data: Provide catalog or product data sheets showing physical, electrical, and environmental characteristics and connection requirements for each component.

C. Product Samples:

1. Provide one (1) 12” piece of each cable type to be used in assembling the systems.

2. Provide one (1) each of all connectors to be used in assembling the systems.

3. Provide one (1) each of all cable labels to be used in assembling the systems.

D. Layout and labeling of plates, panels and patch panels in AutoCAD compatible format. Drawing scale shall be no smaller than 3” = 1’-0”.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect products under provisions of the General Contract requirements.

B. Control inventory and handing of system components so that completion of the work will not be delayed by shortages of equipment or hardware before, during, or after installation.

C. Protect exposed surfaces of installed equipment to prevent incidental or direct damage to system components prior to acceptance by the AUTHORITY.

PART 2 PRODUCTS

2.1 GENERAL

A. All associated system components and equipment shall conform to the manufacturer's most recently published specifications for both function and design feature(s) and are hereby included by reference into the project specifications.

B. All material shall be new.

C. All material shall be UL listed or in the case of Custom Assemblies, built to UL standards.

D. All equipment is intended to be professional grade and rated for continuous duty. Basic guidelines have been established for minimum performance requirements. These requirements must be satisfied, unless a variance (separate document) is submitted and approved by the AUTHORITY.

2.2 MANUFACTURERS

A. Manufacturers are as indicated on the drawings and in the specifications. The naming of a manufacturer, while not intended to be restrictive, is intended to establish design criteria and quality. Catalog and model numbers are intended to indicate the type, quality of design, materials, and operating features necessary to meet system design and performance requirements. In no case shall materials of lesser design or workmanship be deemed acceptable.

2.3 SUBSTITUTIONS

A. Substitutions will be at the sole risk and liability of the Bidder. In the event a product substitution proves to be unreliable or causes system malfunction, or fails to meet performance criteria, the product will be replaced in its entirety and at the expense of the Bidder with no additional claim for payment. The Bidder will also pay any and all charges related to any and all re-work of other trades necessary to correct any and all deficiencies so that an operable system to performance specification is turned over to the AUTHORITY.

B. No substitutions shall be allowed for certified cabling systems.

2.4 AUDIOVISUAL CABLING

A. GENERAL

1. All specifications contained in the manufacturer's technical data sheets are included by reference whether or not included in this specification.

B. MICROPHONE

1. Description: 22/2 Stranded bare copper conductors, shielded with an overall jacket.
2. Rating: CMR, NEC Article 800
3. Approvals: (UL) C(UL) Listed or c(ETL)us Listed
4. Microphone line shall be **West Penn 291**, or approved substitute.

C. MULTI-PAIR MICROPHONE / LINE

1. Description: 22 AWG stranded tinned copper conductors, individually shielded and jacketed pairs with an Overall jacket.
2. Rating: CM, NEC Article 800
3. Approvals: (UL) Listed
4. Multi-Pair Microphone / Line cable shall be.
    a. 6-pair: West Penn **WP4546**, or approved substitute
    b. 8-pair: West Penn **WP4548**, or approved substitute
    c. 12-pair: West Penn **WP45412**, or approved substitute

D. LINE

1. Description: 18/2 Stranded bare copper conductors, shielded with an overall jacket
2. Rating: CMR, NEC Article 800
3. Approvals: (UL) C(UL) Listed or c(ETL)us Listed
4. Cable shall be West Penn **293**, or approved substitute.

E. LOW IMPEDANCE SPEAKER CABLE

1. Description: Stranded bare copper conductors, unshielded Cluster Speaker Cable.
2. Rating: TC, NEC Class 1 – 600V
3. Approvals: (UL) or (ETL)us Listed
4. Low Z speaker cable shall be West Penn **C210** or **C207** as indicated on the drawings, or approved substitute.

F. DISTRIBUTED 70V AUDIO SPEAKERS

1. Description: 16/2 Stranded bare copper conductors, unshielded & unjacketed-Cluster Speaker Cable.

2. Rating: CL2, NEC Article 725
3. Approvals: (UL) or (ETL)us Listed
4. 70V (High Z) Speaker Cable shall be West Penn **C205** or approved substitute.

G. DIGITAL AUDIO

1. Description: 24 AWG solid bare copper conductors, non-plenum, Polyolefin insulation, twisted pairs, rip cord, PVC jacket.
2. Ratings and Approvals:
   a. NEC/(UL) Specification CMR
   b. NEC Articles 800
   c. CEC/C(UL) Specification CMR
   d. IEC Specification 11801 Category 5
   e. EU CE Mark (Y/N) Yes
   f. EU RoHS Compliant (Y/N) Yes
   g. EU RoHS Compliance Date (mm/dd/yyyy): 01/01/2004
   h. TIA/EIA Specification 568-B.2 Category 5e
   i. Other Specification NEMA WC-63.1 Category 5e, UL verified to Category 5e
3. Digital Audio cabling shall be Belden **1583A**, or approved substitute.

H. 15-Pin HD CABLING (Fifteen conductor)

1. Description: 22/15 Stranded bare copper conductors, unshielded with an overall jacket.
2. Rating: CMR, NEC Article 800
3. Approvals: (UL) C(UL) Listed or c(ETL)us Listed
4. 15-Pin HD cable for use with 15-pin HD connectors shall be West Penn **274** or approved substitute.

I. RGBHV VIDEO

1. Description:
   a. Overall Assembly: 5 Minimax Coaxial subunits, Overall Shielded, Overall PVC Jacket.
   b. Individual Coax Units: ASTM Bare copper conductor 25 Awg, Gas Injected PE Dielectric , 100% Aluminum Foil + 95% Tinned Copper Braid, Individual Coax, PVC Jacket.
2. Rating:
   a. UL listed NEC type CM as defined in Article 800
   b. Constructed in accordance with UL Standard 444
   c. Meets 300V requirements as specified in Section 800 and 725 NEC
   d. Complies with UL 1581 Vertical Flame Test
3. RGBHV cable shall be West Penn **WP8255**, or approved substitute.

J. COMPONENT VIDEO

1. Description:

   a. Overall Assembly: 3 Minimax Coaxial subunits, Overall Shielded, Overall PVC Jacket.

   b. Individual Coax Units: ASTM Bare copper conductor 25 Awg, Gas Injected PE Dielectric , 100% Aluminum Foil + 95% Tinned Copper Braid, Individual Coax, PVC Jacket.

2. Rating:

   a. UL listed NEC type CM as defined in Article 800

   b. Constructed in accordance with UL Standard 444

   c. Meets 300V requirements as specified in Section 800 and 725 NEC

   d. Complies with UL 1581 Vertical Flame Test

3. RGB cable shall be West Penn **WP8253**, or approved substitute.

K. COMPOSITE VIDEO

1. Description: RG6/U – 1 Coaxial 18 AWG Solid- 100% Aluminum Foil + 95% Tinned Copper Braid PVC Jacket,

2. Rating: CMR

3. Approvals: (UL) C(UL) Listed or c(ETL)us Listed

4. Composite video cable shall be West Penn **6350**, or approved substitute.

2.5 CERTIFIED CABLING SYSTEM – DIGITAL MEDIA

A. Crestron DigitalMedia™ Cable System

1. High-performance cable consisting of (1) high-bandwidth/low-crosstalk shielded 4-twisted pair (STP) cable, (1) CAT5e unshielded 4-twisted pair (UTP) cable, and (1) DMNet cable.

   a. Description:

      1) The STP "Video Data" cable, which connects to the 'D' port of a DigitalMedia device, is of a specialized construction designed to allow the longest possible cable lengths for transporting high-definition digital video and audio.

      2) The Cat5e "Data Management" cable, which connects to the 'M' port, carries high-speed Ethernet and other data, plus 5V DC power.

      3) Finally, the DMNet cable carries additional proprietary control signals and 24V DC power.

   b. Construction:

      1) ‘D’ Video Data

         i) Four 24 AWG x 8 twisted pair, each pair isolated by an internal spline within an inner jacket, shield, and overall jacket.

         ii) Terminate ‘D’ cable with the Crestron DM-CONN shielded RJ-45 connector.

2) ‘M’ Data Management

i) Four 24 AWG x 8 twisted pair, solid copper, unshielded, and overall jacket.

ii) Terminate ‘M’ cable with one standard RJ-45 connector.

3) DMNet Control Pair

i) Control pair consisting of 22 AWG x 2, 100% aluminum coverage shield, 24 AWG tinned stranded copper drain.

ii) Power pair consisting of 18 AWG x 2 stranded copper, unshielded with overall PVC jacket.

iii) Terminate DMNet cable with one detachable terminal block provided with each device.

4) Outer Jacket

i) All wires contained in a Mylar wrap with overall outer jacket with ripcord.

c. Rating: NEC Article 800; UL Subject 444, Type CMP; CSA Type CMP

d. Outer diameter: 0.58 inch nominal

e. Maximum bend radius: 4.5-in

f. Maximum Pull Tension: 73-lb-ft

g. Cable shall be Crestron DigitalMedia:

1) **DM-CBL-NP** (non-plenum)

2) **DM-CBL-P** (plenum)

2. 350MHz Data-Grade 8G Shielded CAT5e Cable

a. Description: Four 24 AWG x 8 solid copper 350MHz-certified shielded twisted pair, inner PVC jacket, 26 AWG solid tin/copper drain, 100% coverage Aluminum foil shield, ripcord and overall PVC jacket.

b. Rating: OFNR (UL 1666), CSA FT4

c. Maximum bend radius: 2.75-in

d. Maximum Pull Tension: 25-lb/ft

e. Cable shall be Crestron DigitalMedia 8G™:

1) **DM-CBL-8G-NP** (non-plenum)

2) **DM-CBL-8G-P** (plenum)

f. Shielded RJ45 connector for Crestron DigitalMedia DM-CBL-8G cable shall be the Crestron DM-8G-CONN.

g. Professional crimping tool for terminating Crestron DigitalMedia 8G Shielded Twisted Pair cable and DM-8G-CONN connectors shall be the Crestron DM-8G-CRIMP tool.

3. 8G Fiber Optic Cable

a. Description: Four individually jacketed fiber, 50/125 µm nominal, 600 MHz/km minimum bandwidth at 850 nm, strands within a single reinforced outer riser-rated PVC jacket.

b. Maximum bend radius: 6.3-in

c. Maximum Tensile Load: 270-lbf

d. Fiber cable shall be Crestron CresFiber® 8G Fiber Optic Cable:
   1) **CRESFIBER8G-NP** (non-plenum)
   2) **CRESFIBER8G-P** (plenum)
e. Fiber Optic connector for Crestron CRESFIBER8G cable shall be the Crestron CRESFIBER-CONN-SC50UM (AFL Telecommunications™).
   1) Type: SC
   2) Fiber Type: Multimode 50 µm
   3) Insertion Loss: 0.1 dB typical, 0.5 dB maximum
   4) Approvals: TIA/EIA 568A performance, TIA/EIA 604 (focis) connector interface
f. Professional tool for terminating Crestron CRESFIBER8G cable and CRESFIBER-CONN-SC50UM connectors shall be the Crestron CresFiber® Termination Kit (AFL Telecommunications™).

B. Crestron® Certified Copper Interface Cable Assemblies

1. General
   a. Assembly shall have 24k gold-plated connectors
   b. Assembly shall have a high-flex CL3-rated jacket
   c. Assembly shall be RoHS compliant
   d. Assembly shall be available in standard lengths (**LEN)** of 1.5, 3, 6, 12, 20 and 30 feet (unless otherwise noted)
2. HDMI Interface Cable
   a. Supported Display Formats: 1080p60 HDTV with 16-bit color depth and WUXGA computer resolutions
   b. Supported Audio Formats: SACD, DVD-Audio, Dolby® TrueHD, and DTS-HD Master Audio™
   c. Use: Convert HDMI to DVI, or DVI to HDMI
   d. Interface cable shall be the CBL-HD-**LEN** High-speed Category 2 HDMI cable with an HDMI Type A male connectors at each end.
3. HDMI to DVI Interface Cable
   a. Supported Formats: 1080p60 HDTV and WUXGA computer resolutions
   b. Use: Convert HDMI to DVI, or DVI to HDMI
   c. Interface cable shall be the CBL-HD-DVI-**LEN** HDMI to DVI conversion cable with a male HDMI Type A connector at one end, and male DVI-D connector at the other.
4. RCA Stereo Audio Interface Cable
   a. Available in standard lengths (LEN) to 12-ft.
   b. Interface cable shall be the CBL-RCA2-**LEN** unbalanced stereo audio cable with RCA male connectors at each end.
5. RCA Component Video Interface Cable
   a. Supported Formats: Analog 1080p HDTV

b. Available in standard lengths (LEN) to 12-ft.

c. Interface cable shall be the CBL-RCA3-**LEN** high-bandwidth, low-loss HD component video cable featuring RCA male connectors at each end.

6. RCA Composite Video & SPDIF Audio Interface Cable

a. Available in standard lengths (LEN) to 12-ft.

b. Interface cable shall be the CBL-RCA-**LEN** low-loss composite video cable with RCA male connectors at each end.

7. Computer VGA Interface Cable

a. Supported Formats: WUXGA computer resolution

b. Available in standard lengths (LEN) to 12-ft, 25-ft.

c. Interface cable shall be the CBL-VGA-**LEN** high-bandwidth cable with male DB15HD (i.e., DE15, HD-15) connectors at each end.

C. Crestron® Certified Pre-Terminated Fiber Patch Cable Assemblies

1. General

a. Fiber Core: ISO/IEC 11801 type OM2 fiber, IEC 60793-2-10 type A1a.1 fiber, TIA/EIA 492AAAB

b. Assembly shall be OFCP, RoHS and UL E336844 compliant

c. Assembly shall be available in standard lengths (**LEN)** of:

1) PVC: 1.5, 3, 6,12, 20 and 30 feet

2) CLEAR: 30, 60 and 100 feet

3) ARMORED: 60, 100, 200 and 300 feet (unless otherwise noted)

2. CLEAR Simplex Fiber Optic Cable Assembly

a. Description: Single-strand 50/125 µm nominal, 500 MHz/km bandwidth at 850 nm, within a transparent PVC jacket coating.

b. Compatibility: HDMI® over Fiber transmitters and receivers

c. Use: Non-Plenum, visibly exposed areas for digital AV and control applications

d. Maximum bend radius: n/a

e. Maximum tensile strength: 0.7 Gpa

f. Assembly shall be the CRESFIBER-SINGLE-SC-CLEAR-NP-**LEN** single-strand (simplex) Patch Cable with type SC connectors at each end.

3. Simplex Fiber Optic Cable Assembly

a. Description: n/a

b. Compatibility: HDMI® over Fiber signal extenders, DigitalMedia 8G™

c. Use: Plenum

d. Maximum bend radius: n/a

e. Maximum tensile strength: n/a

f. Assembly shall be the CRESFIBER-SINGLE-SC-P-**LEN** single-strand (simplex) Patch Cable with type SC connectors at each end.

4. ARMORED Simplex Fiber Optic Cable Assembly

    a. Description: Single-strand 50/125 µm nominal, 500 MHz/km bandwidth at 850 nm, within a flexible stainless steel tube with Kevlar® and stainless steel braiding flame-retardant PVC, LSZH, PE,PU,PTEE,SGS, & UL jacket.

    b. Compatibility: HDMI® over Fiber signal extenders, DigitalMedia 8G™

    c. Use: Plenum

    d. Maximum bend radius: 1.18-in

    e. Maximum tensile strength: 44-lbf

    f. Assembly shall be the CRESFIBER-SINGLE-SC-ARMORED-P-**LEN** single-strand (simplex) Patch Cable with type SC connectors at each end.

5. Duplex Fiber Optic Cable Assembly

    a. Description: n/a

    b. Compatibility: DigitalMedia™

    c. Use: Plenum

    d. Maximum bend radius: n/a

    e. Maximum tensile strength: n/a

    f. Assembly shall be the CRESFIBER-DUAL-SC-P-**LEN** dual-strand (duplex) Patch Cable with type SC connectors at each end.

6. ARMORED Duplex Fiber Optic Cable Assembly

    a. Description: Dual-strand 50/125 µm nominal, 500 MHz/km bandwidth at 850 nm, within a flexible stainless steel tube with Kevlar® and stainless steel braiding flame-retardant PVC, LSZH, PE,PU,PTEE,SGS, & UL jacket.

    b. Compatibility: DigitalMedia™

    c. Use: Plenum

    d. Maximum bend radius: 1.18-in

    e. Maximum tensile strength: 44-lbf

    f. Assembly shall be the CRESFIBER-DUAL-SC-ARMORED-P-**LEN** dual-strand (duplex) Patch Cable with type SC connectors at each end.

D. Interface Wall Plates

1. General

    a. Pre-labeled, color-coded, gold-plated connectors

    b. Standard colors: **CLR** = [**B**]lack, [**W**]hite, [**A**]lmond (unless otherwise noted)

    c. Mounting 1-gang, 3-1/2” deep, electrical wall box

        1) Gangable using standard DECORA-style plates

2. MP-WP100-**CLR**: Crestron RCA Composite Video w/RCA Stereo Audio plate with three (3) bulkhead type feed-thru connectors providing female RCA connections at the rear of the wall plate for installation using standard RCA cables.

3. MP-WP120-**CLR**: Crestron RCA Component Video w/RCA Stereo Audio plate with five (5) bulkhead type feed-thru connectors providing female RCA connections at the rear of the plate for installation using standard RCA cables.
4. MP-WP125-**CLR**: Crestron RCA Component & Composite Video w/2x RCA Stereo Audio plate with eight (8) bulkhead type feed-thru connectors providing female RCA connections at the rear of the plate for installation using standard RCA cables.
5. MP-WP130-**CLR**: Crestron DB15HD Computer VGA w/Mini-TRS Stereo Audio plate with (1) female DB15HD connector (i.e., HD-15, DE15) and one (1) 1/8" mini-TRS connector. Bulkhead type feed-thru connectors provide a female DB15HD connection at the rear of the wall plate for installation using a standard VGA cable. Audio wiring is connected via a 3-pin terminal block.
6. MP-WP131-**CLR**: Crestron DB15HD Computer VGA w/Mini-TRS Stereo Audio plate with one (1) female DB15HD connector (i.e., HD-15, DE15) and one (1) 1/8" mini-TRS connector. A breakout cable assembly at the rear of the wall plate provides five (5) female BNC connections for installation using a standard 5-BNC cable. Audio wiring is connected via a 3-pin terminal block.
7. MP-WP140-**CLR**: Crestron DVI-I w/Mini-TRS Stereo Audio plate with one (1) Dual Link DVI-I connector and one (1) 1/8" mini-TRS connector. A bulkhead type feed-thru connector is used to provide a female DVI-I connection at the rear of the wall plate for installation using a standard DVI-I or DVI-D cable. Audio wiring is connected via a 3-pin terminal block.
8. MP-WP150-**CLR**: Crestron HDMI® w/Mini-TRS Stereo Audio plate with one (1) Type A HDMI connector and one (1) 1/8" mini-TRS connector. A bulkhead type feed-thru connector is used to provide a female HDMI connection at the rear of the wall plate for installation using a standard HDMI cable. Audio wiring is connected via a 3-pin terminal block.
9. MP-WP151-**CLR**: Crestron HDMI® plate with one (1) Type A HDMI bulkhead type feed-thru connector to provide a female HDMI connection at the rear of the wall plate for installation using a standard HDMI cable.
10. MP-WP162-**CLR**: Crestron DisplayPort plate with one (1) DisplayPort bulkhead type feed-thru connector to provide a female DisplayPort connection at the rear of the wall plate for installation using a standard DisplayPort cable.
11. MP-WP181-C-**CLR**: Crestron DigitalMedia 8G+™ plate with one (1) female 8-pin RJ45 shielded connector labeled for DigitalMedia 8G+. Punch-down terminals are provided at the rear of the wall plate for installation using DM-CBL-8G DigitalMedia 8G™ Cable [or CAT5e].
12. MP-WP185-C-**CLR**: Crestron DigitalMedia™ CAT w/DMNet® plate with two (2) female 8-pin RJ45 connectors, and one (1) 4-pin 3.5mm detachable terminal block. A combination of punch-down and screw terminal connections at the rear of the wall plate facilitate installation using DM-CBL DigitalMedia Cable.

2.6 CERTIFIED CABLING SYSTEM – CRESTRON CRESNET DATA & POWER

A. Rating: NEC Article 800; UL Subject 13, Type CM; CSA Type CMG

B. Data Pair

1. Conductors: 22 AWG x2 stranded bare copper;
2. Colors: Blue/white
3. Insulation: FoamPolyolefin
4. Shield: Aluminum/Polyester (100% coverage);
5. 24 AWG stranded tinned copper drain
6. Capacitance: 12.5 pF/ft, nominal
7. Impedance: 100 ohms, nominal

C. Power Pair

1. Conductors: 18 AWG x2stranded bare copper;
2. Colors: Red/black
3. Insulation: PVC
4. Shield: none

D. Outer Jacket

1. Material: PVC
2. Thickness: 0.032" nominal
3. Outer Diameter : 0.250" nominal
4. Colors: Teal w/yellow stripe, Black w/yellow strip, Orange w/black stripe, Yellow w/black stripe

E. Control cable shall be CRESTRON CRESNET–NP cable for non-plenum spaces or CRESNET-P cable for plenum spaces.

2.7 CONNECTORS

A. General

1. Provide faceplates with connector configurations as shown on the drawings and described herein.
2. Coordinate all plate and panel connectors with corresponding mating connectors for a complete system.
3. Provide blank faceplates over all unused audiovisual backboxes. Cover plate color and construction shall match faceplates used for other devices in the room or area.
4. Where cabling extends out of backboxes directly through faceplates, provide split grommet faceplates. Faceplate shall be split to permit installation around existing cabling.

B. Panel Mount D-Series Connectors

1. General

a. The panel mount connectors shall have the following identification and installation options.

1) Dummy Plug shall be available for the following connectors:

i) Female XLR -Neutrik NDF.

ii) Male XLR - Neutrik NDM.

iii) 1/4" Jacks - Neutrik NDJ.

iv) Female RCA phono receptacles - NDP.

v) 2 & 4 Pole SpeakON chassis and PowerCON chassis - NDL.

2) Soft plastic cover for the solder end of D-size chassis connectors shall be the Neutrik SCDR.

3) Lettering Plate for D-shape-connectors shall be the Neutrik DSS-*.

i) * Lettering Plate shall be available in the following colors: Black, Blue, Brown, Green, Grey, Orange, Red, Violet, White, Yellow

4) Fixing Plate with M3 thread shall be the Neutrik MFD. This plate shall provide efficient mounting of all D-sized chassis connectors using M3 screws.

5) Sealing Gasket shall be the Neutrik SCDP-* . This gasket shall provide a dust and water resistant assembly for all D-shape chassis connectors to front panels.

i) * Sealing Gasket shall be available in the following colors: 0-black, 2-red, 4-yellow, 5-green, 6-blue, 9-white.

6) Hinged Cover for all D-size chassis connectors shall be the Neutrik SCDX-*. Hinged cover shall seal D-size chassis connectors from water, dust and dirt in unmated condition according to IP42.

i) Hinged Cover shall be available in the following colors:

(a SCDX-0 - black

- (if used with opticalCON, black indicates multimode)

(b SCDX-5 - green

- (if used with opticalCON, green indicates singlemode APC)

(c SCDX-6 - blue

- (if used with opticalCON, blue indicates singlemode PC)

(d SCDX-9 - white (e.g. wall outlet)

2. Microphone

a. The microphone connector shall be a UL recognized component.

b. The connector shall be a universal D-Series metal body XLR panel mount series with 3 pole female receptacle solder cups, **black metal housing**, and silver contacts.

c. The panel mount Microphone Input Connector shall be the Neutrik **NC3FD-L-BAG-1** or approved substitute.

3. Line (XLR)

   a. The audio line level input connector shall be a UL recognized component.

   b. The connector shall be a universal D-Series metal body XLR panel mount series with 3 pole male receptacle solder cups, **black metal housing**, and silver contacts.

   c. The connector shall be the Neutrik **NC3MD-L-BAG-1** or approved substitute.

4. Line Level (1/4”)

   a. The connector shall be a 1/4" phone jack in a D-size shell with black metal housing and silver contacts.

   b. The connector shall be a securely locking chassis jack with solder terminals.

   c. The connector shall mate with all mono or stereo plugs specified to EIA RS-453.

   d. The connector shall offer a choice of grounding options.

   e. The connector shall be the **NJ3FP6C-BAG** or approved substitute.

5. RCA Phono Socket

   a. The connector shall be a recessed phono socket in black chrome D-shape housing, color-coded isolation washer, solder version. The connector shall have gold contacts.

   b. The connector shall make ground before signal contact and break signal before ground.

   c. The panel connector shall be the Neutrik **NF2D-B-*** or approved substitute. The following convention shall be followed:

1)	NF2D-B-9	(white)	Stereo audio signal, left channel
2)	NF2D-B-2	(red)	Stereo audio signal, right channel
3)	NF2D-B-0	(black)	Monaural audio signal
4)	NF2D-B-4	(yellow)	Composite video signal

6. Low-Z Speaker

   a. Connector shall have a 4 pole chassis connector, black D-size flange, countersunk thru holes, and 3/16" flat tabs.

   b. Connector shall feature a unique locking system, robust plastic housing and high current silver plated contacts.

   c. Connector shall have a standard of 30 Amp current rating and an optional high current 50 Amp version.

   d. Connector shall have an accurate twist lock latching system.

   e. Connector shall have a metal insert in locking area.

f. Connector shall have an airtight design optimized for speaker applications.

g. The panel mount speaker connector shall be the Neutrik **NL4MP** 4-pole or **NL2MP** 2-pole or approved substitute.

7. Network Connector [RJ45]

   a. The network connector shall be a lockable RJ45 connector system, optimized for professional audio, video, and lightning, network applications. The connector shall fit into standardized D-Series chassis openings.

   b. The network connector shall feature an RJ45 feed through receptacle and D-shape metal flange with the latch lock. Mounting screws shall be included.

   c. The network panel mount connector shall be the Neutrik **NE8FDP-B**.

   d. The following DSS-* Type Color Collars shall be used for identifying RJ45 connectors:

1)	FACILITY Local Area Network	IVORY (verify)
2)	Digital Audio Network (primary signal)	RED
3)	Digital Audio Network (secondary signal)	BLUE
4)	Digital Audio Network (control)	ORANGE
5)	Digital Video Network (copper)	GREEN
6)	Digital Video Network (fiber)	YELLOW
7)	* Field Assignable *	GRAY
8)	Analog TP VIDEO	BLACK

8. Fiber Connector

   a. Connector shall be built in the standard D size shell with Push-Pull locking mechanism for safe connection.

   b. Connector shall have Ruthenium plating.

   c. Connector shall be waterproof to IP65.

   d. Connector shall act as a "feed-through" allowing simplified installations by connecting four conventional LCs on the rear.

   e. Connector shall provide an automatic sealing cover for maximum dust and dirt protection.

   f. Connector shall provide a 4 channel POINT-TO-POINT multichannel routing solution.

   g. Connector shall be supplied with color-coded collars to identify fiber mode.

   h. The connector shall be the Neutrik **NO4FDW-R**.

9. BNC Connector

   a. The bulkhead connector shall provide a true 75 Ω design for serial and digital (HD) signals.

   b. The connector shall be recessed and protected in a D-shape housing.

   c. The connector shall feature an isolated bulkhead jack, feed-through in black D-shape housing.

   d. The connector shall have a gold plated center contact

   e. The connector shall have optional color coding accessories.

f. The panel mount BNC connector shall be the Neutrik **NBB75DFIB-P**.

C. Inline Plugs And Jacks

1. Microphone (XLR)

a. Cable connector shall be constructed of UL recognized components.

b. Cable connector shall be 3 pole male cable connector, black metal housing and silver contacts.

c. Cable connector shall have zinc die cast shell and chuck type strain relief system for secure clamping of cables.

d. Cable connector shall have boot with rubber gland for protection against bending stresses.

e. The cable connector shall have optional color-coded rings and boots available for marking and identification.

f. The cable connector shall be the Neutrik **NC3MX-BAG** or approved substitute.

2. Line Level (XLR)

a. Cable connector shall be constructed of UL recognized components.

b. Cable connector shall be 3 pole female cable connector, black metal housing and silver contacts.

c. Cable connector shall have zinc die cast shell and chuck type strain relief system for secure clamping of cables.

d. Cable connector shall have boot with rubber gland for protection against bending stresses.

e. The cable connector shall have optional color-coded rings and boots available for marking and identification.

f. The cable connector shall be the Neutrik **NC3FX-BAG** or approved substitute.

3. Line Level (1/4")

a. The cable connector shall have a black metal housing and Nickel contacts.

b. The connector housing shall have optional color-coded accessories as indicated on the drawings.

1) Color-coded boots shall be the Neutrik BSP-* or approved substitute. Available colors shall be: 0 – Black, 1 – Brown, 2 – Red, 3 – Orange, 4 – Yellow, 5 – Green, 6 – Blue, 7 – Violet, 8 – Grey, 9 – White.

2) Color-coded rings shall be the Neutrik PCR-* or approved substitute. Available colors shall be : 1 – Brown, 2 – Red, 3 – Orange, 4 – Yellow, 5 – Green, 6 – Blue, 7 – Violet, 8 – Grey, 9 – White.

c. The 2-pole ¼"monaural connector shall be the Neutrik **NP2C-BAG** or approved substitute.

d. The 3-pole ¼" stereo/insert connector shall be the Neutrik **NP3C-BAG** or approved substitute.

4. RCA Phono Plug

a. The cable connector shall have an all metal design, machined brass, black coated shell, and gold plated contacts.

b. The cable connector shall make ground before signal contact and break signal before ground via a spring loaded ground contact consisting of a retractable element with separate wedge contacts to keep the shell in the front position when engaged providing a direct and strictly coaxial electrical connection from the socket via the shell to the cable shield.

c. The cable connector shall have a high grade plastic insulator with high creep resistance.

d. The connector shall be the Neutrik **NF2C-B/2** or approved substitute.

5. Low-Z Speaker

a. The cable connector shall be a 4 pole Cable Connector with latch lock and chuck type strain relief.

b. The connector housing shall have optional color-coded accessories as indicated on the drawings.

1) Color-coded bushing shall be the Neutrik BSL-* or approved substitute. Available colors shall be: 0 – Black, 1 – Brown, 2 – Red, 3 – Orange, 4 – Yellow, 5 – Green, 6 – Blue, 7 – Violet, 8 – Grey, 9 – White.

c. The cable connector shall be the Neutrik **NL4FC** or approved 2 pole substitute.

D. Inline and Panel Mount MULTIPIN Connectors

1. The MULTIPIN Connector shall have a metal shell to protect against moisture and physical abuse.

2. The MULTIPIN Connector shall have a hermaphroditic design to eliminate stocking and logistical problems encountered with male/female connector systems by reducing the number of required parts.

3. The MULTIPIN Connector shall have a heavy-duty dust cap. In line connectors shall also include a strain relief.

4. The MULTIPIN Connector shall be available in four sizes:

a. **W5** 48 contacts; up to 16 pair cable

b. **W6** 84 contact; up to 28 pairs cable

c. **W3** 122 contact; up to 40 pair cable

d. **W4** 176 contact; up to 58 pair cable

5. The Panel Mount MULTIPIN Connector shall have a Mass Angle Adapter assembly to relieve cable stress from mated mass connectors.

6. The MULTIPIN connector shall be the MASS Connector Series from Whirlwind or approved substitute. Follow manufacturer’s convention for wiring MULTIPIN Connector as Input or Output.

E. Cross Connect System

1. All splicing of audio cable shall occur at cross connects within the Equipment Rack(s).
2. All cross connects for microphone and line level audio signals shall use ENTRALEC Series M 4/6 Terminal Block connectors rack mounted on DIN rails.
3. All cross connects for speaker cable shall use ENTRALEC Series M Terminal Block connectors rack mounted on DIN rails. Size connector to accommodate the AWG cable size.
4. Color Coding for Microphone/Line level cabling shall be:
   a. +Signal red
   b. –Signal black
   c. Gnd/Shield green
5. Color Coding for Speaker cabling shall be:
   a. +Signal white
   b. –Signal black

2.8 FACEPLATES AND PANELS

A. Provide faceplates and panels as indicated on the drawings and in the specifications.

B. Standard Trade and Decora Faceplates

1. Match color and finish of audiovisual device.

C. Custom Faceplates

1. Fabricate from 0.125 aluminum in the color and finish specified. Default color is matte black. Default finish is anodized.
2. Engrave with a minimum 1/8” lettering and filled with a contrasting paint color. Default paint color is matte white.
3. Pre-punch for specified connectors. Arrange connectors plumb and square for a professional appearance. Default connector color is matte black.
4. Provide Custom Engraved faceplates by RCI, Whirlwind, Ace Backstage, or approved substitute.

D. Install finished faceplates on backboxes and align for proper fit and finish.

2.9 LABELING AND IDENTIFICATION

A. Cable labels

1. Cable labels shall be pressure sensitive labels with non-smearing printing.
2. The labels shall be long lasting adhesive type.
3. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.

4. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.
5. Provide vinyl substrate with a white printing area and black print. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow, so that the labels are easily distinguishable.
6. Shall be flexible vinyl or other substrates to apply easy and flex as cables are bent.
7. Shall use aggressive adhesives that stay attached to all cable insulation types.
8. Cabling labels shall be generated with laser printers.
9. Physical dimensions of cabling labels provided shall correspond to type of cable. Provide label sizes for various cables as needed.

B. Hardware and equipment identification labels

1. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.
2. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.
3. Where insert type labels are used, provide clear plastic cover over label.

C. Grounding and bonding, pathway, and space labels

1. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.
2. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.

D. Panel labels

1. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.
2. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.
3. Where insert type labels are used, provide clear plastic cover over label.

E. Racks, Cabinets, and Frame Labels

1. Shall be a white background with black lettering.
2. Shall be a gothic style font a minimum of 1/2 inch in height.
3. Shall be phenolic with engraved designation.

PART 3 EXECUTION

3.1 GENERAL

A. The audiovisual cabling and faceplates shall be provided in varying configurations according to the layout and equipment required in the space. The Contractor shall carefully note specific configuration required and provide cabling and routing to meet the functional requirements of the system.

B. Grades, elevations, and dimensions shown on the drawings are approximately correct; however, field check and otherwise verify such data at the site before proceeding with the work. Make necessary survey equipment available at all times and make use of such equipment wherever necessary to properly install raceway, wiring, plates, and panels.

C. Due to the schematic nature and small scale of the audiovisual drawings, it is not possible to indicate exact locations, offsets, fittings, access panels, pull boxes, and miscellaneous parts which may be required to form a complete system. The drawings are generally indicative of the work to be installed. Arrange work accordingly furnishing necessary parts and equipment as may be required to meet the various conditions and to provide a complete installation.

3.2 IDENTIFICATION

A. Pathways

1. Pathways shall be marked at each endpoint and at all intermediate pull or junction boxes. In the case of partitioned pathways (i.e., innerduct) each partition shall have a unique identifier.
2. Label pathways using the appropriate abbreviation and a number.
3. Use adhesive type labels.

B. Racks, Cabinets, And Frames

1. On each plate, panel, equipment rack, distribution frame, or cabinet, provide a nameplate with white background and black lettering. Additionally, all rack mounted power strips and receptacles on racks, frames, or cabinets shall be labeled with panel name and circuit number.

3.3 WARRANTY

A. Guarantee material and labor for a period of one (1) year from date of substantial completion.

B. Any defects arising during this warranty period shall be corrected without claim for additional payment or cost to the AUTHORITY. Equipment providing comparable functionality shall be provided within two business days. Defective equipment shall be replaced with like make and model within five business days.

3.4 COORDINATION

A. Coordinate work in finished areas with the AUTHORITY for final approval as it relates to location, finish, materials, color, and texture.

B. When work is installed without proper coordination, changes to this work deemed necessary by the AUTHORITY shall be made to correct conditions without additional claim for payment.

3.5 LADDERS AND SCAFFOLDING

A. Furnish and erect ladders and scaffolding required for the installation of wiring, equipment and fixtures.

3.6 INSTALLATION

A. General: Install system wiring in accordance with NFPA 70 and other applicable codes.

B. Wiring Methods: Install wiring in raceway except within racks and consoles. Conceal wiring except in unfinished spaces.

C. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace and train the conductors to terminal points with no excess. Provide and use lacing bars.

D. Splices, Taps, and Terminations: Splice cable only in accessible junction boxes using approved terminal block units. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.

E. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.

F. Repairs: Wherever walls, ceilings, floors, or other building finishes are cut for installation, repair, restore, and refinish to original appearance.

3.7 WIRING INFORMATION

A. All wires shall be permanently identified at each wire end by marking with adhesive or crimp-on markers and a chart kept on each wire's function. This applies to wire within a rack assembly as well as wire installed in conduit.

B. Wire ends should be wrapped with heat shrink tubing. Each shield or drain wire should be covered with heat shrink to avoid unintentional connections.

C. Use ring or tongue lugs on all barrier strip terminals. Do not exceed two lugs per terminal. Use solder or crimping tools which are designed for the application. Do not cut strands from conductors to fit lugs or terminals.

D. Form, in an orderly manner, all conductors in enclosures and boxes, wire ways and wiring troughs, providing circuit and conductor identification. Use tie wraps of appropriate size and type. Limit spacing between ties to six (6) inches and provide circuit and conductor identification at least once in each enclosure.

E. Provide ample service loops at each termination so that plates, panels, patch bays, and equipment can be dismounted for service and inspection.

F. Observe and terminate connections using correct polarity.

3.8 INSPECTION

A. Make observations to verify that boxes, plates and panels are properly labeled and interconnecting wires and terminals are identified.

END OF SECTION

SECTION 27 41 16.16

AUDIOVISUAL HD DIGITAL TRANSPORT & DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Procurement Documents, apply to this Section.

1.2 SUMMARY

A. This Specification, in conjunction with the Drawings, establishes the requirements necessary to achieve the intended performance, installation and functions of the HD Digital Transport and Distribution System.

B. Provide the services necessary to furnish, install, train, and to provide maintenance support for the HD Digital Transport and Distribution System including all required peripheral apparatus conforming to acceptable industry standards. All work shall be in accordance with the true intent of these Drawings and Specifications, and as required to leave the HD Digital Transport and Distribution System complete and in satisfactory operating condition.

C. Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these Specifications, Manufacturers recommendations and the latest edition or revision of all applicable codes and standards.

D. The HD Digital Transport and Distribution System shall include providing and integrating the following principal systems:

1. Audio/Video switching.
2. Audio/Video distribution at native resolution without compression.
3. Video interface equipment.
4. Audio interface equipment.
5. HDMI signal transport.
6. HDMI 1.3 support.
7. Deep Color support.
8. Resolution management.
9. HDCP key handling/management.
10. Fast HDMI switching with keep alive HDCP link.
11. Multi-Channel Surround Sound Audio
12. Digital diagnostic tools

E. The HD Digital Transport and Distribution System shall operate as a stand alone point-to-point system delivering local content to a far-end sink (display). It shall also operate as part of a larger matrix switching system.

F. Related Sections:

1. 26 05 00 Common Work Results for Electrical
2. 26 05 19 Low Voltage Electrical Power Conductors and Cables
3. 26 05 26 Grounding and Bonding for Electrical Systems
4. 26 05 28 Hangers and Supports for Electrical Systems
5. 26 05 33.13 Conduits for Electrical Systems
6. 26 05 33.19 Wireways for Electrical Systems
7. 26 05 33.23 Boxes for Electrical Systems
8. 26 33 53 Static Uninterruptible Power Supplies
9. 26 43 13 Surge Protective Devices for Low Voltage Electric Power Circuits
10. 27 00 00 Communications
11. 27 05 13.43 Cable Services
12. 27 08 00 Commissioning of Communication Systems
13. 27 11 00 Communications Equipment Room Fittings and Appurtenances
14. 27 32 43 Radio Communications Equipment
15. 27 41 16.13 Audiovisual Cabling, Connectors, Faceplates & Labeling
16. 27 41 16.16 Audiovisual HD Digital Transport & Distribution System
17. 27 41 16.19 Integrated Audiovisual System
18. 33 82 13 Copper Communications Distribution Cabling
19. 33 82 23 Fiber Communications Distribution Cabling

1.3 DEFINITIONS

A. Source – AV equipment connected to the inputs of the AV switching system

B. Sink – AV equipment connected to the outputs of the AV switching system (i.e. displays, audio processors)

C. KSV – Commonly called an HDCP ‘key’. A unique ID for each HDMI sink that must be sent to HDCP-enabled sources in order for the sinks to receive content.

D. Video timing – A combination of resolution and refresh rate (i.e. 1920x1080@60).

1.4 REFERENCES

A. Reference Standards:

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

B. International Code Council (ICC):

1. International Building Code.

C. Society of Motion Picture and Television Engineers (SMPTE):

1. SMPTE RP 94-2000, Gain Determination of Front Projection Screens.

D. Underwriters Laboratories Inc. (UL).

E. Underwriters’ Laboratories of Canada (ULC).

1.5 CONFLICT BETWEEN DRAWINGS AND SPECIFICATIONS

A. It is intended that any contractor furnishing materials and/or labor necessary for the completion of this specification shall furnish it in compliance with this specification. Where conflict exists with other specifications concerning such materials and labor, this specification takes precedence unless otherwise approved in writing by the AUTHORITY.

B. Drawings pertaining to this specification shall be considered as a part of said specification and shall be a part of the bid documents.

1.6 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. All materials shall be new and shall conform to applicable provisions of Underwriters Laboratories and the American Standards Association.

C. Procure and pay for all necessary permits, licenses and inspections and observe any requirements stipulated therein. Conform in all trades with all local regulations and codes.

D. Comply with federal, state and local labor regulations and applicable union regulations.

1.7 REQUIREMENTS OF REGULATORY AGENCIES

A. The system shall be registered under the most current applicable rulings of the Federal Communications Commission (FCC). Provide the FCC registration number with the equipment submittal. All components and installations shall bear an Underwriters' Laboratories (UL) listing and shall conform with the latest edition or revision of the following codes and standards were required:

1. ANSI - American National Standards Institute
2. ASTM - American Society for Testing and Materials
3. BICSI - Building Industry Consulting Services International
4. EIA - Electronics Industries Association
5. FCC - Federal Communications Commission
6. ICEA - Insulated Cable Engineers Association
7. IEEE - Institute of Electrical and Electronics Engineers
8. ISO - International Organization for Standardization
9. NEC - National Electrical Code
10. NEMA - National Electrical Manufacturer's Association
11. NFPA - National Fire Protection Association.
12. TIA - Telecommunications Industry Association
13. UL - Underwriters Laboratories, Inc.

1.8 SUBMITTALS

A. Certification: Provide written certification that products provided under this section meet the requirements of 49 CFR 661 Buy America Act.

B. Manufacturer shall provide 6 sets of full system submittals. Submittals shall include:

1. A separate cover sheet clearly disclosing and identifying all proposed substitutions or deviations from system design or specification. If none, cover sheet shall state “No Substitutions or Deviations from Design and Specifications”.

C. Action

1. Product Data: Submit product data, including manufacturer’s technical product data sheet, for specified products.
2. Shop Drawings:
   a. Within Seven (7) calendar days after award of contract, submit detailed shop drawings to the AUTHORITY for approval. Do not begin installation or fabrication without such approval. All shop drawings shall be marked with the pertaining specification paragraph or drawing number when submitted.
   b. Shop drawings shall be provided clearly depicting any proposed modification to the project drawings.
   c. Shop drawings shall be provided indicating proposed mounting arrangements and details of all equipment, including positioning devices, framework supports and interface with adjacent architecture.
   d. Indicate dimensions, fabrication and installation details.
   e. Include electric wiring diagrams.

D. Information

1. Quality Assurance:
   a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
   b. Certificates: Product certificates signed by manufacturer certifying that materials comply with specified performance characteristics, criteria and physical requirements.
   c. Manufacturer’s installation instructions.

E. Closeout

1. Operation and Maintenance Data:
   a. Manufacturer’s instructions detailing maintenance requirements.
   b. Parts catalog that includes complete list of repair and replacement parts, with cuts and identifying numbers.

1.9 JOB CONDITIONS

A. Keep the job adequately staffed at all times. Unless illness, loss of personnel or other circumstances beyond the control of the contractor, maintain the same individual in charge throughout.

B. Cooperate with all appropriate parties in order to achieve well-coordinated progress with the overall construction completion schedule and satisfactory final results.

C. Watch for conflicts with work of other contractors on the job and execute, without claim for extra payment, moderate moves or changes as are necessary to accommodate other equipment or to preserve symmetry and aesthetically pleasing appearance.

D. Immediately report to the AUTHORITY any design or installation irregularities, particularly design elements that interfere with the intended coverage angles of loudspeakers and projectors, so that appropriate action may be taken.

E. Do all cutting, patching and painting necessary for proper and finished installation of the system and repair any damage done as a result of such installation. Cleanup and dispose of trash from all work areas.

1.10 WARRANTY

A. Project Warranty: Refer to Contract Conditions for project warranty provisions.

B. Manufacturer's Warranty: Submit, for AUTHORITY's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and does not limit, other rights AUTHORITY may have under Contract Documents.

C. Warranty: Commencing on date of acceptance by AUTHORITY.

PART 2 PRODUCTS

2.1 BASIS OF DESIGN

A. The HD Digital Transport and Distribution System shall be the Crestron DigitalMedia manufactured by Crestron Electronics, Inc. or AUTHORITY approved substitute.

2.2 HD CONTENT POINT-TO-POINT TRANSPORT SYSTEM

A. Provide and install as indicated on the drawing an HD Content Point-to-Point Transport System.

B. The HD Content Point-to-Point Transport System shall be an advanced signal extender system incorporating the following features:

1. HD Content Transmitter.

2. HD Content Receiver.
3. UTP/STP or Fiber Optic cabling.
4. HDCP 1.1 support.
5. Fast HDMI switching.
6. CEC support.
7. Uncompressed video and audio transport.
8. HDMI 1.3 with Deep Color.
9. 7.1 channel HD lossless audio.
10. Video resolutions up to 1920x1200 or 1080p/60.
11. Advanced video detection on every video type, including resolution, frame rate and color depth.
12. IR and RS-232 control over local device(s) (when used with a control system by same manufacturer).
13. Ethernet support.
14. Signal transmission up to 450 feet via UTP/STP cable.
15. Signal transmission up to 3000 feet via fiber.

C. The HD Content Point-to-Point Transport System shall operate as a stand alone system. It shall also integrate with the HD Content Switcher.

2.3 TRANSMITTER

A. The HDMI Transmitters shall be able to extend HDMI (including audio), DVI-I, RGBHV, RGBS, RGsB, YPbPr, Y/C, Composite, S/PDIF, Analog 2-channel audio, and HID (Human Interface Device) data. Where two or more signal inputs are available, the transmitter shall include integrated switcher with signal sensing. The switcher shall switch to the last detected input (when not used with a control system by the same manufacturer). The HDMI transmitter types shall be as follows:

B. Transmitter Type 1

1. The transmitter shall meet the following minimum requirements:
   a. One (1) HDMI input (Video & Audio).
      (1) Supports HDMI 1.3 with Deep Color.
      (2) Supports HDCP 1.1.
      (3) Supports 7.1 channel lossless audio.
   b. One (1) USB HID port.
      (1) Supports USB 1.1.
   c. One (1) IR/1-way RS-232 port.
   d. One (1) 10/100 LAN port.
   e. One set of UTP/STP HDMI extended signal outputs.
      (1) Signal transmission up to 450 feet.
   f. Rack mountable.
   g. Surface mountable.
2. The CAT transmitter shall be a Crestron DM-TX-100 or approved substitute.

C. Transmitter Type 2

1. The transmitter shall meet the following minimum requirements:
    a. One (1) HDMI input (Video & Audio).
        (1) Supports HDMI 1.3 with Deep Color.
        (2) Supports HDCP 1.1.
        (3) Supports 7.1 channel lossless audio
        (4) Supports DVI-D
        (5) Supports Display port
    b. One(1) RGB input
        (1) RGBS
        (2) RGsB
        (3) RGBHV
    c. One (1) Video input comprised of 3 RCA jacks.
        (1) YPbPr
        (2) Y/C
        (3) Composite
    d. Two (2) analog stereo audio inputs.
        (1) (1) 3.5mm TRS (L/R unbalanced).
        (2) (1) 2 RCA (L/R unbalanced).
    e. One (1) S/PDIF audio input.
        (1) (1) RCA jack.
        (2) Supports up to 5.1 channel audio.
    f. One (1) USB HID port.
        (1) Supports USB 1.1.
    g. One (1) IR/1-way RS-232 port.
    h. One (1) 10/100 LAN port.
    i. One set of UTP/STP HDMI extended signal outputs.
        (1) Signal transmission up to 450 feet.
    j. Surface mountable on US 2-gang or EU 1-gang electrical box.
2. The CAT transmitter shall be a Crestron DM-TX-200 or approved substitute.

D. Transmitter Type 3

1. The transmitter shall meet the following minimum requirements:
    a. One (1) HDMI input (Video & Audio).
        (1) Supports HDMI 1.3 with Deep Color.
        (2) Supports HDCP 1.1.
    b. Supports 7.1 channel lossless audio
    c. One (1) DVI-D input.
        (1) DVI-D
        (2) RGB
        (3) RGBHV
        (4) RGBS

(5) RGsB

d. One (1) Video input comprised of 3 RCA jacks.
   (1) YPbPr
   (2) Y/C
   (3) Composite
e. One (1) HDMI monitor output.
   (1) Buffered output of local inputs.
f. Two (2) analog stereo audio inputs.
   (1) (1) 3.5mm TRS (L/R unbalanced).
   (2) (1) 2 RCA (L/R unbalanced).
g. One (1) S/PDIF audio input.
   (1) (1) RCA jack.
   (2) Supports up to 5.1 channel audio.
h. One (1) IR/1-way RS-232 port.
i. One (1) 2-way RS-232 port.
j. One (1) 10/100 LAN port.
k. One set of UTP/STP HDMI extended signal outputs.
   (1) Signal transmission up to 450 feet.
l. Rack mountable.
m. Surface mountable on standard single gang electrical box.

2. The CAT transmitter shall be a Crestron DM-TX-300N or approved substitute.

E. Transmitter Type 4

1. The transmitter shall meet the following minimum requirements:
   a. One (1) HDMI input (Video & Audio).
      (1) Supports HDMI 1.3 with Deep Color.
      (2) Supports HDCP 1.1.
      (3) Supports 7.1 channel lossless audio.
   b. One (1) USB HID port.
      (1) Supports USB 1.1.
   c. One (1) IR/1-way RS-232 port.
   d. One (1) 10/100 LAN port.
   e. One set of fiber HDMI extended signal outputs.
      (1) Signal transmission up to 1000 feet.
      (2) Uses two (2) multimode fibers.
   f. Rack mountable.
   g. Surface mountable on standard single gang electrical box.
2. The FIBER transmitter shall be a Crestron DM-TX-100-F or approved substitute.

F. Transmitter Type 5

1. The transmitter shall meet the following minimum requirements:

a. One (2) DVI-I input.
    (1) DVI-D
    (2) RGBHV
    (3) RGBS
    (4) RGsB
b. One (2) HDMI monitor pass-through outputs.
    (1) Buffered output of local inputs.
c. Two (2) analog stereo audio inputs.
    (1) (2) 3.5mm TRS (L/R unbalanced).
d. One (1) S/PDIF audio input.
    (1) (1) RCA jack.
    (2) Supports up to 5.1 channel audio.
e. One (1) IR/1-way RS-232 port.
f. One (1) 2-way RS-232 port.
g. One (1) 10/100 LAN port.
h. One set of fiber HDMI extended signal outputs..
    (1) Signal transmission up to 1000 feet.
i. Rack mountable.
j. Flush mountable.

2. The FIBER transmitter shall be a Crestron DM-TX-300N-F or approved substitute.

G. Transmitter Type 6

1. The transmitter shall meet the following minimum requirements:
    a. One (1) HDMI input (Video & Audio).
        (1) Supports HDMI 1.3 with Deep Color.
        (2) Supports HDCP 1.1.
        (3) Supports 7.1 channel lossless audio.
        (4) Supports DVI-D
        (5) Supports Display port
    b. One set of UTP/STP HDMI extended signal outputs.
        (1) Signal transmission up to 450 feet.
    c. Standard single gang electrical box mountable.
2. The CAT transmitter shall be a Crestron DM-TX1-1G or approved substitute.

H. Transmitter Type 7

1. Features similar to Type 2 (See above).
2. Uses DM-CBL (STP+CAT5e+Cresnet) cable for transmission.
3. Two gang Decorator format.
4. Powered remotely through DMNet.
5. Use with a DM Switcher or directly to a compatible receiver.
6. The CAT transmitter shall be a Crestron DM-TX-200-2G or approved substitute.

I. Transmitter Type 8

1. Features similar to Type 5 (See above).
2. Uses DM-CBL (STP+CAT5e+Cresnet) cable for transmission.
3. Three gang Decorator format.
4. Powered remotely through DMNet.
5. Use with a DM Switcher or directly to a compatible receiver.
6. The CAT transmitter shall be a Crestron DM-TX-400-3G or approved substitute.

J. Transmitter Type 9

1. The transmitter shall meet the following minimum requirements:
   a. One (1) HDMI input (Video & Audio).
      (1) Supports HDMI 1.3 with Deep Color.
      (2) Supports DVI (video only)
      (3) Supports DisplayPort Multimode
   b. One (1) analog Audio / Video input.
      (1) RGBHV
      (2) Component
      (3) S-Video
      (4) Composite
      (5) 1/8” stereo audio
2. Uses a single DM-CBL-8G STP cable for transmission.
3. Supports USB HID keyboard/mouse
4. 10/100 LAN port
5. Powered locally or through POE
6. Local HDMI output
7. Use with a DM Switcher or directly to a compatible receiver.
8. The 8G transmitter shall be a Crestron DM-TX-201-C or approved substitute.

K. Transmitter Type 10

1. Same as DM-TX-201-C.
2. Uses a single 50u MM CRESFIBER8G cable for transmission.
3. Powered locally only.
4. The 8G transmitter shall be a Crestron DM-TX-201-S or approved substitute.

2.4 RECEIVER

A. The HDMI Receiver shall receive any signal sent from the HDMI Transmitter. All video and audio signals shall be output via the HDMI connector. HID data shall be output via the USB connector.

B. Receiver Type 1

1. The receiver shall accept the HD signal via UTP/STP wire and convert it to one (1) HDMI output. When used with a supported control system, the receiver shall provide local control to device(s). In addition, when used with the Matrix switcher, the receiver shall provide Ethernet connectivity to any compatible devices.
2. The receiver shall meet the following minimum requirements:
    a. HDMI digital video/audio output.
        (1) One (1) 19-pin Type A HDMI female connector.
    b. One (1) USB 1.1 port for USB HID data.
        (1) Mouse, keyboard, game controller, or other USB HID device support.
        (2) USB Type A female connector.
    c. Two (2) relays.
        (1) 4-pin 3.5mm detachable terminal block comprising (2) normally open, isolated relays.
        (2) Rated 1 Amp, 30 Volts AC/DC.
        (3) MOV arc suppression across contacts.
    d. One (1) bidirectional RS-232 port.
        (1) One (1) 5-pin 3.5mm detachable terminal block.
        (2) GND, TX, RX, CTS, RTS support.
        (3) Up to 115.2k baud, hardware and software handshaking support.
    e. Two (2) IR/Serial ports.
        (1) One (1) 4-pin 3.5mm detachable terminal block.
        (2) IR output up to 1.1 MHz.
        (3) 1-way serial TTL/RS-232 (0-5 Volts) up to 19200 baud.
    f. One (1) 10/100 LAN port.
    g. One (1) STP input.
        (1) Two (2) RJ-45 female connectors.
    h. One (1) power input.
        (1) (1) 4-pin 3.5mm detachable terminal block.
    i. Shall support transmission distances of up to 450ft.
    j. Flush mountable to a 2-gang, 4" square, or Euro electrical box.
    k. One (1) 2-pin 3.5mm detachable terminal block Digital/contact closure sensing input;
        (1) Rated for 0-24 Volts DC, referenced to GND;
        (2) Input Impedance: 2.2k ohms pulled up to 5 Volts DC;
        (3) Logic Threshold: 2.5 Volts DC nominal with 1 Volt hysteresis band.
3. The CAT receiver shall be a Crestron DM-RMC-100, DM-RMC-100-1, or approved substitute.

C. Receiver Type 2

1. The receiver shall accept the HD signal via multimode fiber and convert it to one (1) HDMI output. When used with a supported control system, the receiver shall provide local control to device(s). In addition, when used with the Matrix switcher, the receiver shall provide Ethernet connectivity to any compatible devices.
2. The receiver shall meet the following minimum requirements:
    a. HDMI digital video/audio output.
        (1) One (1) 19-pin Type A HDMI female connector.
    b. One (1) USB 1.1 port for USB HID data.
        (1) Mouse, keyboard, game controller, or other USB HID device support.
        (2) USB Type A female connector.
    c. Two (2) relays.
        (1) 4-pin 3.5mm detachable terminal block comprising (2) normally open, isolated relays.
        (2) Rated 1 Amp, 30 Volts AC/DC.
        (3) MOV arc suppression across contacts.
    d. One (1) bidirectional RS-232 port.
        (1) One (1) 5-pin 3.5mm detachable terminal block.
        (2) GND, TX, RX, CTS, RTS support.
        (3) Up to 115.2k baud, hardware and software handshaking support.
    e. Two (2) IR/Serial ports.
        (1) One (1) 4-pin 3.5mm detachable terminal block.
        (2) IR output up to 1.1 MHz.
        (3) 1-way serial TTL/RS-232 (0-5 Volts) up to 19200 baud.
    f. One (1) Digital/contact closure sensing input.
        (1) One (1) 2-pin 3.5mm detachable terminal block
        (2) Rated for 0-24 Volts DC, referenced to GND;
        (3) Input Impedance: 2.2k ohms pulled up to 5 Volts DC;
        (4) Logic Threshold: 2.5 Volts DC nominal with 1 Volt hysteresis band.
    g. One (1) 10/100 LAN port.
    h. One (1) Fiber input.
        (1) Two (2) multi-mode fiber inputs.
        (2) Two (2) SC multimode fiber connectors.
    i. One (1) power input.
        (1) (1) 2-pin 3.5mm detachable terminal block.
    j. Shall support transmission distances of up to 1000ft.
    k. Flush mountable to a 2-gang, 4" square, or Euro electrical box.
3. The FIBER receiver shall be a Crestron DM-RMC-100-F or approved substitute.

D. Receiver Type 3

1. The receiver shall accept the HD signal via UTP/STP wire and convert it to one (1) HDMI output. When used with a supported control system, the receiver shall provide local control to device(s The transmitter shall meet the following minimum requirements:
    a. One (1) HDMI output (Video & Audio).
        (1) Supports HDMI 1.3 with Deep Color.
        (2) Supports HDCP 1.1.
        (3) Supports 7.1 channel lossless audio.
        (4) Supports DVI-D
        (5) Supports Display port
    b. One set of UTP/STP HDMI extended signal outputs.
        (1) Signal transmission up to 450 feet.
    c. Standard single gang electrical box mountable.
2. The CAT receiver shall be a Crestron DM-RX1-1G or approved substitute.

E. Receiver Type 4

1. Similar to DM-RMC-100 except no relays or sensing port.
2. Uses a single DM-CBL-8G STP cable for transmission.
3. Power locally or through POE.
4. The 8G receiver shall be a Crestron DM-RMC-100-C (8G Copper) or approved substitute.

F. Receiver Type 5

1. Same as Type 4 (See above)
2. Uses a single 50u MM CRESFIBER8G cable for transmission.
3. Powered locally only.
4. The 8G receiver shall be a Crestron DM-RMC-100-S (8G Fiber) or approved substitute.

G. Receiver Type 6

1. Similar to Type 4 (See above) but adds the following:
    a. Built in HD Scaler
    b. Flattens 3D video
    c. 4x4 Video wall capable
    d. 2x Relays
    e. Analog Audio Output
        (1) Stereo out (RCA)
        (2) Powered 15W / channel, stereo
2. Uses a single DM-CBL-8G STP cable for transmission.
3. Powered locally only.
4. The 8G receiver shall be a Crestron DM-RMC-200-C (8G Copper) or approved substitute.

H. Receiver Type 7

1. Same as DM-RMC-200-C without

a. Built in amplifier
b. HD Scaler

2. Uses a single 50u MM CRESFIBER8G cable for transmission.
3. Powered locally only.
4. The 8G receiver shall be a Crestron DM-RMC-150-S (8G Fiber) or approved substitute.

I. Receiver Type 8

1. One (1) HDMI or DVI output.
2. Built in HD Scaler
3. Flattens 3D video
4. Control via
   a. CEC
   b. RS-232
   c. IR
   d. Ethernet
5. USB HID keyboard/mouse
6. Mounts to 2-gang box
7. Uses a single DM-CBL-8G STP cable for transmission.
8. Powered locally only.
9. The 8G+ receiver shall be a Crestron DM-RMC-SCALER-C (8G Copper) or approved substitute.

J. Receiver Type 9

1. Same as DM-RMC-SCALER-C
2. Uses a single 50u MM CRESFIBER8G cable for transmission.
3. Powered locally only.
4. The 8G+ receiver shall be a Crestron DM-RMC-SCALER-S (8G Fiber) or approved substitute.

2.5 REPEATER

A. The Repeater shall provide signal regeneration when used with the UTP/STP HD Content Point-to-Point Transport System. The Repeater shall be placed in-line, between the Transmitter, Receiver, Content Matrix, or other Repeaters.

B. The Repeater shall meet the following minimum requirements:

1. One (1) set of STP/UTP inputs.
   a. 8-pin RJ45 female shielded.
2. One (1) power input.
   a. 4-pin 3.5mm detachable terminal block.
3. One (1) set of STP/UTP outputs.
   a. 8-pin RJ45 female shielded.
4. One (1) power output.
   a. 4-pin 3.5mm detachable terminal block.

C. The repeater shall be a Crestron DM-DR or approved substitute.

2.6 HD CONTENT MATRIX SWITCHER

A. The HDMI Matrix shall consist of a card-cage type unit, capable of accepting different input and output cards.

B. Any input shall be routable to any output. Matrix shall provide almost instantaneous HDMI switching for sources with HDCP. Breakaway audio, video, and USB switching shall also be available.

C. The HDMI Matrix shall be compatible with the HD Content Point-to-Point Transport System.

D. 8x8 Matrix – 8 inputs, 8 outputs

1. The matrix shall meet the following minimum requirements:
   a. Ethernet support.
      (1) Gigabit uplink.
      (2) Integrated 10/100 managed Ethernet switch.
   b. Eight (8) field configurable input card slots.
   c. Two (2) factory configurable output card slots.
      (1) Output card accommodates 4 signal outputs.
   d. Easy software setup tool.
   e. Front panel LCD diagnostic screen.
      (1) HDCP key register detection.
      (2) HDMI Cable test tool.
      (3) Automatic resolution management via EDID.
   f. HDCP digital rights key management.
   g. Fast HDMI switching with keep-alive HDCP link.
   h. CEC signal management.
      (1) Intercept CEC data being sent from HDMI devices.
      (2) Send control information.
2. The matrix shall be a Crestron DM-MD8X8 or approved substitute.

E. 16x16 Matrix – 16 inputs, 16 outputs

1. The matrix shall meet the following minimum requirements:
   a. Ethernet support.
      (1) Gigabit uplink.
      (2) Integrated 10/100 managed Ethernet switch.
   b. Sixteen (16) field configurable input card slots.
   c. Four (4) factory configurable output card slots.
      (1) Output card accommodates 4 signal outputs.
   d. Easy software setup tool.
   e. Front panel LCD diagnostic screen.

(1) HDCP key register detection.
(2) HDMI Cable test tool.
(3) Automatic resolution management via EDID.

f. HDCP digital rights key management.

g. Fast HDMI switching with keep-alive HDCP link.

h. CEC signal management.

(1) Intercept CEC data being sent from HDMI devices.
(2) Send control information.

2. The matrix shall be a Crestron DM-MD16X16 or approved substitute.

F. 32x32 Matrix – 32 inputs, 32 outputs

1. The matrix shall meet the following minimum requirements:

a. Ethernet support.

(1) Gigabit uplink.
(2) Integrated 10/100 managed Ethernet switch.

b. Thirty Two (32) field configurable input card slots.

c. Eight (8) factory configurable output card slots.

(1) Output card accommodates 4 signal outputs.

d. Easy software setup tool.

e. Front panel LCD diagnostic screen.

(1) HDCP key register detection.
(2) HDMI Cable test tool.
(3) Automatic resolution management via EDID.

f. HDCP digital rights key management.

g. Fast HDMI switching with keep-alive HDCP link.

h. CEC signal management.

(1) Intercept CEC data being sent from HDMI devices.
(2) Send control information.

2. The matrix shall be a Crestron DM-MD32X32 or approved substitute.

G. 6x1 Matrix –6 inputs, 1 output

1. The matrix shall meet the following minimum requirements:

a. Ethernet support.

(1) Gigabit uplink.
(2) Integrated 10/100 managed Ethernet switch.

b. One (1) HDMI input (Video & Audio).

(1) Supports HDMI 1.3 with Deep Color.
(2) Supports HDCP 1.1.
(3) Supports 7.1 channel lossless audio

c. One(1) RGB input

(1) RGBS
(2) RGsB

(3) RGBHV

d. One (1) Video input comprised of 3 BNC connectors.
   (1) YPbPr
   (2) Y/C
   (3) Composite
e. Two (2) analog stereo audio inputs.
   (1) (2) 5 pin 3.5mm terminal block (L/R balanced/unbalanced).
f. One (1) S/PDIF audio input.
   (1) (1) RCA jack.
   (2) Supports up to 5.1 channel audio.
g. One (1) USB HID port.
   (1) Supports USB 1.1.
h. One (1) IR/1-way RS-232 port.
i. One (1) 10/100 LAN port.
j. Four (3) sets of UTP/STP HDMI extended signal inputs.
   (1) Signal transmission up to 450 feet.
k. One (1) set of UTP/STP HDMI extended signal outputs.
   (1) Signal transmission up to 450 feet.
l. One (1) HDMI output (Video & Audio).
   (1) Supports HDMI 1.3 with Deep Color.
   (2) Supports HDCP 1.1.
   (3) Supports 7.1 channel lossless audio
m. One (1) analog stereo audio inputs.
   (1) (1)5 pin 3.5mm terminal block (L/R balanced/unbalanced).
n. Easy software setup tool.
o. One (1) USB port.
   (1) Supports USB 1.1.
   (2) Computer console
p. HDCP digital rights key management.
q. Fast HDMI switching with keep-alive HDCP link.
r. CEC signal management.
   (1) Intercept CEC data being sent from HDMI devices.
   (2) Send control information.
   (3) Freestanding rack mountable
   (4) The matrix shall be a Crestron DM-MD6X1 or approved substitute.

2.7 INPUT CARD

A. The HDMI input cards shall be compatible with the HDMI Matrix. Input cards shall accept various signal types. Input signals shall be converted to HDMI format. Input cards shall provide HDMI (connector) buffered output of input signal. Input cards shall be field upgradeable/installable.

B. HDMI Input Card

1. The HDMI input card shall accept an HDMI signal. This signal shall be available as an output on the matrix.
2. The HDMI input card shall meet the following minimum requirements:
   a. One (1) HDMI input.
      (1) 19-pin type A female HDMI connector.
      (2) Supports HDCP 1.1.
      (3) Supports HDMI 1.3 with Deep Color.
   b. One (1) HDMI output.
      (1) Buffered output from input.
      (2) 19-pin type A female HDMI connector.
      (3) Supports HDCP 1.1.
      (4) Supports HDMI 1.3 with Deep Color.
   c. One (1) USB 1.1 port for USB HID data.
      (1) Mouse, keyboard, game controller, or other USB HID device support.
      (2) USB Type A female connector.
   d. Digital to analog converter.
      (1) 24-bit, 48 KHz
   e. One (1) stereo analog audio output.
      (1) Two (2) RCA female connectors.
      (2) Unbalanced line-level output.
      (3) Provides pass-through signal converted from HDMI input.
      (4) Maximum Output Level: 2 Vrms.
      (5) Output Impedance: 100 ohms nominal.
   f. Analog shall meet or exceed:
      (1) Frequency response: 20Hz to 20kHz ±0.5dB.
      (2) S/N Ratio: >95dB, 20Hz to 20kHz A-weighted;
      (3) THD+N: <0.005% @ 1kHz;
      (4) Stereo Separation: >90dB
3. The input card shall be a Crestron DMC-HD or approved substitute.

C. HDMI Input Card w/DSP

1. The HDMI input card shall accept an HDMI signal. It shall provide a 2-channel mix of multi-channel audio sources. The original audio track(s) shall also be preserved and passed through to the matrix. This signal shall be available as an output on the matrix.
2. The HDMI input card shall meet the following minimum requirements:
   a. One (1) HDMI input.
      (1) 19-pin type A female HDMI connector.
      (2) Supports HDCP 1.1.
      (3) Supports HDMI 1.3 with Deep Color.
   b. One (1) HDMI output.

(1) Buffered output from video input.
(2) Audio consists of either 2-channel mixed audio or original multi-channel audio track.
(3) 19-pin type A female HDMI connector.
(4) Supports HDCP 1.1.
(5) Supports HDMI 1.3 with Deep Color.

c. One (1) USB 1.1 port for USB HID data.
(1) Mouse, keyboard, game controller, or other USB HID device support.
(2) USB Type A female connector.

d. Audio processor.
(1) HD audio decoder DSP.
(2) Dual 32-bit cores.
(3) Support for various audio/surround formats:
(a) Bypass.
(b) Stereo.
(c) PCM 96/24.
(d) MLP Lossless.
(e) Dolby Pro Logic IIx.
(f) Dolby Digital 5.1.
(g) Dolby Digital EX.
(h) Dolby TrueHD.
(i) DTS Neo:6.
(j) DTS Virtual.
(k) DTS Digital 5.1 Discrete.
(l) DTS ES 6.1 Discrete.
(m) DTS ES 6.1 Matix.
(n) DTS 96/24.
(o) DTS-HD Master Audio.

e. Digital to analog converter.
(1) 24-bit, 48 KHz

f. Provide 2-channel mix of either surround audio or 2-channel pass-thru audio on one (1) stereo analog audio output.
(1) Two (2) RCA female connectors.
(2) Unbalanced line-level output.
(3) Provides pass-through signal converted from HDMI input.
(4) Maximum Output Level: 2 Vrms.
(5) Output Impedance: 100 ohms nominal.

g. Analog shall meet or exceed:
(1) Frequency response: 20Hz to 20kHz ±0.5dB.
(2) S/N Ratio: >95dB, 20Hz to 20kHz A-weighted;
(3) THD+N: <0.005% @ 1kHz;

(4) Stereo Separation: >90dB

3. The input card shall be a Crestron DMC-HD-DSP or approved substitute.

D. Video Input Card

1. The Video Input Card shall accept an analog audio/video signal and convert it to an HDMI signal. This signal shall be available as an output on the matrix.
2. The video input card shall meet the following minimum requirements:
   a. One (1) Video input.
      (1) Three (3) RCA female connectors.
      (2) Auto-sensing multi-format analog video input.
      (3) Support for the following video types:
         (a) YPbPr (component).
         (b) Y/C (S-Video).
         (c) Composite.
      (4) Support for the following video formats:
         (a) NTSC
         (b) PAL
      (5) Support for the following video resolutions:
         (a) 480i
         (b) 480p
         (c) 576i
         (d) 576p
         (e) 720p
         (f) 1080i
         (g) 1080p
   b. Video analog to digital converter.
      (1) 10 bit, 170MHz.
   c. One (1) HDMI output.
      (1) Buffered output from input.
      (2) 19-pin type A female HDMI connector.
      (3) Pass through of video input signal (matched format/resolution).
   d. Audio analog to digital converter.
      (1) 24-bit, 48 KHz
   e. One (1) stereo analog audio input.
      (1) Two (2) RCA female connectors.
      (2) Unbalanced line-level input.
      (3) Maximum Input Level: 2 Vrms.
      (4) Input Impedance: 15k ohms nominal.
   f. Analog shall meet or exceed:
      (1) Frequency response: 20Hz to 20kHz ±0.75dB.
      (2) S/N Ratio: >95dB, 20Hz to 20kHz A-weighted;
      (3) THD+N: <0.005% @ 1kHz;

(4) Stereo Separation: >90dB

3. The input card shall be a Crestron DMC-VID-RCA-A or approved substitute.

E. Video Input Card w/ S/PDIF

1. The video w/S/PDIF Input Card shall accept an analog audio/video signal and convert it to an HDMI signal. This signal shall be available as an output on the matrix.
2. The video input card shall meet the following minimum requirements:
   a. One (1) Video input.
      (1) Three (3) RCA female connectors.
      (2) Auto-sensing multi-format analog video input.
      (3) Support for the following video types:
         (a) YPbPr (component).
         (b) Y/C (S-Video).
         (c) Composite.
      (4) Support for the following video formats:
         (a) NTSC
         (b) PAL
      (5) Support for the following video resolutions:
         (a) 480i
         (b) 480p
         (c) 576i
         (d) 576p
         (e) 720p
         (f) 1080i
         (g) 1080p
   b. Video analog to digital converter.
      (1) 10-bit, 170MHz.
   c. One (1) HDMI output.
      (1) Buffered output from input.
      (2) 19-pin type A female HDMI connector.
      (3) Pass through of video input signal (matched format/resolution).
      (4) Pass through of audio input signal.
   d. One (1) digital audio input.
      (1) One (1) RCA female connectors.
      (2) S/PDIF coaxial input.
      (3) Pass through to HDMI output.
3. The input card shall be a Crestron DMC-VID-RCA-D or approved substitute.

F. Video Input Card w/ BNC connectors

1. The Video Input Card shall accept an analog audio/video signal and convert it to an HDMI signal. This signal shall be available as an output on the matrix.
2. The BNC video input card shall meet the following minimum requirements:

a. One (1) Video input.
   (1) Three (3) BNC female connectors.
   (2) Auto-sensing multi-format analog video input.
   (3) Support for the following video types:
      (a) YPbPr (component).
      (b) Y/C (S-Video).
      (c) Composite.
   (4) Support for the following video formats:
      (a) NTSC
      (b) PAL
   (5) Support for the following video resolutions:
      (a) 480i
      (b) 480p
      (c) 576i
      (d) 576p
      (e) 720p
      (f) 1080i
      (g) 1080p

b. Video analog to digital converter.
   (1) 10 bit, 170MHz.

c. One (1) HDMI output.
   (1) Buffered output from input.
   (2) 19-pin type A female HDMI connector.
   (3) Pass through of video input signal (matched format/resolution).

d. Audio analog to digital converter.
   (1) 24-bit, 48 KHz

e. One (1) stereo analog audio input.
   (1) Two (2) RCA female connectors.
   (2) Unbalanced line-level input.
   (3) Maximum Input Level: 2 Vrms.
   (4) Input Impedance: 15k ohms nominal.

f. Analog shall meet or exceed:
   (1) Frequency response: 20Hz to 20kHz ±0.75dB.
   (2) S/N Ratio: >95dB, 20Hz to 20kHz A-weighted;
   (3) THD+N: <0.005% @ 1kHz;
   (4) Stereo Separation: >90dB

3. The input card shall be a Crestron DMC-VID-BNC or approved substitute.

G. Security Camera Input Card

1. The Security Camera Input Card shall accept analog video signal, provide image processing, and output the result to an HDMI signal. This signal shall be available as an output on the matrix.

2. The input card shall provide an on-board video processor.
    a. Shall support the following display modes:
        (1) Quad Screen.
        (2) Dual Screen.
        (3) Full Screen.
        (4) Sequential switching.
    b. Shall support text overlay;
        (1) Dynamic colored window labeling.
        (2) Time/date.
3. The HDMI input card shall meet the following minimum requirements:
    a. Four (4) video inputs.
        (1) Four (4) RCA female connectors.
        (2) Auto-sensing analog video input.
        (3) Support for composite video.
            (a) Input Level: 1 Vp-p nominal.
            (b) Input Impedance: 75 ohms nominal.
        (4) Support for the following video formats:
            (a) NTSC
            (b) PAL
        (5) Support for the following video resolutions:
            (a) 480i
            (b) 576i
    b. Video analog to digital converter.
        (1) 8-bit per color, 27MHz.
    c. One (1) HDMI output.
        (1) Buffered output from input.
        (2) 19-pin type A female HDMI connector.
        (3) Pass through of processed video signal.
        (4) Matched format/resolution of input signal.
4. The input card shall be a Crestron DMC-VID4 or approved substitute.

H. DVI Input Card

1. The Video Input Card shall accept a DVI video signal, injected audio and convert to HDMI signal. This signal shall be available as an output on the matrix.
2. The HDMI input card shall meet the following minimum requirements:
    a. One (1) DVI input.
        (1) One (1) DVI-I female connector.
        (2) Auto-sensing multi-format analog video input.
        (3) Support for the following video types:
            (a) DVI
            (b) YPbPr (component).
            (c) Y/C (S-Video).

(d) RGB

(4) Support for the following video formats:

(a) NTSC

(b) PAL

(5) Support for the following video resolutions:

(a) 480i

(b) 480p

(c) 576i

(d) 576p

(e) 720p

(f) 1080i

(g) 1080p

b. Video analog to digital converter.

(1) 10-bit, 170MHz.

c. One (1) HDMI output.

(1) Buffered output from input.

(2) 19-pin type A female HDMI connector.

(3) Pass through of video input signal (matched format/resolution).

(4) Pass through of audio input signal.

d. One (1) analog audio input.

(1) One (1) 5 pin 3.5mm terminal block- detachable.

(2) Pass through to HDMI output.

3. The input card shall be a Crestron DMC-DVI or approved substitute.

I. UTP/STP Input Card

1. The UTP/STP Input Card shall accept UTP/STP signal and convert to HDMI signal and separate audio output. This signal shall be available as an output on the matrix.
2. The UTP/STP input card shall meet the following minimum requirements:

a. One (1) UTP/STP input.

(1) Two (2) 8 pin RJ45 UTP/STP connectors, female.

(2) Support for the following video resolutions:

(a) 480i

(b) 480p

(c) 576i

(d) 576p

(e) 720p

(f) 1080i

(g) 1080p

b. Video analog to digital converter.

(1) 10-bit, 170MHz.

c. One (1) HDMI output.

(1) Buffered output from input.
(2) 19-pin type A female HDMI connector.
(3) Pass through of video input signal (matched format/resolution).
(4) Support for various audio/surround formats:
(a) Bypass.
(b) Stereo.
(c) PCM 96/24.
(d) MLP Lossless.
(e) Dolby Pro Logic IIx.
(f) Dolby Digital 5.1.
(g) Dolby Digital EX.
(h) Dolby TrueHD.
(i) DTS Neo:6.
(j) DTS Virtual.
(k) DTS Digital 5.1 Discrete.
(l) DTS ES 6.1 Discrete.
(m) DTS ES 6.1 Matix.
(n) DTS 96/24.
(o) DTS-HD Master Audio.
(5) Pass through of audio input signal.

d. One (1) analog audio output.
(1) Two (2) RCA female connectors.
(2) Pass through to HDMI output.
(3) Digital to analog conversion 24 bit 48 kHz

3. The input card shall be a Crestron DMC-CAT or approved substitute.

J. UTP/STP Input Card w/ DSP

1. The UTP/STP-DSP input Card shall accept UTP/STP signal and convert to HDMI signal and separate audio output as full surround and simultaneous two channel down-mix. This signal shall be available as an output on the matrix.
2. The UTP/STP input card shall meet the following minimum requirements:
a. One (1) UTP/STP input.
(1) Two (2) 8 pin RJ45 UTP/STP connectors, female.
(2) Support for the following video resolutions:
(a) 480i
(b) 480p
(c) 576i
(d) 576p
(e) 720p
(f) 1080i
(g) 1080p

b. Video analog to digital converter.
    (1) 10-bit, 170MHz.
c. One (1) HDMI output.
    (1) Buffered output from input.
    (2) 19-pin type A female HDMI connector.
    (3) Pass through of video input signal (matched format/resolution).
    (4) Support for various audio/surround formats:
        (a) Bypass.
        (b) Stereo.
        (c) PCM 96/24.
        (d) MLP Lossless.
        (e) Dolby Pro Logic IIx.
        (f) Dolby Digital 5.1.
        (g) Dolby Digital EX.
        (h) Dolby TrueHD.
        (i) DTS Neo:6.
        (j) DTS Virtual.
        (k) DTS Digital 5.1 Discrete.
        (l) DTS ES 6.1 Discrete.
        (m) DTS ES 6.1 Matix.
        (n) DTS 96/24.
        (o) DTS-HD Master Audio.
    (5) Pass through of audio input signal.
        (a) Two channel down-mix
d. One (1) analog audio input.
    (1) Two (2) RCA female connectors.
    (2) Pass through to HDMI output.
    (3) Digital to analog conversion 24 bit 48 kHz

3. The input card shall be a Crestron DMC-CAT-DSP or approved substitute.

K. Fiber Input Card

1. The UTP/STP input Card shall accept UTP/STP signal and convert to HDMI signal and separate audio output as full surround and simultaneous two channel down-mix. This signal shall be available as an output on the matrix.
2. The fiber input card shall meet the following minimum requirements:
    a. One (1) multimode fiber input.
        (1) Two (2) SC female optical connectors
            (a) Signal transmission up to 1000 feet
        (2) Support for the following video resolutions:
            (a) 480i
            (b) 480p
            (c) 576i

(d) 576p
(e) 720p
(f) 1080i
(g) 1080p

b. Video analog to digital converter.
(1) 10-bit, 170MHz.

c. One (1) HDMI output.
(1) Buffered output from input.
(2) 19-pin type A female HDMI connector.
(3) Pass through of video input signal (matched format/resolution).
(4) Support for various audio/surround formats:
(a) Bypass.
(b) Stereo.
(c) PCM 96/24.
(d) MLP Lossless.
(e) Dolby Pro Logic IIx.
(f) Dolby Digital 5.1.
(g) Dolby Digital EX.
(h) Dolby TrueHD.
(i) DTS Neo:6.
(j) DTS Virtual.
(k) DTS Digital 5.1 Discrete.
(l) DTS ES 6.1 Discrete.
(m) DTS ES 6.1 Matix.
(n) DTS 96/24.
(o) DTS-HD Master Audio.
(5) Pass through of audio input signal.
(a) Two channel down-mix

d. One (1) analog audio output.
(1) Two (2) RCA female connectors.
(2) Unbalanced line-level output.
(3) Maximum Input Level: 2 Vrms.
(4) Input Impedance: 15k ohms nominal.

e. Analog shall meet or exceed:
(1) Frequency response: 20Hz to 20kHz ±0.75dB.
(2) S/N Ratio: >95dB, 20Hz to 20kHz A-weighted;
(3) THD+N: <0.005% @ 1kHz;
(4) Pass through to HDMI output.
(a) Supports DVI
(5) Digital to analog conversion 24 bit 48 kHz

3. The input card shall be a Crestron DMC-F or approved substitute.

L. Fiber Input Card w/ DSP

1. The fiber-DSP input Card shall accept optical signal and convert to HDMI signal and separate audio output as full surround and simultaneous two channel down-mix. This signal shall be available as an output on the matrix.
2. The UTP/STP input card shall meet the following minimum requirements:
   a. One (1) fiber input.
      (1) Two (2) SC connectors, female.
      (2) Support for the following video resolutions:
         (a) 480i
         (b) 480p
         (c) 576i
         (d) 576p
         (e) 720p
         (f) 1080i
         (g) 1080p
   b. Video analog to digital converter.
      (1) 10-bit, 170MHz.
   c. One (1) HDMI output.
      (1) Buffered output from input.
      (2) 19-pin type A female HDMI connector.
      (3) Pass through of video input signal (matched format/resolution).
      (4) Support for various audio/surround formats:
         (a) Bypass.
         (b) Stereo.
         (c) PCM 96/24.
         (d) MLP Lossless.
         (e) Dolby Pro Logic IIx.
         (f) Dolby Digital 5.1.
         (g) Dolby Digital EX.
         (h) Dolby TrueHD.
         (i) DTS Neo:6.
         (j) DTS Virtual.
         (k) DTS Digital 5.1 Discrete.
         (l) DTS ES 6.1 Discrete.
         (m) DTS ES 6.1 Matix.
         (n) DTS 96/24.
         (o) DTS-HD Master Audio.
      (5) Pass through of audio input signal.
         (a) Two channel down-mix
   d. One (1) analog audio input.
      (1) Two (2) RCA female connectors.

(2) Pass through to HDMI output.
(3) Digital to analog conversion 24 bit 48 kHz

3. The input card shall be a Crestron DMC-F-DSP or approved substitute.

M. 8G Copper Input Card

1. Similar to DMC-CAT / DMC-CAT-DSP except utilizes a single cable transmission using the DM-CBL-8G cable.
2. The input card shall be a Crestron DMC-C / DMC-C-DSP or approved substitute.

N. 8G Fiber Input Card

1. Similar to DMC-F / DMC-F-DSP except utilizes a single MM Fiber transmission using the DM-CRESFIBER8G cable.
2. The input card shall be a DMC-S / DMC-S-DSP or approved substitute.

2.8 OUTPUT CARD

A. The HDMI output cards shall be compatible with the HDMI Matrix. Output cards shall transmit any input signal. Output cards shall have various arrangements of connector types. Output cards shall have up to four (4) outputs per card. Output card types shall be as follows:

B. Fiber Output Card

1. The fiber Output Card shall provide transmission of any HDMI signal inputted to the matrix.
2. The Output Card shall provide four (4) discrete outputs.
3. The Output Card shall interface with multimode optical cable.
4. The Output Card shall be a Crestron DMCO-44 or approved substitute.

C. Fiber Output Card- w/ HDMI Connectors

1. The fiber Output Card shall provide transmission of any HDMI signal inputted to the matrix.
2. The Output Card shall provide four (4) discrete outputs.
3. The Output Card shall interface with multimode optical cable.
   a. Two (2) optical outputs.
   b. Two (2) 19-pin Type A HDMI outputs.
4. The Output Card shall be a Crestron DMCO-43 or approved substitute.

2.9 HD SOURCE/SINK CONTROLLER

A. The HD Source/Sink Controller shall provide control of connected devices (i.e. Blu-Ray Players, LCD Monitors, Projectors, etc.) when used in conjunction with a Crestron Electronics 2-Series Ethernet-enabled Control Processor. It shall support IR and RS-232/422/485 protocols, closed-contact input, low-voltage relay, and HDMI CEC (Consumer Electronics Control). No additional cabling (above the required cabling for the HD Digital Transport and Distribution System) shall be required.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.

3.2 SYSTEM DESIGN

A. The contractor shall provide AV source equipment with support for enough KSVs so that it can be routed to all sinks simultaneously.

B. If a particular AV source cannot be found to support enough KSVs to route to all sinks simultaneously, the contractor shall:

1. Notify the AUTHORITY.
2. Configure the AV switching equipment so that it shall not send an AV source more KSVs than it supports.

C. The contractor shall configure the EDID presented to each AV source to indicate only the video timings supported by ALL sinks used for viewing and distributing video.

D. The contractor shall configure the EDID presented to each AV source to indicate support for only the audio formats actually supported by ALL the sinks used for distributing audio.

E. The contractor shall verify the data rate supported by each shielded twisted pair cable used for AV distribution.

F. The contractor shall provide display equipment that does not overscan the video signal when full-pixel sources are routed.

3.3 DEMONSTRATION AND ACCEPTANCE TESTING

A. The demonstration and acceptance tests shall be done by a Crestron DigitalMedia Certified Design Professional (DMC-E)

B. The contractor shall provide a copy of the following information in electronic format in order to verify the AV switching equipment has been installed and configured correctly:

1. The number of HDCP KSVs УKeysΦ supported by each source
2. The video timing, HDCP use and audio format of each source when operating (not needed for walk-in equipment)
3. The video timings and supported audio formats for each connected sink
4. The video timings and supported audio formats presented in the EDID to each source – the preferred video timing shall be indicated
5. The length of cable used on all shielded twisted pair cable used for AV distribution

6. The data rate supported by each shielded twisted pair cable used for AV distribution

3.4 VIDEO FORMATS AND ASSOCIATED DATA RATES

Video Format	Data Rate (Gbps)
1080p Deep Color	6.75
1600x1200	4.86
1920x1200	4.62
1080p	4.44
1360x768	2.54
720p / 1080i	2.22
1024x768	1.91

END OF SECTION

SECTION 27 41 16.19

INTEGRATED AUDIOVISUAL SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Procurement Documents, apply to this section.

1.2 SUMMARY

A. Section includes:

1. Video Wall System
2. Video Wall Pedestal Assembly
3. Digital Video System
4. Digital Audio System
5. Touch Panel Control Programming
6. Accessories
7. Interface With Owner (AUTHORITY) Provided Equipment (OPE)

B. Related Sections:

1. 26 05 00 Common Work Results For Electrical
2. 26 05 19 Low Voltage Electrical Power Conductors And Cables
3. 26 05 26 Grounding And Bonding For Electrical Systems
4. 26 05 28 Hangers And Supports For Electrical Systems
5. 26 05 33.13 Conduits For Electrical Systems
6. 26 05 33.19 Wireways For Electrical Systems
7. 26 05 33.23 Boxes For Electrical Systems
8. 26 33 53 Static Uninterruptible Power Supplies
9. 26 43 13 Surge Protective Devices For Low Voltage Electric Power Circuits
10. 27 00 00 Communications
11. 27 05 13.43 Cable Services
12. 27 08 00 Commissioning Of Communication Systems
13. 27 11 00 Communications Equipment Room Fittings and Appurtenances
14. 27 32 43 Radio Communications Equipment
15. 27 41 16.13 Audiovisual Cabling, Connectors, Faceplates & Labeling
16. 27 41 16.16 Audiovisual Hd Digital Transport & Distribution System
17. 27 41 16.19 Integrated Audiovisual System
18. 33 82 13 Copper Communications Distribution Cabling
19. 33 82 23 Fiber Communications Distribution Cabling

1.3 REFERENCES

A. Reference Standards:

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

1.4 DESCRIPTION OF WORK

A. Provide fully operational and tested audiovisual systems ready for use by the AUTHORITY. Furnish and install audiovisual equipment, cabling, and supporting devices as required in the contract documents. Provide all software, programming, and provisioning of equipment and systems required for optimal operation of systems.

B. Provide coordination with the AUTHORITY for installation of the audiovisual systems.

C. Provide trim rings, flanges, or escutcheon rings as appropriate around all penetrations through finished construction. Provide escutcheon rings at finished ceiling penetrations created by equipment mounts and conduit stubs. The trim rings, flanges, or escutcheon rings color shall match the adjacent finishes and be approved by the AUTHORITY.

D. All individual components required for a fully functioning system may not be shown on equipment lists and schematic diagrams. Provide all components needed for a fully functional audiovisual system. These include but are not limited to:

1. Compact flash cards
2. Copper / Fiber cabling
3. Copper / Fiber extenders
4. Certified CAT6 patch cables
5. Distribution amplifiers
6. Interfaces
7. Splitters
8. Terminations
9. Wiring blocks
10. Wiring harnesses
11. Cable assemblies
12. Adapters
13. Connectors
14. Infrared eyes
15. Communications, sensor, and control modules
16. Mounting hardware
17. Power supplies

1.5 SOFTWARE REQUIREMENTS

A. Uncompiled Source Code

1. The original uncompiled source code for the audiovisual system equipment shall be provided to the AUTHORITY in electronic form with the following stipulations:

a. The Contractor or delegated subcontractor shall submit for review and approval with the AUTHORITY, a written agreement restricting the AUTHORITY's use and distribution of the uncompiled source code. The uncompiled source code shall be permitted to be used only by the AUTHORITY for future maintenance of and upgrades to the specific audiovisual systems within the scope of this project. The uncompiled source code developed by the Contractor or delegated subcontractor shall not be used in any other AUTHORITY audiovisual system(s) outside the scope of this project. The electronic copy of the source code shall remain on the AUTHORITY's premises. The AUTHORITY is not permitted to distribute the uncompiled source code into the possession of any third party without written approval from the project subcontractor originally responsible for creating the code. Future third party maintenance providers retained by the AUTHORITY shall have access to the uncompiled source code on the designated AUTHORITY's workstation on AUTHORITY's premises.

b. Upon acceptance of the written agreement by the AUTHORITY and Contractor or delegated subcontractor, the Contractor shall submit one (1) copy of the uncompiled source code in electronic form on CD with one license of the Manufacturer's programming software.

1.6 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. Engage an experienced Installer who is a factory-authorized service representative of the specified and approved equipment to perform the work of this Section.

C. The Contractor shall show satisfactory evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor shall maintain at his facility the necessary spare parts in the proper portion as recommended by the manufacturer to maintain and service the equipment being supplied.

D. Pay any and all expenses incurred by these equipment manufacturers' representatives.

E. Electrical Component Standard

1. Provide work complying with applicable requirements of NFPA 70 "National Electrical Code" including but not limited to:

a. Article 250. Grounding.

b. Article 300, Part A. Wiring method.

c. Article 310. Conductors for General Wiring.

d. Article 725. Remote Control, Signaling, Circuits.

e. Article 800. Communication Systems.

1.7 PERFORMANCE OF EQUIPMENT

A. Materials, equipment and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the work in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance and capacity. No approval either written or verbal of any drawings, descriptive data or samples or such material, equipment and/or appurtenance shall relieve the Contractor of his responsibility to turn over the same to the AUTHORITY in optimal working order at the completion of the work.

B. Any material, equipment or appurtenances, the operation, capacity or performance of which does not comply with the drawings and/or specification requirements or which is damaged prior to acceptance by the AUTHORITY shall be held to be defective material and shall be removed and replaced with proper and acceptable materials, equipment and/or appurtenances or put in proper and acceptable working order, satisfactory to the AUTHORITY, without additional claim for payment or cost to the AUTHORITY.

1.8 SUBMITTALS

A. Certification: Provide written certification that products provided under this section meet the requirements of 49 CFR 661 Buy America Act.

B. Obtain written approval of the AUTHORITY prior to commencement of work, fabrication, and installation of Audiovisual Systems. Submit all information specified or as directed.

1. Review and approval of shop drawings does not constitute final approval of system performance, nor in any way relieve the contractor from the responsibility of furnishing material(s) or performing work required by the Contract Documents.

C. Submit the following:

1. Itemized list of all equipment and materials to be used in assembling the systems.
2. If different than the ‘As Specified’ design, block diagram of system components indicating proposed point-to-point wiring connections, wire/circuit numbers, and, if applicable, patch bay designations of all equipment. Drawing shall indicate make and model numbers of all system components. Show all transformers, switches, control circuits, and equipment.
3. If different than the ‘As Specified’ design, electrical characteristics and connection requirements including a complete list of wire/circuit numbers and associated terminations at plug boxes, terminal strips, or patch panels.
4. Detailed 3-wire schematic diagrams of any custom circuitry.
5. If different than the ‘As Specified’ design, detailed schematic diagrams for typical connections between signal lines, patch panels, plug boxes, and equipment rack(s).
6. Detailed drawings of all fabrications and/or modifications used in the assembly of custom devices.
7. Scale drawings suitable for use in the fabrication of custom assemblies. Indicate all materials, finishes, and panel markings.
8. Layout of equipment mounted in racks and cabinets.

9. Layout and labeling of patch panels, as applicable.
10. Component interconnection wiring and wiring diagrams of field wiring to video and audio components and remote input devices.
11. Detailed structural drawings showing mounting and/or suspension of all loudspeakers including associated rigging, rated connections and attachment(s) to structural framing. Assemblies attached to or suspended from overhead structures shall be certified by a professional structural engineer.

D. A detailed list of test equipment, including makes and model numbers of equipment, to be used in testing and tuning the systems to specified performance.

E. Test Reports: Indicate satisfactory completion of each test recommended by the manufacturer.

F. Product Data: Provide catalog or product data sheets showing physical, electrical, and environmental characteristics and connection requirements for each component.

G. Provide two bound Operating and Maintenance (O&M) manuals (1 original, 1 copy) to the AUTHORITY five (5) days prior to system commissioning. The manuals shall contain printed operating instructions for all system functions whose format has been specifically compiled for use in the AUTHORITY's system operation. Standard factory equipment operating instructions are NOT acceptable. Manuals shall contain "as built" schematic wiring diagrams of all systems, as well as internal wiring diagrams of any equipment racks, control panels, and equalizer settings.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, handle, and protect products under provisions of the General Contract requirements.

B. Control inventory and handing of system components so that completion of the work will not be delayed by shortages of equipment or hardware before, during, or after installation.

C. Protect exposed surfaces of installed equipment as necessary to prevent incidental or direct damage to system components prior to system acceptance by the AUTHORITY.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Ventilate equipment enclosed in racks and cabinets as required to maintain normal operating conditions per manufacturer's published data.

B. Provide products especially designed for use in confined enclosures or humid, hot, or dusty environments.

PART 2 PRODUCTS

2.1 GENERAL

A. All electronic and associated system components and equipment shall conform to the manufacturer's most recently published specifications for both function and design feature(s) and are hereby included by reference into the project specifications.

B. All equipment and material shall be new.

C. All equipment must be UL listed or in the case of Custom Assemblies, built to UL standards.

D. All equipment is intended to be professional grade and rated for continuous duty. Basic guidelines have been established for minimum performance requirements. These requirements must be satisfied, unless a variance (separate document) is submitted and approved by the AUTHORITY.

E. Stands, booms, wall panels and plates shall have an ebony matte finish in exposed occupied areas. Bright reflective finish is not acceptable in the Camera Monitoring or Dispatch areas.

2.2 OWNER (AUTHORITY) PROVIDED EQUIPMENT (OPE)

A. Certain equipment and services will be provided (furnished and installed) by the AUTHORITY. Owner Provided Equipment interfacing with the Audiovisual System includes:

1. All video displays EXCEPT Video Wall Cubes.
2. All Video Teleconferencing equipment EXCEPT Camera extenders and 70V power amplifiers.
3. All Network Electronics unless specifically indicated.
4. All Conference Room Furniture unless specifically indicated.

2.3 VIDEO WALL CUBES

A. Purpose:

1. Provide a seamless 5 wide x 2 high Video Wall Array surface template for SOCC monitoring operations.

B. Basis of Design: The requirements of the Buy America Act are in effect for this project. These requirements must be satisfied without exception if a conforming product can be identified and procured for the project. In the event a product satisfying these requirements is unavailable, the ACT provides guidance for remedy. A conforming product could not be identified during the design process, therefore, to establish design, performance and budget criteria, the following product is offered as the temporary 'basis of design'.

1. Type: Mitsubishi Electric USA
2. Model: VS-72WE75S
    a. Performance Criteria
        (1) Size: 72-in diagonal
        (2) Resolution: 1900 x 1200, native
        (3) Aspect Ratio:
        (4) LED performance: 8,000 hrs.

(5) Brightness:
(6) View Angle:
(7) Heat dissipation:

3. Input Card: DVI. Coordinate and verify input card requirements with Video Wall Processor manufacturer.

2.4 VIDEO WALL PROCESSING SYSTEM

A. Purpose:

1. Provide processing and display of IP Security Cameras, Workstation Computer Displays, and outputs from the High-Definition Multi-Room Signal Routing System to the video wall Array.

B. Basis of Design:

1. Type: Jupiter Systems PixelNet / HD/SD MPEG Decoder Hybrid Display Wall Processor System
2. Model: EAI WMAT DS PN.16H.40D containing quantities of the following:
   a. 3-630-002-00: PixelNet Domain Controller, QUAD CORE XEON @ 2.4GHz, 8GB DDR3, 500GB SATA HDD, 1U rackmount, dual GigE ports, Windows 7 (64bit) and PDC Software, preloaded.
      (1) Provide Middle Atlantic Products RM-KB-LCD17 rackmount LCD, Keyboard and Touchpad for PixelNet Domain Controller(s).
   b. 2-540-168- 00: DVI-I Input Node with a DVI-I input connector and loopthrough (digital-to-digital, RGB-to-RGB) connector, and two PixelNet Ports.
   c. 2-540-178-00: TeamMate Output Node with DVI-I output connector and two PixelNet Ports for use in tiled walls or discrete displays. BNC connector for frame-lock synchronization. (Drives a single DVI or Analog RGB display at up to 2048x1200@60Hz.).
   d. 4-626-007-00: 26-port backbone switch. 1U. 26 SFP+ ports.
   e. 4-626-007-01: SFP+ Multi Mode Fiber Module. To 330m.
   f. 4-750-142-03: SFP+ passive twin ax cable, 3m.
   g. 4-626-009-00: Stackable 48-Port PixelNet Switch with 4 10G
   h. SFP+
   i. PixelNet Power 1U: Consolidated power supply for up to 30 PixelNet nodes. 1U, rack mountable with preinstalled rack ears and 1U breakout panel. Includes 4x 450W rectifiers for N+2 hotswappable configuration. Requires two main (AC) power cords. Takes up to 30 PixelNet node (DC) power cables.
   j. 5-649-045-00: AC power cord, USA, 2.5m.
   k. 4-649-044-03: PixelNet breakout panel-to-node DC power cable, 3ft.
   l. 4-649-044-06: PixelNet breakout panel-to-node DC power cable, 6ft.
   m. 4-649-044-15: PixelNet breakout panel-to-node DC power cable, 15ft.
   n. 5-612-029-00: Single-node 100-240V auto-ranging power supply.
   o. 5-649-007-01: IEC 60320 C13 power cord with NEMA 5-15 plug for USA
   p. 3-500-116-00: 1U rackmount shelf with dual-output power supply to accommodate two PixelNet nodes.

q. 3-500-118-00: PixelNet flat-surface mount kit includes two side mounted brackets and screws. For horizontal or vertical mounting of one PixelNet node.
r. 3-500-116-01: 1U rackmount shelf for two PixelNet nodes
s. 5-602-021-00: 75 ohm, BNC (M) terminator, one required for source node plus one to terminate each sync string
t. 5-602-023-00: 75 ohm, BNC (F-F-F) T-adapter, one required per output node.
u. EAI-1212160390: HD/SD MPEG Decoder w/44 hardware decoding channels.
v. Warranty:
(1) Hardware: 2-years
(2) Software: 1-year support, all systems

C. Inputs:

1. Minimum forty-four (44) AUTHORITY IP Camera sources
2. Minimum two (2) Computer Monitors per each Camera Monitoring and
3. Dispatch Operator Station (15 current; 9 future Workstations)
4. Minimum two (2) Computer Monitors for the Master Control Workstation
5. Minimum eight (8) Crestron Digital Media HDMI sources

D. Outputs:

1. Ten (10) 72-in Video Wall Cubes
2. Four (4) 62-65-in LCD Display Monitors
3. Two (2) 42-in LCD Display Monitors

E. Master Control Workstation:

1. Install and configure Video Wall middle-ware bridge on OPE Master Control Workstation (MCW).
2. Configure MCW software to allow triggered or manual selection of any security camera, HD TV channel, or High-Definition Multi-Room Signal Routing System source to the display array. Coordinate Alarm Trigger(s) for WMATA Alarm Software, Crestron Touchpanel or directly through Jupiter control point software.
3. AUTHORITY to provide MCW and peripherals.
4. AUTHORITY to provide Library Table of all security camera sources.
5. AUTHORITY to provide security camera monitoring software to interface with pre-existing middle-ware bridge to Video Wall Processor to allow selection and display of any IP security camera.

F. Provide a minimum of eight (8) Display Templates to include, bit not be limited to, the following:

1. Camera Monitoring: Forty (40) selectable security cameras to the cubes and four (4) selectable security cameras or HD TV to the LCD displays.
2. Camera Monitoring with HD TV: Same as (1.) above with enlarged window for (1) HD TV channel (reduces number of security cameras visible in cubes).
3. Same as (2.) above with two (2) enlarged windows for (2) HD TV channels (further reduces number of security cameras in cubes).

4. Video Conferencing: Enlarged windows for both local and distant videoconferencing cameras with selectable security cameras around / between the VTC windows to the cubes and four (4) selectable security cameras or HD TC to the LCD displays.
5. Coordinate additional four (4) templates with AUTHORITY.
6. Include two (2) Display Template programming revisions for changes requested by the AUTHORITY.

2.5 VIDEO WALL PEDESTAL SUPPORT ASSEMBLY

A. Purpose:

1. Custom pre-fabricated support structure for support of model-specific Video Wall Cubes and housing associated electronic equipment, racks, speakers.

B. Basis of Design:

1. Type: Custom Display Solutions, (CDS) Inc.
2. Model: MW072-CS05 Titan CSP Mediawall Solution, 72-in 2x5 Array

C. Precision Welded Steel/Extruded Aluminum CSP Designed to Support a 2x5 Array of 72” Mitsubishi 72WEFL Cubes

D. (2) Extending Scissor Design Monitor Mounts, to support (2) 42-in LCD Display Monitors (Display Monitors by AUTHORITY)

E. Micro-Adjustment for Monitor Alignment

F. Removable Front and Side Access Panels in Black Laminated MDF

G. (2) Speaker Mounting Brackets with Black Laminated MDF Panel and Speaker Grill Detail

H. (2) Lower Panels in Black Laminated MDF (for Subwoofer) with Speaker Grill Detail

I. Feature: (2) Middle Atlantic SRSX-24 Slide-Out Swivel Racks located in Center Bay behind Center Bay Smoked, Tempered Glass Door Kit

J. Fixed Bottom Shelf

K. Panel Attachment Clips and Hardware

L. Orbital Leveling Feet (+1.25/-0.75” Travel)

M. Anchor Brackets and Hardware to Secure Cube Bases to the Floor

N. Detailed CAD Drawing Installation Instructions

O. Crating and shipping to site

2.6 AUDIOVISUAL TRUE HIGH-DEFINITION MULTI-ROOM SIGNAL ROUTING SYSTEM

A. Purpose:

1. Route any HD source to any sink (HD Display or Device)
2. Switching and lossless distribution of HDMI® and other signals to support the latest Blu-ray Disc® players, HDTV receivers, digital media servers, computers, and other AV devices.
3. Integrated Ethernet networking and USB HID distribution connectivity solution.

4. Built-in control for managing displays and other room devices without necessitating any additional wiring.
5. Built-in redundant power supplies to ensure continuous operation for mission critical applications.

B. Basis of Design: Crestron DM-MD32X32-RPS DigitalMedia™ Matrix Switcher with Redundant Power Supply including, but not limited to, the following components:

1. Transmitters
2. Modular Input Cards
    a. DMC-HD-DSP: HDMI® Input Card w/Down-mixing
    b. DMC-DVI: DVI/RGB Input Card
    c. DMC-C-DSP: DigitalMedia 8G+™ Input Card w/Down-mixing
3. Modular Output Cards
    a. DMCO-43: 2 DM 8G Fiber w/1 HDMI & 2 HDMI w/2 Stereo Analog Audio Output Card
    b. DMCO-44: 4 DM 8G Fiber w/2 HDMI Output Card
    c. DMCO-45: 2 DM 8G Fiber w/1 HDMI & 2 DM 8G+ w/1 HDMI Output Card
    d. DMCO-55: 4 DM 8G+ w/2 HDMI Output Card
4. Receivers
5. Touchpanels
6. Power Supply(s)
7. Certified copper and fiber cabling systems

2.7 AUDIOVISUAL DUAL BUSS CONTROL SYSTEM WITH CARD FRAME

A. Purpose:

1. Optional Isolation of Crestron Digital Media System Network
2. Integration of all Audiovisual System control functions
3. System scalability and adaptability

B. Basis of Design: Crestron RACK2 including, but not limited to, the following modular components:

1. (1) C2NET-2 Ethernet Interface
    a. LAN A – Secure single-point connection for the entire internal network to the AUTHORITY's LAN/WAN and Internet using a single external IP address.
    b. LAN B – Dedicated internal network for Crestron and other related IP enabled devices.
2. (4) C2COM-3 RS-232/422/485 Interface
    a. Display Wall Processor
    b. Security Camera HD/SD MPEG Decoder Processor
    c. Audio DSP-1
    d. Audio DSP-2
    e. HD TUNER-1
    f. HD TUNER-2
    g. HD TUNER-3

h. HD TUNER-4
i. VTC-CR1
j. VTC-CR2

3. (3) CNXRY-8 Relay Output
4. (3) C2IR-8 IR-Serial Output

C. Utilize a real time, event driven, multi-tasking, multi-threaded operating system with dual bus architecture.

D. Utilize a Motorola Coldfire processor at no less that 257 MIPS.

E. High speed processor shall communicate directly with Ethernet, control ports and proprietary control network utilizing high-speed, parallel bus infrastructure. Control processors that communicate via a serial bus shall not be accepted.

F. Control processor shall contain 36 MB of memory, with expansion up to 4GB via compact flash plug in cards (externally accessible/hot-swappable).

G. Control processor shall accept industry standard compact flash cards or IBM microdrive plug-in cards, for program, web-page, or miscellaneous file memory expansion, via a built-in compact flash card slot.

H. Control processor shall utilize a FAT32 file structure.

I. Support internal communications speed via two, independent communications busses. First control bus speed shall be at least 40 mb/s, second control bus speed shall be at least 300 mb/s.

J. Control system shall be capable of firing all internal IR ports simultaneously.

K. Control System shall be fully compatible with Crestron RoomView multisystem management software and other Crestron e-Control Power Applications (i.e. e-Outlook, e-PowerPoint, etc.).

L. Control System shall support the option of up to (x4) add-on single or dual Port 10/100 BaseT Ethernet Modules, via a direct processor 300 mb/s communications bus/card-slot, that supports all of the following features:

1. TCP/IP Communications
2. DHCP and DNS Support
3. 802.11b and Bluetooth Compatibility
4. Native Email Client
5. Remote Diagnostics
6. Remote Program Loading and Administration
7. Built-In Web Server
8. FAT32 File System for easy data management
9. SSL security plug in
10. Native NAT/Fire-Wall/Router w/dual port option
11. PDA Integration and Control, XPanel PDA - Pocket PC 2002
12. WebTablet Integration and Control – Microsoft Tablet PC
13. Self Generating Executable GUI, XPanel EXE – Microsoft Family of OS
14. Self Generating ActiveX powered IE Integration and Control, XPanel IE
15. Self Generating Java powered Web Integration and Control

M. Support user assigned or dynamic IP address.

N. Full API (Applications Interface) directly to control system via TCP/IP for integration with Visual Basic, C++, Java, etc. applications. API support through included Crestron ActiveX module and/or Crestron Dynamic Link Library (.DLL).

O. Control system shall include a 2 line by 40-character front panel LCD communication center/display, along with 10 programmable function hard buttons. Display and buttons shall provide the following information without the use of a computer:

1. View control program (name, date, creator).
2. Manually control any function (I/O, relays, etc).
3. Report Crestron network devices.
4. Report error messages.
5. User definable functions – program LCD menu with dealer name, telephone number, control functions (use like a touch panel).

P. Front panel LED display panel for status indication of every port and card slot.

Q. Patent pending Network Analyzer to continuously monitor the integrity of the Cresnet network for wiring faults, marginal communication performance, network errors – all information is viewable.

R. Integrated 12 slot card cage to support any mix of control cards for IR, RS-232/422/485, relay, digital I/O, analog input, volume, MIDI, and more.

S. Integrated 4 slot card cage for 300 mb/s high-speed cards.

T. Front and rear programming ports.

U. Support RS-485 token passing network with data communication for a minimum distance of 5000 feet.

V. Allow proprietary network expansion via add-on card RS-232 ports or Ethernet Port that allow high-speed network acceleration.

W. Support a minimum of 253 proprietary network devices simultaneously.

X. Support direct communication to LAN based thin servers by same manufacturer.

Y. Control System shall include an integrated 8-Port CNXHUB Cresnet Expander, acting as a network expander/hub, data repeater, splitter, and wiring block.

Z. Control system shall support object-oriented logic based programming language and a C-like language programming language. Both programming types are supported to run simultaneously and integral to each other.

AA. Control system manufacture shall supply Windows-based graphical programming software for drag and drop object oriented programming for the control system operation.

BB. Control system manufacture shall provide Windows-based graphical programming software, which is self-documenting in that it generates a symbolic flow diagram printout from the system program.

CC. The control system shall support a variety of wireless communication modes, including one-way and two-way radio frequency and infrared transmission.

DD. The control system shall include the following hardware configuration:

1. Twelve (12) 40 mb/s card slots for IR, RS-232/422/485, relay, digital I/O, analog input, volume, MIDI, and more.

2. Four (4) High-speed, 300 mb/s card slots, for 10 or 100 BaseT Ethernet, future USB, USBII, MPEG decoding and more.
3. One compact flash memory upgrade slot.
4. Cresnet network interface.
5. Front and rear programming ports.
6. 8-Port CNXHUB Cresnet Expander
7. Two line by 40-character LCD communications center w/10-buttons.
8. Patent pending Network Analyzer.
9. 19" rack mount chassis.

2.8 LOCAL AUDIO SYSTEM FOR CAMERA MONITORING AND DISPATCH AREAS

A. Purpose:

1. To provide user selectable audio to the Camera Monitoring and Dispatch areas.

B. Basis of Design:

1. CD Player D&M
2. Audio Switch HP Procurve (unmanaged)
3. Audio DSP BSS London Architect
4. Amplication Crown CTS
5. Speakers EAW

C. Provide and configure system as indicated on the drawings.

D. Connect switch to dedicated internal network for Crestron only.

E. Program DSPs as indicated in Article “SOFTWARE PROGRAMMING”.

2.9 DIGITAL VIDEO SYSTEM TOUCHPANEL CONTROLLER

A. Purpose:

1. To integrate and manage audiovisual control of the following systems and components:
   a. Jupiter PixelNet Processor(s)
   b. Jupiter HD/SD MPEG Security Camera Decoder Processor(s)
   c. Crestron Digital Media Matrix Switcher
   d. BSS Audio DSPs
   e. HD Tuners
   f. VTC Controllers

B. Basis of Design:

1. Crestron
   a. Conference Rooms: V12-TILT
   b. Camera Monitoring, Dispatch and [Video Wall] Master Control Station: V15-TILT

C. Provide Touch Panel Controller(s) as indicated on the drawings.

D. Provide power supplies, cabling, connectors and other incidental components for a fully functioning system.

E. Program Touch Panel Controller as indicated in Article “SOFTWARE PROGRAMMING”.

2.10 SOFTWARE PROGRAMMING

A. Digital Audio Signal Processor

1. Create Control Panels and Presets for use with Master Control Workstation and SOCC Touchpanels
   a. Select audio source to route to Local Audio System
   b. Volume Up / Down
   c. Volume MUTE

B. Touchpanels

1. System Control
   a. Control audiovisual systems using color touchpanel controls located at Conference Room tables, SOCC Camera Monitoring, SOCC Dispatch, and Master Control Consoles as indicated on the drawings.
   b. The control system shall be connected to a system-wide isolated control network, allowing control and management of all audiovisual systems in the building.
   c. Support staff shall have the ability to lock out particular systems or functions to prevent unauthorized use.
2. General Conference Room Requirements
   a. Control and operation of the local VTC system
      (1) VTC Camera Pan and Tilt operation
      (2) Control of ACT audio system
   b. Selection of HD TV to local LCD displays
   c. Control and selection of local DigitalMedia audiovisual sources to local LCD displays
   d. Selection of remote VTC system
3. General SOCC Camera Monitoring and Dispatch Requirements
   a. Selection of Security Cameras to:
      (1) Video Wall templates
      (2) Local (SOCC / Dispatch) LCD displays
      (3) Conference Room LCD displays
   b. Selection of any extended Workstation Monitor(s) to:
      (1) Video Wall templates
   c. Selection of HD TV to:
      (1) Video Wall templates
      (2) Local (SOCC / Dispatch) LCD displays
      (3) Remote (Break Room, Roll Call, etc) LCD displays
   d. Selection of Conference Room VTC system(s) to Video Wall template(s)
   e. Selection of Conference Room audiovisual sources to Video Wall templates
   f. Selection of audio source to local audio system

C. Programming Protocol

1. Develop Menu and Submenu Page layouts for each touchpanel indicated on the drawings.
2. Submit printed Menu and Submenu Page layouts to AUTHORITY for approval.
3. Following approval of printed layouts, program and demonstrate sequence and flow of Menu and Submenu Page layouts to AUTHORITY for approval.
4. Following approval of demonstration templates, complete touchpanel programming.

2.11 EXPOSED AUDIOVISUAL CABLING

A. Conceal all permanently attached cabling in conduit or braided sleeving.
   1. Arrange visible raceway in a neat and orderly manner to minimize impact on the aesthetic.
   2. Enclose any exposed wiring between junctions and equipment racks or devices within flame retardant #BSFR expandable, black, braided sleeving. Attach ends of sleeving inside junction boxes and racks so that a neat, professional, appearance is maintained.
      a. Plastic sleeving shall not be acceptable in exposed occupied areas.

2.12 EQUIPMENT RACKS

A. Provision equipment and accessories in racks as indicated on the drawings.

2.13 CONFERENCE ROOM TABLE BOX 'POP-UPS'

A. Purpose:
   1. To house data, power, and AV connections in a pneumatically powered hide-away "pop up" design.

B. Basis of Design:
   1. FSR PTB – 4

C. Provide Pop-Up Table Box with 4–Gang opening and AC on each side.
   1. Provide cut-outs for Pop-Up Table Boxes in Conference Room Tables provided by the AUTHORITY. Install base flush to conference table surface per manufacturer's instructions.
   2. Provide black cover.
   3. Provision equipment in Pop-Up Table Box as indicated on the drawings.
   4. Provide black 4-gang Decora faceplates. Install matching blanking inserts in unused openings.

2.14 IN-WALL BOX & MOUNTS FOR LARGE SCREEN LCD DISPLAYS

A. Purpose:
   1. To provide a secure mounting solution with access for maintenance at wall-mounted LCD Displays. Use In-Wall Box to house and secure extenders, interface cabling and connections, and power for Flat Panel Displays.

B. Basis of Design:
   1. Chief PAC501-B In-Wall Box Assembly

C. Furnish and install the following at each wall mounted LCD Display Monitor indicated on the drawings.

1. CHIEF PAC501-B In-Wall Box
2. CHIEF PACHFK1 Header/Footer Kit
3. CHIEF PNRIW In-Wall Swing Arm Mount
4. CHIEF PSB-xxxx Mounting Bracket (LCD Display Model Specific) with horizontal and vertical adjustment necessary to CENTER the LCD Display Monitor on the In-Wall Box. Verify Display manufacturer and model with AUTHORITY.

D. Adjust components such that In-Wall Box is not visible behind LCD Display.

2.15 PLATES AND PANELS

A. Provide wall plates with connector configurations as shown on the Drawings and described herein.

B. Coordinate all wall plate connectors with corresponding mating connectors for a complete system.

C. Provide blank faceplates over all unused audiovisual backboxes. Cover plate color and construction shall match faceplates used for other devices specified for the project.

2.16 AUDIOVISUAL CREDENZA RACK (BLDG 'C' CONFERENCE AND CLASSROOMS)

A. Purpose:

1. To provide professional furniture grade housing, cooling, and concealment of videoconferencing equipment.

B. Basis of Design:

1. Middle Atlantic Products 120V Frame model #C5F3 A/V Credenza Rack.

C. Furnish rack in 3 bay configuration. Overall dimensions shall be 31-1/2" H x 70" W" x 27-1/2" D.

D. Usable height shall be 14 rackspaces per bay. Rack frames shall ship fully assembled and be constructed of steel.

E. Total weight capacity with Middle Atlantic finishing kit shall be 600 lbs., with a maximum of 350 lbs. to be placed on the top surface. Total weight capacity of the frame only shall be 800 lbs.

F. Equip each rack bay with 2 pairs of 11-gauge steel rackrail tapped with 10-32 mounting holes in universal EIA spacing, black e-coat finish and numbered rack spaces.

G. Include two 59 CFM free air rated (138 CFM free air rated Total) thermostatically controlled cooling fans per bay and provide 133 CFM installed and produce 35 dBA. Thermostatically controlled fans shall be powered on at 87°F and turn off at 85°F. Credenza rack shall have venting on the top and bottom of the face of the rack.

H. Include two adjustable side mounted horizontal lacing bars for enhanced cable management. Credenza rack shall have a steel rear access panel and be finished in a durable black powder coat.

I. Finishing Kit

1. Top, sides, front doors and kick plate shall ship separately from the Rack Frame.
2. Construct top of 1-1/8” thick triple refined MDF, sides of 1” thick triple refined MDF, front doors of 3/4” thick triple refined MDF, and kick plate of 1/2” thick triple refined MDF.
3. Top, sides and front doors shall be available in a traditional or contemporary style. Front doors shall be available as solid or plexi.
4. Available finishes for top, sides and front doors include:
   a. Dark Cherry,
   b. Dark Pecan,
   c. Ebony Ash,
   d. Aged Cherry,
   e. Honey Maple,
   f. Light Walnut,
   g. Maple,
   h. Shark Gray,
   i. Wenge,
   j. Pepperstone,
   k. Graystone. or
   l. Darkstone RTF thermolaminate finish.
5. Provide model # C5K3-TPD-xx Finishing Kit where ‘xx’ represents color of Finishing Kit. Submit manufacturer’s Finishing Kit samples to AUTHORITY for color selection.

J. Include 4 fine floor casters.

K. Credenza rack shall be GREENGUARD Indoor Air Quality Certified for Children and Schools, RoHS EU Directive 2002/95/EC compliant, and manufactured by an ISO 9001 and ISO 14001 registered company.

L. Warranty rack frame to be free from defects in material or workmanship under normal use and conditions for the lifetime of the rack, fans for a period of three years and wood panels for a period of 7 years.

M. Provide the following manufacturer options:

1. One (1) model # C5-SH-SYS Shelf System Insert (Left outside Bay)
2. One (1) model # C5-ARB adjustable rail Bracket
3. Two (2) model # C5-SDSH-Txx left and right hand Flip Up Side Shelf where ‘xx’ = color specified for finishing kit
4. Three (3) model # C5-KEY sets Front Door Keys

PART 3 EXECUTION

3.1 GENERAL

A. The audiovisual cabling and faceplates shall be provided in varying configurations according to the layout and equipment required in the space. The Contractor shall carefully note specific configuration required and provide cabling and routing to meet the functional requirements of the AUTHORITY.

B. Grades, elevations, and dimensions shown on the drawings are approximately correct; however, field check and otherwise verify such data at the site before proceeding with the work. Make necessary survey equipment available at all times and make use of such equipment wherever necessary to properly install equipment.

C. Due to the schematic nature and small scale of the audiovisual drawings, it is not possible to indicate exact locations, offsets, fittings, access panels, pull boxes, and miscellaneous parts which may be required to form a complete system. The drawings are generally indicative of the work to be installed. Arrange work accordingly furnishing necessary parts and equipment as may be required to meet the various conditions and to provide a complete installation.

D. Provide all calibration and adjustment required for the audiovisual system to perform to its capability as finally approved by the AUTHORITY.

3.2 INSTALLATION

A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions and the Industry Standard EIA/TIA 568 and 569.

B. Impedance and Level Matching: Carefully match input and output impedance and signal levels at signal interfaces. Provide matching networks where required.

C. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and other applicable codes. Provide conductors as recommended by system manufacturer to provide control functions indicated or specified.

D. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace and train the conductors to terminal points with no excess. Provide and use lacing bars for a professional neat appearance.

E. Provide physical isolation between audiovisual and adjacent power, network, and telephone wiring. Provide physical separation as recommended by equipment manufacturer for other intercommunication system conductors.

F. Splices, Taps, and Terminations: Splice cable only in accessible junction boxes using approved terminal block units. Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.

G. Identification of Conductors and Cables: Use approved wire and cable marking methods so all conductors are labeled in conjunction with system wiring diagrams.

H. Repairs: Wherever walls, ceilings, floors, or other building finishes are cut for installation, repair, restore, and refinish to original appearance.

3.3 COORDINATION

A. Coordinate with the AUTHORITY for testing and certifying all of the audiovisual equipment, infrastructure, and supporting hardware and raceways. Provide and initiate coordination needed for fully functioning audiovisual system prior to the scheduled project completion date. Specifically coordinate with the AUTHORITY's network administrator for integration between the audiovisual systems and the AUTHORITY's IP network.

B. Devices and appurtenances which are to be installed in finished areas shall be coordinated with the AUTHORITY for final approval as it relates to location, finish, materials, color, and texture.

3.4 GROUNDING

A. Provide equipment grounding connections for systems as indicated. Tighten connections to comply with tightening torque specified in UL 486A to assure permanent and effective grounds.

B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide <=5 ohm ground at equipment location. Measure, record, and report ground resistance.

3.5 WIRING INFORMATION

A. All wires shall be permanently identified at each wire end by marking with adhesive or crimp-on markers and a chart kept on each wire's function. This applies to wire within a rack assembly as well as wire installed in conduit.

B. Wire ends should be wrapped with heat shrink tubing. Each shield or drain wire should be covered with heat shrink to avoid unintentional connections.

C. Use ring or tongue lugs on all barrier strip terminals. Do not exceed two lugs per terminal. Use solder or crimping tools which are designed for the application. Do not cut strands from conductors to fit lugs or terminals.

D. Form, in an orderly manner, all conductors in enclosures and boxes, wire ways and wiring troughs, providing circuit and conductor identification. Use tie wraps of appropriate size and type. Limit spacing between ties to six (6) inches and provide circuit and conductor identification at least once in each enclosure.

E. Provide ample service loops at each termination so that plates, panels, patch bays, and equipment can be dismounted for service and inspection.

F. Observe and terminate connections using correct polarity when more than one loudspeaker is used in the same area.

3.6 COMMISSIONING

A. The AUTHORITY may engage a third party independent commissioning agent to verify operation of all audiovisual systems. The Contractor shall provide coordination with the commissioning agent, fully demonstrate the audiovisual systems, and perform tests as necessary for the CA to verify system performance.

3.7 FIELD QUALITY CONTROL

A. Provide services of a factory trained service representative to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Upon completing installation of the system, align, adjust, and balance the system and perform complete pre-testing. Determine, through pre-testing, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until optimal performance and conditions are achieved.

C. Upon completion of pre-testing, notify the AUTHORITY a minimum of 10 days in advance of acceptance test performance schedule and conduct tests in his presence. Provide a written record of test results.

3.8 INSPECTION

A. Make observations to verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

3.9 PERFORMANCE TESTING FOR DIGITAL VIDEO AND AUDIO DISTRIBUTION

A. Prepare an AV System Test Report for the DM-MD32X32-RPS digital video system. The report shall contain information required to satisfy the 'Demonstration and Acceptance Testing' section of the HD Digital Transport and Distribution System specification (HD-DTDS). The report shall identify and document the following:

1. Test the EDID and HDCP subsystems to ensure they are configured correctly.
2. Test to ensure that the cabling can support the required data rates.

B. Open Items: Report and correct any deficiencies identified in the "Open Items" section of the report. Document corrective actions taken to clear deficiencies.

C. Important Notices: Report deficiencies that may be acceptable in the "Important Notices" section of the report. Important notices may result in unexpected behavior and shall be individually reviewed by the sign-off engineer for corrective action.

D. The EDID and HDCP system configuration and results of cable testing shall be detailed in the format provided by the manufacturer. Include results of testing, corrective actions, and final sign-off of the following in the system Operation and Maintenance manual.

1. Open Items
    a. Action:
    b. EDID
    c. Cabling
2. Important Notices
    a. HDCP
    b. EDID
    c. Cabling
3. Firmware and Serial Numbers
    a. DM Switcher Chassis and Cards
        (1) Name
        (2) Device
        (3) Firmware version

(4) Serial number
b. Connected Devices
(1) Device
(2) Firmware version
(3) Serial number
(4) Connected to…
4. Video Timings on Input EDIDs
a. Matrix of timings present at each input slot.
5. Video Timings Detected on Output EDIDs
a. Matrix of timings reported by each device connected to the HDMI outputs.
6. Video Timings Detected on Loop Out EDIDs
a. Matrix of timings reported by each device connected to the HDMI loop outputs on each Input Card
7. Audio Formats On Input EDIDs
8. Audio Formats Detected on Output EDIDs
9. Audio Formats Detected on HDMI Loop Out EDIDs

3.10 DIGITALMEDIA CABLE CERTIFICATION

A. Test DigitalMedia™ infrastructure wiring before connecting DM equipment. Certify cable plant using methods and typical certifications for an Ethernet style data network (most of the terminology and values are functions and vocabulary of the test equipment).

1. DM 8G STP Cable (DM-CBL-8G)
a. Certification: EIA/TIA-568-B.2 Category 5e
b. Equipment: Fluke DTX-1800
c. Settings:
(1) Cat5e Channel for port-to-port (Tx to Rx)
(2) Cat5e Permalink for Patch Points (< 40-ft)
(3) Cable: Foil Twisted Pair (FTP) shield test
(4) Velocity of propagation 69%
(5) T568B wiring recommended; T568A if matches plant wiring
2. DM Fiber and 8G Fiber (CRESFIBER8G)
a. Inspect each fiber end with a 100x-200x microscope and clean before testing.
b. Test for optical loss.
c. Certification: IEC 61280-4-1 Single Reference Cable Method
d. Certification: TIA 526-14 OFSTP-14 Method B with acceptable link attenuation <4dB @ 850/1300 nm
e. Equipment:
(1) Fiber Optic Microscope (ex. SPCfiber DI-200 Fiber Optic Inspection Scope)
(2) Fiber Optic Cleaning Wipes (ex. MicroCare Fiber Wipes or wipes included with CRESFIBER-TK)
(3) Multimode Fiber Optic Loss Test Kit (ex. Noyes CKM-2)
3. HDMI Cables

a. Equipment: Quantum Data 780
b. Certification: Wire Test function

3.11 AUDIO SYSTEM PERFORMANCE AND VERIFICATION TESTING

A. Definition: The primary audio signal path for the Audio System shall be defined as the output originating at the audio mixer main outputs and continuing uninterrupted through processing and amplifiers to, and including, the loudspeaker system(s).

B. Performance and Verification Testing of the Audio System shall be performed by the Contractor and monitored by the AUTHORITY.

1. Coordinate testing with the AUTHORITY. During testing, the space shall be free and clear of any activities that may interfere with the testing procedure.
2. The Contractor shall supply personnel as necessary to complete the testing in a continuous and timely manner not to exceed one (1) normal workday.
3. The Contractor shall bear any and all costs associated with the conduct, completion, documentation and/or remedies necessary to complete the Performance and Verification Testing procedures.

C. The Contractor shall supply test equipment meeting the following minimum specifications at no additional cost to the AUTHORITY.

1. Oscilloscope: 20MHz Bandwidth, Sensitivity 1mV/cm
2. Digital Multi-meter: 1% Accuracy
3. Function Generator: 1MHz Bandwidth, Distortion < 1%
4. Real Time Analyzer: 1/3 Octave, Type I
5. Impedance Meter: 20-20kHz, 1-50kOhm @100, 300, 1k, 10k Hz
6. Pink Noise Generator: 20-20k Hz
7. Polarity Meter: Microphone, line, speaker level
8. Millivolt Meter: Analog meter movement

D. The audio system shall be capable of delivering a sound pressure level (SPL) of no less than 90 db across the entire programmed or fixed seating area when measured using a 0 dBv full audio bandwidth signal through the main console output(s) and unity gain structure (0 dbv, nominal) throughout the entire primary audio signal path without audible distortion or clipping at the input or output of any processing equipment in the primary signal path, amplifiers, or the manufacturer’s published aes power handling rating (watts) for the loudspeaker system(s).

1. A minimum of six (6) [4 in Camera Monitoring and 2 in Dispatch] measurement locations will be required. Submit locations to the AUTHORITY for approval prior to testing. Results of sound pressure readings shall be plotted on a plan view of the seating area.

E. The Audio System shall be capable of delivering a measured frequency response of ± 2 db at RASTI frequencies across the entire fixed seating area when measured using a full bandwidth signal not less than 20 dba above ambient level.

1. The location of measurements shall be the same as those approved for the SPL measurements. Results of frequency response readings shall be plotted on a plan view of the seating area.

F. The Audio System shall be capable of demonstrating a Speech Intelligibility Index predicted for RASTI frequencies of not less than 0.70 throughout the entire programmed or fixed seating area with the HVAC system turned off.

1. Speech Intelligibility Index results shall be plotted on a plan view of the seating area.

G. The Audio System shall maintain a Signal-to-Noise (S/N) ratio of better than 80 dB throughout the entire primary audio signal path as measured on an analog millivolt meter.

H. All switching of audio signals in the primary and secondary audio signal path(s) shall be designed and implemented using noiseless switching, i.e., the Audio System shall be free of clicks, pops, snaps, thumps, or any other noise when any system routing or operating control is activated.

I. All system outputs of the Audio System shall be swept with a wide band [20 MHz] oscilloscope to verify the primary audio signal path is free of any oscillations, radio, crosstalk, or parasitic frequency signals.

1. Record results and provide and install any remedial filtering required for correction with no additional claim for payment.

3.12 RETESTING

A. Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the specifications and complies with applicable standards.

3.13 TRAINING

A. All workmanship and fine tuning of equipment shall be performed to optimize the system performance and fidelity of the audiovisual systems. Final configuration of systems shall be approved by the AUTHORITY before final acceptance and training commences.

B. The Contractor shall submit a detailed outline of the training courses to be approved by the AUTHORITY prior to training beginning.

C. The Contractor shall provide training for the AUTHORITY's end user personnel for audiovisual systems. This training shall consist of the following:

1. Upon substantial completion of the installation and following formal system acceptance, the Contractor shall demonstrate operation and maintenance of the Audiovisual systems to the AUTHORITY's representative(s). Training shall not exceed one (1) 8-hour day during a normal workweek (Mon-Fri).
2. At a time not-to-exceed six months from the date of substantial completion, or formal acceptance of the system, whichever occurs first, the Contractor shall return to the project site and provide a second training session for the AUTHORITY's representative(s). Training shall not exceed 4 hours during a normal workweek (Mon-Fri).

D. The contents of the training will be submitted to the AUTHORITY for approval prior to providing the training.

E. The AUTHORITY may video tape the training for their use at their discretion.

3.14 WARRANTY

A. Guarantee material, equipment and labor for a period of one (1) year from date of substantial completion. Replace defective material and workmanship furnished and installed and other work and equipment damaged thereby. In addition this warranty period shall cover all software updates required due to patches for software “bugs” and software compatibility issues. This shall include all upgrades required in order to be compatible with the AUTHORITY’s Data Network (LAN) during the warranty period.

B. In addition to the two (2) year guarantee, furnish any Manufacturer’s warranties or guarantees that come with specific pieces of equipment that exceed the (2) year guarantee. These additional warranties shall be given to the AUTHORITY for the time period specified.

C. Any defects arising during this warranty period shall be corrected without cost to the AUTHORITY. Equipment providing comparable functionality shall be provided within two business days. Defective equipment shall be replaced with like make and model within two weeks.

D. The contractor shall consider the possibility of allowing AUTHORITY's trained maintenance personnel to affect repairs of crucial nature during the warranty period, even before the service representative arrives at the site. Repairs by AUTHORITY shall not be made except upon prior written authorization of Contractor.

END OF SECTION

SECTION 27 51 16

PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS

PART 2 GENERAL

2.01 SUMMARY

A. Section Includes: This Section includes material and labor requirements for the public address system.

B. Related Sections:
1. Section 26 05 00 - Common Work Results for Electrical
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems
3. Section 26 05 28 - Hangers and Supports for Electrical Systems
4. Section 26 05 53 - Identification for Electrical Systems
5. Section 26 05 28.33 - Conduits and Backboxes for Electrical Systems
6. Section 26 05 33.23 - Boxes for Electrical Systems

2.02 REFERENCES

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

2.03 SYSTEM DESCRIPTION

A. Provide an eight zone paging system located where the private business exchange (PBX) is located.

B. Provide and eight port VoIP Gateway for paging located where the private business exchange (PBX) is located.

C. Provide and two port VoIP Gateway for paging located in the Pennsy Drive Buildings A, B and C.

D. Provide a two zoned public address amplifier in Pennsy Drive Buildings A, B and C.

E. Provide ceiling speakers as shown on the drawings.

F. Provide all necessary cable, connectors and accessories for an operational system.

G. A user shall be able to broadcast zone paging thru the phone system from a centralized private business exchange (PBX).

H. Each speaker transformer shall be tapped to provide the best performance for each speaker location.

2.04 SUBMITTALS

A. Submit the following:
   1. Provide a zone paging assignment coordination plan for the Owner and Engineer to review and approve. The submittal shall be submitted not less than 4 weeks prior to the start of equipment installation.
   2. Submit catalog data on all furnished equipment, including, but not limited to:
      a. Amplifier
      b. Speakers
      c. Voice Over IP Gateway
      d. Zone paging system
   3. Provide as build drawings of the system.

2.05 OPERATION AND MAINTENANCE MANUAL

A. Provide (6) copies of an operation and maintenance manual to the Owner.

2.06 QUALITY ASSURANCE

A. Conform all work to the applicable requirements of NFPA 70.

2.07 WARRANTY

A. All equipment and systems shall be warranted by the Installer for a period of one year following shipment.

PART 3 PRODUCTS

3.01 AMPLIFIER

A. Channels: 2

B. Sensitivity: 1.4V

C. Signal to Noise Ratio (below rated power 20Hz to 20Hz, A- Weighted): 105dB

D. Total Harmonic Distortion (THD) (full rated power, 20Hz to 20Hz): <0.1%

E. Damping Factor (10Hz to 100 Hz): <3000

F. Frequency Response (at 1W into 4/8 ohms): +/- 0.25dB

G. Crosstalk (below rated power 20Hz to 1KHz): >80dB

H. Common Mode Rejection (20Hz to 1KHz): >50dB

I. Maximum Input Level (before input compression): +20 dBu

J. Load Impedance: 70V, 100V (2-16 Ohms)

K. Voltage Gain (at maximum level setting) (8/4 ohm operation): 24W

L. Provisions for mounting the amplifier in a 19” rack shall be included as a factory design.

M. Contractor shall supply all related appurtenances for a complete and functional system.

N. Acceptable manufacturer
   1. Crown
      a. CTs 600
   2. Approved equal

3.02 CEILING SPEAKERS

A. Freq. Range (-10 dB) 1: 80 Hz - 20 kHz

B. Power Capacity2: 80 Watts Continuous Program Power 40 Watts Continuous Pink Noise

C. Nominal Sensitivity3: 86 dB SPL @ 1 m (3.3 ft)

D. Nominal Coverage Angle4: 130° conical coverage

E. Directivity Factor (Q): 2.4 averaged 500 Hz to 4 kHz

F. Directivity Index (DI): 3.8 averaged 500 Hz to 4 kHz

G. Rated Maximum SPL: 102 dB @ 1 m (3.3 ft)

H. Nominal Impedance (24C): 16 ohms (Min Z 16.1 Ω @ 320 Hz)

I. Transformer Taps (24CT): 70V: 30W, 15W, 7.5W & 3.7W taps 100V: 30W, 15W, & 7.5W taps

J. Transducers:
   1. Low-Frequency: 100 mm (4.0 in) Polypropylene-coated,1" coil on aluminum former
   2. High-Frequency: 19 mm (0.75 in) Titanium coated polyester

K. Physical:
   1. Enclosure: Backcan: Formed steel
   2. Baffle/Rim: Medium impact polystyrene, fire rated UL94V-0

L. Overload Protection: Full-range power limiting to protect network and transducers. (On Control 24C, not on Control 24CT)

M. Termination: Removable locking connector with screw-down terminals. 2 input terminals and 2 loop-thru output terminals. Max. wire size 12 AWG (2.5 mm2)

N. Safety Agency Rating: Suitable for use in air handling spaces per UL1480, UL2043, NFPA90 & NFPA 70. S7232/UL Listed, Signaling Speaker. Transformer UL registered per UL1876. In accordance with EC60849/EN60849.

O. All speaker assemblies shall be factory made and finished. Contractor shall provide colors that best match the décor of the surroundings.

P. Contractor shall supply all related appurtenances for a complete and functional system.

Q. Acceptable manufacturer
   1. JBL Professional
      a. Model: 24C/CT
   2. Approved equal

3.03 VOICE OVER IP GATEWAY

A. Number of Ports: 1, 2, 4 or 8

B. Port Interface: FXO, FXS & E&M support on each port (MVP130BG supports FXS and FXO only)

C. FXS Interface: KTS, telephone set, or fax; ground and loop start

D. FXO Interface: PBX station; CO line, loop start, 2-wire

E. E&M Interface: PBX E&M trunk; 2- or 4-wire

F. E&M Signal Types: I through V

G. Dialing: DTMF or pulse

H. Connectors: 1 RJ-48 (E&M); 1 RJ-11 (programmable FXS or FXO) per port

I. LAN Port
   1. Format: Ethernet/Ethernet II or SNAP
   2. Interface: 10/100BaseT

J. Command Port
   1. 1- & 2-Port Interface: RS-232C/D; RJ-45 (RJ-45 to DB9 cable included)
   2. - & 8-Port Interface: RS-232C/D; DB25 (DB9 to DB25 cable included)

K. Speed & Format: 115.2K bps asynchronous

L. Protocols**:** H.323 V4, SIP, H.450.2, H.450.4, H.450.6 & H.450.8, RTP, RTCP, SMTP, Q.931, T.38 & Group 3 fax relay, DTMF out-of-band (RFC 2833)

M. Bandwidth Management**:** G.711, G.723, G.726, G.727, G.729, & proprietary voice compression, silence suppression, VAD, CNG

N. Voice Quality: DiffServ, G.165, G.168, adaptive echo cancellation, forward error correction, bad frame interpolation, tunable latency dynamic jitter buffers

O. Management: Web browser, Windows®, SNMP agent

P. Power:
   1. Voltage & Frequency: 115V/240V AC, 47/60 Hz
   2. Power Consumption: 1-Port - 4.5 W, 2-Port - 19 W;
   3. 4- & 8-Port - 46 W

Q. Certification
   1. EMC: FCC Part 15 Class A, EN55022, EN55024, EN61000-3-2, EN61000-3-3
   2. Safety: CE, UL 60950, EN60950, cUL, ACA TS-001
   3. Telecom: FCC Part 68, CS-03, TBR21

R. Acceptable manufacturer
   1. Bogen
      a. 2 Port, Model: MVP210BG
      b. 8 Port, Model: MVP810BG
   2. Approved equal

3.04 ZONE PAGING SYSTEM

A. One zone to 99 zones of simultaneous high-power and low-power paging

B. Up to 32 paging zone groups

C. Universal analog telephone interface designed for direct connection to loop start and ground start trunks, to PBX or KEY paging ports which supply DTMF capability, and to analog T/R lines

D. Modular integration assures reconfiguring and expansion with minimum time and expense

E. Optional talkback paging and time-triggered signaling events with PCMTBM module

F. Field programmable using DTMF and switches

G. Signaling features include night ringer zone group, emergency/shift change zone group, code call zone group

H. Emergency All-Facility Override Paging

I. Background music assigned per zone; Local Background music sourcing capability

J. Relay drivers and AUX contacts included

K. Allows total system amplifier power of up to 250W

L. Mounting Kit for 2 to 6 modules available as an accessory (RPK84)

M. Mounting Kit for up to 10 modules available as an accessory (RPK88)

N. Ringer Equivalence: 1.0B

O. Operating Voltage: 12V DC

P. Operating Current (max.): 1.5A (9-zone system)

Q. Audio Power Capability: 250W

R. Operating Temperature: 25 to 100°F

S. Operating Humidity**:** 0 to 90% non-condensing

T. Acceptable manufacturer
   1. Bogen
      a. Model PCM2000
      b. Rack Mount Kit RPK88
   2. Approved equal

PART 4 EXECUTION

4.01 INSTALLATION

A. All wiring shall be in conduit or other approved means. All devices, conduit, junction boxes, etc., shall be securely hung and fastened with appropriate fittings to ensure positive grounding throughout the entire system.

B. Wiring splices are to be avoided to the maximum extent possible, and if needed, they shall only be made in junction boxes and shall be crimp connected. Transposing or changing the color coding of wires is not permitted. Wire nut-type connections are not acceptable. All conductors in conduit containing more than one wire shall be labeled on each end with AE-Z markers or equal.

C. When more than one speaker is present in a room all speakers in the area shall be connected in phase to ensure sound quality.

D. Sound quality shall be verified in each speaker location and adjustments made accordingly to provide the best sound.

4.02 TRAINING

A. Upon completion of work, provide a minimum of four person hours of instruction to persons designated by the Owner in the operation of the system.

END OF SECTION

SECTION 28 31 00

FIRE ALARM, DETECTION AND NOTIFICATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. The requirements of the Contract Documents, including the Procurement Documents shall apply to the work of this section.

B. The fire alarm system installed shall be the Edwards Systems Technology (EST), EST-3 as manufactured by UTC Fire and Security. All devices and components of the fire alarm system shall be shown to be compatible as published in the EST-3 UL Compatibility List.

C. The fire alarm system cabinet shall accommodate security system modules as required to meet project scope of work.

D. At the time of bid, all exceptions taken to these Specifications, all variances from these Specification and all substitutions of operating capabilities or equipment called for in these Specification shall be listed in writing and forwarded to WMATA. Any such exception, variances or substitutions which were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment.

E. WMATA retains rights to review the Contractor's system and component configuration and products selected, and to accept or not accept for reasons of specification compliance or noncompliance. The Contractor shall remain responsible for providing an acceptable design and final product that meets the intent of this specification. The Contractor shall remain responsible for bearing any additional costs associated with changes necessary to satisfy the performance requirements of this specification.

F. The entire system shall be installed with aesthetics in mind. All control panels and remote annunciators installed in public spaces shall be semi-flush mounted with no exposed conduit or cable trays unless approved by WMATA.

G. See the Procurement Document for Spare Parts Requirements.

H. Training materials, maintenance manuals and technician training shall be provided in compliance with these provisions. See the Procurement Document for details.

I. New and updated printed As-Built Drawing pages and CAD files shall be provided to reflect any changes made in the rail station communications room. As-Built Drawings shall be provided for the system in both printed and electronic format. The contractor shall update the Data Files to reflect any changes to the system.

1.02 WORK INCLUDED

A. The work covered by this Section of the Specification shall include all labor, equipment, materials and services to furnish and install a complete fire alarm system. It shall be

complete with all necessary hardware, software and memory specifically tailored for this installation. It shall be possible to permanently modify the software on site by using a plug-in programmer. The system shall consist of, but not be limited to, the following:

1. Fire Alarm Control Panel and related remote data gathering panels.
2. Remote Annunciators with semi flush backbox.
3. Addressable manual fire alarm pull stations.
4. Addressable analog area smoke detectors.
5. Addressable analog duct smoke detectors.
6. Addressable analog heat detectors.
7. Audible notification appliances - horns.
8. Visual notification appliances - strobes.
9. Proprietary supervising station alarm connection control.
10. Air handling systems shutdown control.
11. Battery standby.

1.03 RELATED SECTIONS

A. Section 26 05 26 Grounding and Bonding for Electrical Systems.
B. Section 26 05 28 Hangers and Supports for Electrical Systems.
C. Section 26 05 63 Acceptance of Electrical Systems.
D. Section 26 05 19 Low Voltage Electrical Power Conductors and Cables.
E. Section 26 05 33.13 Conduits for Electrical Systems.
F. Section 26 05 33.23 Boxes for Electrical Systems.

1.04 APPLICABLE CODES AND STANDARDS

A. All equipment shall be UL listed for its intended use and conform to the latest UL Standards.
B. Underwriters Laboratories Inc.: The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system under the following standards as applicable:

1. UL 38 Manually Activated Signaling Boxes.
2. UL 217 Smoke Detectors Single Station.
3. UL 268 Smoke Detectors for Fire Protective Signaling Systems.
4. UL 268A Smoke Detectors for Duct Applications.
5. UL 346 Waterflow Indicators for Fire Protective Signaling Systems.
6. UL 464 Audible Signaling Appliances.
7. UL 521 Heat Detectors for Fire Protective Signaling Systems.
8. UL 864 Control Units for Fire Protective Signaling Systems.
9. UL 1638 Visual Signaling Appliances.
10. UL 1481 Power Supplies for Fire Protective Signaling Systems.
11. UL 1711 Amplifiers for Fire Protective Signaling Systems.
12. UL 1971 Standard for Signaling Devices for the Hearing Impaired
13. UUKL The Fire Alarm system shall be UUKL for Smoke Control.

C. This installation shall comply with:

1. State and Local Building and Fire Codes

2. Americans with Disabilities Act (ADA)
3. National Fire Protection Association Standards: NFPA 70
4. National Fire Protection Association Standards: NFPA 72
5. Local and State Authorities Having Jurisdiction
6. International Standards Organization (ISO): ISO-9001

1.05 RELATED DOCUMENTS

A. Secure permits and approvals prior to installation.

B. Prior to commencement and after completion of work notify Authorities Having Jurisdiction.

C. Submit letter of approval for installation before requesting acceptance of system.

1.06 RELATED WORK

A. The Contractor shall coordinate work in this Section with all related trades. Work and/or equipment provided in other Sections and related to the fire alarm system shall include, but not be limited to:

1. Sprinkler waterflow and supervisory switches shall be furnished and installed by the fire protection contractor, but wired and connected by the Contractor. Modification of existing sprinkler devices to accommodate monitoring by the new fire alarm system shall be the responsibility of the fire alarm system installing contractor.

2. Duct smoke detectors shall be furnished, wired and connected by the Contractor. The HVAC contractor shall furnish necessary duct opening to install the duct smoke detectors.

3. New air handling control circuits and status contacts to be furnished by the HVAC control equipment.

4. Emergency generator status monitoring

    a. Running indication
    b. Fail to start indication

5. Conduit, Wire and Cables: See Specification Section 26 05 19.

6. Provide materials and labor for FACP to be monitored by OCC facilities located at the Carmen Turner, JBG and SOC facilities.

    a. Fiber optic patch panels and fiber or telephones lines shall be the responsibility of the Installing Contractor.

1.07 SUBMITTALS

A. Provide a list of all types of equipment and components provided. This shall be incorporated as part of a Table of Contents, which will also indicate the manufacturer's part number, the description of the part, and the part number of the manufacturer's product datasheet on which the information can be found. As provided in Part 2 of this Section of the Specifications, include any and all exceptions, variances or substitutions listed at the time of bid. Any such exceptions, variances or substitutions that were not listed at the time of bid and are identified in the submittal, shall be grounds for immediate disapproval without comment.

B. Provide a Sequence of Operation matrix. The sequence of operation shall be building specific, and shall provide individual sequences for every type of alarm, supervisory, or trouble condition which may occur as part of normal or off-normal system use.

C. Provide manufacturer's ORIGINAL printed product data, catalog cuts and description of any special installation procedures. Photocopied and/or illegible product data sheets shall not be acceptable. All product datasheets shall be highlighted or stamped with arrows to indicate the specific components being submitted for approval.

D. Provide manufacturer's installation instruction manual for specified system.

E. Provide samples of various items when requested.

F. Provide copy of state License to perform such work.

G. Provide copies of NICET Level III Fire Alarm certifications for a minimum of two (2) technicians assigned to this project also responsible for FACP programming.

H. Provide shop drawings as follows:

1. Coversheet with project name, address and drawing index.

2. General notes drawing with peripheral device backbox size information, part numbers, device mounting height information, and the names, addresses, point of contact, and telephone numbers of all contract project team members.

3. Building specific device riser diagram, which individually depicts all control panels, annunciators, addressable devices, and notification appliances. Shall include a specific, proposed point descriptor above each addressable device. Shall include a specific, discrete point address that shall correspond to addresses depicted on the device layout floor plans. Drawing shall provide wire specifications, and wire tags shown on all conductors depicted on the riser diagram. All circuits shall have designations that shall correspond with those require on the control panel and floor plan drawings. End-of-line resistors (and values) shall be depicted.

4. Control panel termination drawing(s). Shall depict internal component placement and all internal and field termination points. Drawing shall provide a detail indicating where conduit penetrations shall be made, so as to avoid conflicts with internally mounted batteries. For each additional data gathering panel, a separate control panel drawing shall be provided, which clearly indicated the designation, service and location of the control enclosure. End-of-line resistors (and values) shall be depicted.

5. See section 3.4 DOCUMENTATION AND TRAINING for other documents relating to this section.

6. Building specific device wiring diagram drawing(s) shall be provided which depict all system components, and their respective field wiring termination points. Wire type, gauge, and jacket shall also be indicated. When an addressable module is used in multiple configurations for monitoring or controlling various types of equipment, different device typical diagrams shall be provided. End-of-line resistors (and values) shall be depicted.

7. Device layout floor plans shall be created for every area served by the fire alarm system. Floor plans shall indicate accurate locations for all control and peripheral devices. Drawings shall be no less than 1/8-inch scale. All addressable devices shall be depicted with a discrete address that corresponds with that indicated on the Riser Diagram. All notification appliances shall also be provided with a circuit address that corresponds to that depicted on the Riser Diagram. If individual floors need to be segmented to accommodate the 1/8" scale requirements, KEY PLANS and BREAK-LINES shall be provided on the plans in an orderly and professional manner. End-of-line resistors (and values) shall be depicted.

8. Contained in the title block of each drawing shall be symbol legends with device counts, wire tag legends, circuit schedules for all addressable and notification appliance circuits, the project name/address, and a drawing description which corresponds to that indicated in the drawing index on the coversheet drawing. A section of each drawing title block shall be reserved for revision numbers and notes. The initial submission shall be Revision 0, with Revision A, B, or C as project modifications require.

I. Battery calculations shall be provided on a per power supply/charger basis. These calculations shall clearly indicated the quantity of devices, the device part numbers, the supervisory current draw, the alarm current draw, totals for all categories, and the calculated battery requirements (which reflect a 20% DEGRADE, for 24 Hour supervisory, 5 minute alarm operation). Battery calculations shall also reflect all control panel component, remote annunciator, and auxiliary relay current draws. Failure to provide these calculations shall be grounds for the complete rejection of the submittal package.

J. Table of contents, product data sheets, sequences of operation, battery calculations, installation instructions, licenses, NICET certifications and 11" x 17" reduced shop drawings shall be provided by the fire alarm vendor as part of a single, spiral bound submittal book. The submittal book shall have laminated covers indicating the project address, SED number, system type, and contractor. The book shall consist of labeled dividers, and shall not exceed 9 ½" in width, and 11 ½" in height.

K. Scale drawing sets shall be submitted along with the submittal booklets. These drawings shall be 22" x 34" and of a sufficient resolution to be completely legible when reduced to 11' x 17" size.

PART II - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Edwards Systems Technology (EST) by UTC Fire and Security.

B. All products UL Listed and/or FM Approved and shall be compatible as published in the EST-3 UL Compatibility List.

2.02 CIRCUITING GUIDELINES

A. Each addressable analog loop shall be circuited so device loading is not to exceed 80% of loop capacity in order to leave for space for future devices. The loop shall have Class A operation.

B. Where it is necessary to interface conventional initiating devices provide intelligent input modules to supervise Class B zone wiring.

C. Each of the following types of devices or equipment shall be provided with supervised circuits as shown on the drawings but shall be typically as follows:

1. Sprinkler Valve Supervisory Switches: Provide one (1) supervisory module circuit for each sprinkler valve supervisory switch.

2. When water flow and tamper switches exist at the same location, provide one (1) dual input addressable module.

3. When odd numbers of devices exist at a single location, provide additional single input addressable module.

D. Each of the following types of alarm notification appliances shall be circuited as follows:

1. Audible Signals: Provide sufficient spare capacity to assure that an increase of 20% of the audible devices can be supported without the need for additional components (power supplies, signal circuit modules, batteries, etc.)

2. Visual Signals: Provide sufficient spare capacity to assure that an increase of 20% of the visual devices can be supported without the need for additional components (power supplies, signal circuit modules, batteries, etc.)

E. Each of the following types of remote equipment associated with the fire alarm system shall be provided with a form ‘C’ control relay contact as shown on the drawings, but shall be typically as follows:

1. HVAC Fan Systems: Provide one (1) shutdown control relay contact for each HVAC fan system.

2. HVAC Supply Fans: Provide one (1) shutdown control relay contact for each HVAC supply fan.

3. HVAC Return Fans: Provide one (1) shutdown control relay contact for each HVAC return fan.

F. Provide a dedicated 24VDC circuit to feed all auxiliary relays required for inductive loads. Circuits shall be supervised via an end-of-line relay and addressable input

module. Auxiliary relays shall not derive their power from the starter or load being controlled.

G. Each control or data gathering panel shall have a dedicated 20 Amp, 120 VAC feed. This feed shall come from an emergency circuit breaker panel where available, and shall have a locked circuit breaker. Earth grounds shall also terminate to the same circuit breaker panel from each respective control panel.

2.03 FIRE ALARM SYSTEM SEQUENCE OF OPERATION

A. The system shall identify any off normal condition and log each condition into the system database as an event.

1. The system shall automatically display on the control panel Liquid Crystal Display the first event of the highest priority by type. The priorities and types shall be alarm, supervisory, trouble, and monitor.

2. The system shall have a Queue operation, and shall not require event acknowledgment by the system operator. The system shall have a labeled color coded indicator for each type of event; alarm - red, supervisory - yellow, trouble - yellow, monitor - yellow. When an unseen event exists for a given type, the indicator shall be lit.

3. For each event, the display shall include the current time, the total number of events, the type of event, the time the event occurred and up to a 42 character custom user description.

4. The user shall be able to review each event by simply selecting scrolling keys (up-down) for each event type.

5. New alarm, supervisory, or trouble events shall sound a silencing audible signal at the control panel.

B. Operation of any alarm initiating device shall automatically:

1. Update the control/display as described above (A.1.)

2. Sound all audible appliances in a Temporal-3 Pattern. All audible appliances shall be synchronized with each other when two or more horns can be heard. Audible devices shall have the ability to be silenced.

3. Activate all strobe appliances throughout the facility. All strobe appliances shall be synchronized with each other in any location with two or more devices in a common field of view. Visual devices shall be non-silenced unless the system is successfully reset.

4. Operate control relay contacts to shutdown all HVAC units.

5. Operate control relay contacts to return all elevators that serve the floor of alarm initiation to the ground floor. If the alarm originates from the ground floor, operate

control circuits contacts to return all elevators to the floor above or to a level as directed by the local fire department.

6. Visually annunciate the individual point of alarm on all remote annunciator panels. The visual indication shall remain on until the alarm condition is reset to normal.

7. Transmit an alarm condition, via the integral central station communicator, to central station/Local Fire Department and Proprietary supervising station (as required by the AHJ).

C. Activation of a sprinkler supervisory initiating device shall:
   1. Update the control/display as described above (A.1.)

   2. Transmit a supervisory condition, via the integral central station communicator, to central station/Local Fire Department and Proprietary supervising station (as required by the AHJ).

   3. Visually annunciate the individual point of alarm on all remote annunciator panels. The visual indication shall remain on until the alarm condition is reset to normal.

D. The entire fire alarm system wiring shall be electrically supervised to automatically detect and report trouble conditions to the fire alarm control panel. Any opens, grounds or disarrangement of system wiring and shorts across alarm signaling wiring shall automatically:
   1. Update the control/display as described above (A.1.)

   2. Transmit a trouble condition, via the integral central station communicator, to central station/Local Fire Department and Proprietary supervising station (as required by the AHJ).

   3. Visually and audibly annunciate a general trouble condition, on the remote annunciator panels. The visual indication shall remain on until the trouble condition is repaired.

E. The fire alarm and detection system provides controls to and/or interfaces with the following systems and equipment:

   1. Ventilation Fans
   2. Fire Sprinkler Systems
   3. Manual Pull Stations
   4. Automatic Public Address
   5. Carbon Monoxide Detection

2.04 SUPPORT FOR INSTALLER AND WMATA MAINTENANCE

A. Provide a coded one-man walk test feature. Allow audible or silent testing. Signal alarms and troubles during test. Allow receipt of alarms and programmed operations for alarms from areas not under test.

B. Provide internal system diagnostics and maintenance user interface controls to display/report the power, communication, and general status of specific panel components, detectors, and modules.

C. Provide loop controller diagnostics to identify common alarm, trouble, ground fault, Class A fault, and map faults. Map faults include wire changes, device type changes by location, device additions/deletions and conventional open, short, and ground conditions. Ground faults on the circuit wiring of remote module shall be identified by device address.

D. Allow the user to display/report the condition of addressable analog detectors. Include device address, device type, percent obscuration, and maintenance indicator. The maintenance indicator shall provide the user with a measure of contamination of a device upon which cleaning decisions can confidently be made.

E. Allow the user to report history for alarm, supervisory, monitor, trouble, smoke verification, watchdog, and restore activity. Include Facility Name, Licensee, Project Program Compilation date, Compiler Version, Project Revision Number, and the time and date of the History Report.

F. Allow the user to disable/enable devices, zones, actions, timers and sequences. Protect the disable function with a password.

G. Allow the user to activate/restore outputs, actions, sequences, and simulate detector smoke levels.

H. Allow the service user to enter time and date, reconfigure an external port for download programming, initiate auto programming and change passwords. Protect these functions with a password.

I. WMATA shall retain complete rights and ownership to all software running in the system. The fire alarm equipment vendor shall provide useable hard and soft copies of the software database to WMATA at the end of the warranty period. The database provided shall be useable by any authorized and certified distributor of the product line, and shall include all applicable passwords necessary for total and unrestricted use and modification of the database.

2.05 UL LISTED AND APPROVED EQUIPMENT

A. Fire Alarm Control Panel Requirements:

The fire alarm control panel or panels and all system devices (horn-strobes, strobes, pull stations, smoke and heat detectors, etc. shall be Edwards Systems Technology (EST) type EST3 series (or equal). All under one label “UL listed and approved” for the use of fire alarm systems in this area of the United States of America. The operating controls shall be located behind locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified.

B. System Controllers

The main controller 3-CPU3 shall be supervised, site programmable, and of modular design supporting up to 125 detectors and 125 remote modules per addressable Signaling line Circuit (SLC). The CPU shall support up to 10 SLC's per panel for a total system capacity of 2500 Intelligent Addressable points. The system shall be designed

with peer-to-peer networking capability for enhanced survivability, with support for up to 64 nodes, each with up to 2500 points and an overall capacity of 160,000 points. The cabinets shall be steel, with a red finish.

C. The system shall store all basic system functionality and job specific data in non-volatile memory. All site specific and operating data shall survive a complete power failure intact. Passwords shall protect any changes to system operations.

D. The Main Controller Module shall control and monitor all local or remote peripherals. It shall support a large 960 character LCD, power supply, remote LCD and zone display annunciators, printers, and support communication interface standard protocol (CSI) devices such as color computer annunciators and color graphic displays. If configured as a network, each system shall display each and every point in the system and shall also support up to 64 remote LCD display annunciators. Remote LCD annunciators shall also display each and every point in the system and be sized with the same number of characters as in the main FACP display.

E. The panel shall have a means for proprietary supervising station remote site monitoring to include the following as required:

1. The panel shall have a dialer alarm communicator transmitter (DACT) module to transmit alarm, supervisory and trouble signals to a Central Monitoring Station. The DACT shall support dual telephones lines, Contact I.D. communications, and configured for dual tone multi-frequency (DTMF) or pulse modes. It shall be possible to delay AC power failure reports, auto test call, and be site programmable. The dialer shall be capable of transmitting every individual alarm condition to the central station

2. The Network Communications card Model 3-RS485A shall be provided for each building to allow building to building, peer to peer networking. Fiber Optics Communications Interface Model 3-FIBMB shall be provided for each building to allow building to building peer to peer networking and proprietary supervising station and be wired in a Class A configuration.

F. The system shall have built-in automatic system programming to automatically address and map all system devices attached to the main controller. A minimum default single stage alarm system operation shall be supported with alarm silence, event silence, drill, lamp test, and reset common controls.

G. Advanced Windows-based System Definition Utility with Program Version Reporting to document any and all changes made during system start-up or system commissioning shall be used to maintain site specific programming. Time and Date Stamps of all modifications made to the program must be included to allow full retention of all previous program version data. It shall support programming of any input point to any output point. The system shall support the use of Bar Code readers to assist custom programming functions. It shall allow authorized customization of fundamental system operations using initiating events to start actions, timers, sequences and logical algorithms. The system program shall meet the requirements of this project, current codes and standards, and satisfy the local Authority Having Jurisdiction.

H. The system shall support distributed processor intelligent detectors with the following operational attributes; integral multiple differential sensors, automatic device mapping, electronic addressing, environmental compensation, pre-alarm, dirty detector identification, automatic day/night sensitivity adjustment, normal/alarm LEDs, relay bases, sounder bases and isolator bases.

I. The system shall use full digital communications to supervise all addressable loop devices for placement, *correct location*, and operation. It shall allow swapping of "same type" devices without the need of addressing and impose the "location" parameters on replacement device. It shall initiate and maintain a trouble if a device is added to a loop and clear the trouble when the new device is mapped and defined into the system.

J. Each controller shall contain a RS232 printer/programming port for programming locally via an IBM PC. When operational, each controller shall support a printer through the RS232 port and be capable of message routing.

K. System circuits shall be configured as follows: Addressable analog SLC loops Class B; Initiating Device Circuits Class B; Notification Appliance Circuits Class B; Network Communications Class A; Annunciator Communications Class A. NO TEE TAPS PERMITTED

L. Single stage operation shall be provided.

M. The system shall have a UL Listed Detector Sensitivity test feature, which will be a function of the smoke detectors and performed automatically every 4 hours.

N. The system shall support 100% of all remote devices in alarm and provide support for a 100% compliment of detector isolator bases.

O. All panel modules shall be supervised for placement and return trouble if damaged or removed.

P. The system shall have a CPU watchdog circuit to initiate trouble should the CPU fail.

Q. The system evacuation signal rate shall be temporal 3-3-3.

R. Audible notification appliances shall be affected by signal silence features. Visual signal appliance shall not be affected by signal silence features.

S. User Interface

The 3-LCDXL Display Module shall be of membrane style construction with a 24 line by 40-character (960 total characters) Liquid Crystal Display (LCD). The LCD shall use super-twist technology and backlighting for high contrast visual clarity and a colored gray/black and white display. In the normal mode the LCD shall display the time, a customer facility name, and the number of history events. In the alarm mode the LCD display the total number of events and the type of event on display. The LCD shall reserve 42 characters of display space for each user custom message by addressable device. The module shall have visual indicators for the following common control functions; Power, Alarm, Supervisory, Monitor, Trouble, Disable, Ground Fault, CPU fail, and Test. There shall be common control keys and visual indicators for reset, alarm silence, panel silence, and drill. Provide four pairs of display control keys for selection of event display by type (alarm, supervisory, monitor and trouble) and forward / backward scrolling through event listings. The operation of these keys shall be integrated with the related common control indicators to flash the indicators when undisplayed events are available for display and turn on steady when all events have been displayed. The LCD shall display the first event of the highest priority as well as the previous seven (7) alarm events "hands free" in chronological order so that the arriving firefighter may track the fires progression. Provide system function keys; status, reports, enable, disable, activate, restore, program, and test. The module shall have a numeric keypad, zero

through nine with delete and enter keys. As an alternate if the above cannot be provided, provide UL-Listed 864 PC graphics display.

T. Power Supplies

The power supply shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 7.0A continuous for notification appliance circuits. The power supply shall be capable of providing 7A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 5 minutes.

U. Auxiliary power supplies shall be a high efficiency switch mode type with line monitoring to automatically switch to batteries for power failure or brown out conditions. The automatic battery charger shall have low battery discharge protection. The power supply shall provide internal power and 24 Vdc at 7.0A continuous for notification appliance circuits. The power supply shall be capable of providing 7A to output circuits for a maximum period of 100 ms. All outputs shall be power limited. The battery shall be sized to support the system for 24 hours of supervisory and trouble signal current plus general alarm for 5 minutes.

V. Network alpha-numeric annunciators shall be located throughout the facility as indicated on the plans. The system shall have the capacity to support 64 network annunciators or EST3 network panel nodes. Each annunciator shall contain a supervised, back lit, liquid crystal with a minimum of 8 line with 21 characters per line. Where required, the annunciator shall include additional zonal annunciation and manual control without additional enclosures.

X. The annunciator shall support full ability to serve as the operating interface to the system and shall include the following features;

1. Matched appearance with other system displays;
2. Each LCD Display on each node (cabinet) in the system shall be configurable to show the status of any or all of the following functions anywhere in the system:
    a. Alarm
    b. Supervisory
    c. Trouble
    d. Monitor

Y. It must be possible to have up to 64 network annunciators or EST3 panels on the network.

Z. Each annunciator must be capable of supporting custom messages as well as system event annunciation. It must be possible to filter unwanted annunciation of trouble, alarm or supervisory functions on a by point or by geographic area.

AA. The graphic remote annunciators shall be mounted in stand-alone enclosures or integrated into the network panels. The annunciator graphical diagram shall be 1/16 inch per foot scale minimum and operating on nominal 24 Vdc. All annunciator switches shall be system input points and shall be capable of controlling any system output or function. The graphic annunciator shall be UL and ULC Listed. The graphic shall be back-lit using

high intensity LEDs. The unit shall be semi-flush or surface mounted. The main graphic door shall be tamper resistant and equipped with a key lock. It shall be possible to update the graphic image in the field without replacing the entire graphic.

2.06 COMPONENTS

A. Central Processing Unit Module — Provide a 3-CPU1 with a 33-RS 232 Communication Card and a 3-RS 485B Network Communication Card.

B. Primary Power Supply — Provide a 3-PPS/M with power input of 120 VAC, 3.0A, 50/60 Hz and power output of Internal DC 24 Vdc @ 7.0 A Max, Auxiliary DC Two 24 Vdc @ 3.5 Max.

C. Main Liquid Crystal Display module — Provide a 3-LCD which can display eight (8) lines by 20 characters graphic LCD display-168 characters

D. Signature driver controller module — Provide a 3-SDDC.

E. Modem Communicator — Provide a 3-MODCOM The 3-MODCOM is a combination digital dialer/modem utilized by the Edwards 3000 system, to communicate to industry standards digital dialer receivers for status reports. The 3-MODCOM also communicates via an integral modem to computers equipped with a 3-ACDB (Access Controlled Database Program) for downloading user access levels. The 3-MODCOM is a dual-line capable digital dialer V.32bis 14.4K full duplex modem.

F. Fiber Communicator – Provide a 3-FIBMB2 for communications.

G. Intelligent Devices — General: Each remote device shall have a microprocessor with non-volatile memory to support its functionality and serviceability. Each device shall store as required for its functionality the following data: device serial number, device address, device type, personality code, date of manufacture, hours in use, time and date of last alarm, amount of environmental compensation left/used, last maintenance date, job/project number, current detector sensitivity values, diagnostic information (trouble codes) and algorithms required to process sensor data and perform communications with the loop controller. Each device shall be capable of electronic addressing, either automatically or application programmed assigned, to support physical/electrical mapping and *supervision by location.* Setting a device's address by physical means shall not be necessary.

H. Intelligent Detectors — General: The System Intelligent Detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Signal patterns that are not typical of fires shall be eliminated by digital filters. Devices not capable of combining different fire parameters or employing digital filters shall not be acceptable. Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and analog loop controller. Detectors not capable of making independent alarm decisions shall not be acceptable. Maximum total analog loop response time for detectors changing state shall be 0.5 seconds. Each detector shall have a separate means of displaying communication and alarm status. A green LED shall flash to confirm communication with the analog loop controller. A red

LED shall flash to display alarm status. The detector shall be capable of identifying up to 32 diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other contaminates as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24-hour long term and 4-hour short-term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour. The intelligent analog detectors shall be suitable for mounting on any Signature Series detector mounting base.

I. Fixed Temperature/Rate of Rise Heat Detector, SIGA-HRS: Provide intelligent combination fixed temperature/rate-of-rise heat detectors SIGA-HRS. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 135^0F and a rate-of-rise alarm point of 15^0F per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft centers and be suitable for wall mount applications.

J. Photoelectric Smoke Detector, SIGA-PS: Provide intelligent photoelectric smoke detectors SIGA-PS. The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool. The photo detector shall be rated for ceiling installation at a minimum of 30 ft centers and be suitable for wall mount applications. The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3 ft high and 3 ft wide with air velocities up to 4,000 ft/min. without requiring specific duct detector housings or supply tubes. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photo detector shall be suitable for operation in the following environment: Temperature: 32^0F to 120^0F, Humidity: 0-93% RH, non-condensing, Elevation: no limit.

K. 4D Multisensor Detector, SIGA-IPHS: Provide intelligent 4D multisensor smoke detectors SIGA-IPHS. The multisensor analog detector shall use a light scattering type

photoelectric smoke sensor, a unipolar ionization smoke sensor and an ambient temperature sensor to sense changes in air samples from its surroundings. The integral microprocessor shall employ time based algorithms to dynamically examine values from the three sensors simultaneously and initiate an alarm based on that data. The 4D Multisensor shall be capable of adapting to ambient environmental conditions. The temperature sensor shall self-adjust to the ambient temperature of the surrounding air and input an alarm when there is a change of 65^0F in ambient temperature. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, age and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool. Separately mounted photoelectric detectors, ionization detectors and heat detectors in the same location are not acceptable alternatives. The 4D Multisensor smoke detector shall be rated for ceiling installation at a minimum of 30 ft centers and suitable for wall mount applications.

L. Standard Detector Mounting Bases, SIGA-SB / SIGA-SB4: Provide standard detector mounting bases SIGA-SB suitable for mounting on North American 1-gang, 3½" or 4" octagon box and 4" square box. The base shall, contain no electronics, support all Signature Series detector types and have the following minimum requirements: Removal of the respective detector shall not affect communications with other detectors, Terminal connections shall be made on the room side of the base, bases that must be removed to gain access to the terminals shall not be acceptable. The base shall be capable of supporting one (1) Signature Series SIGA-LED Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.

M. Duct Detector Housing, SIGA-SD: Provide model SIGA-SD Low profile intelligent addressable DUCT smoke detector as indicated on the project plans. Provide for variations in duct air velocity between 100 and 4,000 feet per minute and include a wide sensitivity range of .79 to 2.46%/ft. Obscuration. Include one Form-C shut down relay rated 2.0 amps @ 30 Vdc and also include slave high contact relays if required. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. The addressable DUCT housing shall be suitable for extreme environments, including a temperature range of –20 to 158 degrees F and offer a harsh environment gasket option. Provide Remote Alarm LED Indicators SIGA-LED and/or remote test station model SD-TRK as indicated on the project plans.

N. Intelligent Modules — General: It shall be possible to address each Intelligent Signature Series module without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Modules requiring EPROM, PROM, ROM changes or DIP switch and/or jumper changes shall not be acceptable. The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment: Temperature: 32°F to 120°F, Humidity: 0-93% RH, non-condensing.

O. Single Input Module, SIGA-CT1 (Waterflow Detectors, Tamper Switches etc.): Provide intelligent single input modules SIGA-CT1. The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½"deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types: Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.), Normally-Open Alarm Delayed Latching (Waterflow Switches), Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.), Normally-Open Active Latching (Supervisory, Tamper Switches).

P. Dual Input Module, SIGA-CT2: Provide intelligent dual input modules SIGA-CT2. The Dual Input Module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" deep 1-gang boxes and 1 ½" deep 4" square boxes with 1-gang covers. The dual input module shall support the following circuit types: Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.), Normally-Open Alarm Delayed Latching (Waterflow Switches), Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.), Normally-Open Active Latching (Supervisory, Tamper Switches).

Q. Monitor Module, SIGA-MM1: Provide intelligent monitor modules SIGA-MM1. The Monitor Module shall be factory set to support one (1) supervised Class B Normally-Open Active Non-Latching Monitor circuit. The monitor module shall be suitable for mounting on North American 2 ½" deep 1-gang boxes and 1 ½" deep 4" square boxes with 1-gang covers.

R. Universal I/O module Motherboard – Provide a SIGA-U106 and U102R The SIGA-U106/2R are motherboards that provide mounting and wire terminations for SIGA "M" series modules. Ths SIGA-U106 supports up to six modules, and the U102R has the capacity for up to two (2) modules. Locations: Communication Equipment Room, and Ancillary locations. (Edwards-MFC-A cabinet).

S. Waterflow/Tamper Module, SIGA-WTM: Provide intelligent waterflow/tamper modules SIGA-WTM. The Waterflow/Tamper Module shall be factory set to support two (2) supervised Class B input circuits. Channel A shall support a Normally-Open Alarm Delayed Latching Waterflow Switch circuit. Channel B shall support a Normally-Open Active Latching Tamper Switch. The waterflow/tamper module shall be suitable for mounting on North American 2 ½" deep 1-gang boxes and 1 ½" deep 4" square boxes with 1-gang covers.

T. Single Input Signal Module, SIGA-CC1: Provide intelligent single input signal modules SIGA-CC1. The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The module shall be suitable for mounting on North American 2 ½" deep 2-gang boxes and 1 ½" deep 4" square boxes with 2-gang covers. The single input signal module shall support the following operations: Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A).

U. Control Relay Module, SIGA-CR: Provide intelligent control relay modules SIGA-CR. The Control Relay Module shall provide one form "R" dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be

confirmed by the system firmware. The control relay module shall be suitable for mounting on North American 2 ½" deep 1-gang boxes and 1 ½" deep 4" square boxes with 1-gang covers.

V. Intelligent Manual Pull Stations — General: It shall be possible to address each Signature Series fire alarm pull station without the use of DIP or rotary switches. Devices using DIP switches for addressing shall not be acceptable. The manual stations shall have a minimum of 2 diagnostic LEDs mounted on their integral, factory assembled single or two stage input module. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The station shall be capable of storing up to 24 diagnostic codes that can be retrieved for troubleshooting assistance. Input circuit wiring shall be supervised for open and ground faults. The fire alarm pull station shall be suitable for operation in the following environment: Temperature: 32°F to 120°F, Humidity: 0-93% RH, non-condensing.

W. Manual Pull Station, SIGA-270: Provide intelligent double action, single stage fire alarm stations SIGA-270. The fire alarm station shall be of metal construction with an internal toggle switch. Provide a locked test feature. Finish the station in red with silver "PULL IN CASE OF FIRE" English lettering. The manual station shall be suitable for mounting on North American 2 ½" deep 1-gang boxes and 1 ½" deep 4" square boxes with 1-gang covers.

X. Notification Appliances – General: All appliances shall be UL Listed for Fire Protective Service. All strobe appliances or combination appliances with strobes shall be capable of providing the "Equivalent Facilitation" which is allowed under the Americans with Disabilities Act accessibly guidelines (ADA(AG)), and shall be UL 1971, and ULC S526 Listed. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel (NO EXCEPTIONS) specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturers' instructions. Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from THE CONTROL PANEL MANUFACTURER clearly stating that the control equipment (as submitted) is 100% compatible with the submitted Notification Appliances.

Y. Strobes, G1RF-VM Series: Provide EST Series G1RF-VM series low profile wall mounted strobes at the locations shown on the drawings. Strobes shall provide synchronized flash outputs. Strobe output shall be field selectable as indicated on the drawings in one of the following intensity levels; 15/75, 15cd, 30cd, 75cd or 110cd*. Low profile strobes shall mount in a North American 1-gang box or surface mounted on a matching back box provided by the manufacturer, as directed in the field.

   * The fire alarm vendor may select below 75 candela where allowed by the appropriate release of ADA. 15/75 strobes may be used in corridors and in locations where 15 candela is required per NFPA wall and ceiling tables (see NFPA 72).

Z. Temporal Horn Strobes, G1RF-HDVM Series: Provide EST Series G1RF-HDVM low profile wall mount horn/strobes at the locations shown on the drawings. The horn/strobe shall provide an audible output of 84.4 dBA at 10 ft at the high setting and for smaller room size locations (as indicated on the plans) a low dB setting (field selectable) of 79.4 dB at 10 ft. when measured in reverberation room per UL-464. Strobes shall provide synchronized flash outputs. The strobe output shall be as indicated on the drawings in one of the following field selectable intensity levels*; 15/75, 15cd, 30cd, 75cd & 110cd

devices. The horn shall have a selectable steady or synchronized temporal output. Low profile horn/strobes shall mount in a North American 1-gang box or surface mounted on a matching back box provided by the manufacturer, as directed in the field.

* The fire alarm vendor may select below 75 candela where allowed by the appropriate release of ADA. 15/75 strobes may be used in corridors and in locations where 15 candela is required per NFPA wall and ceiling tables (see NFPA 72).

AA. Temporal Horn, G1RF-HD: Provide EST Series G1RF-HD low profile wall mount horn at the locations shown on the drawings. The horn shall provide an audible output of 84.4 dBA at 10 ft at the high setting and for smaller room size locations (as indicated on the plans) a low dB setting (field selectable) of 79.4 dB at 10 ft. when measured in reverberation room per UL-464. The horn shall have a selectable steady or synchronized temporal output. Low profile horn shall mount in a North American 1-gang box or surface mounted on a matching back box provided by the manufacturer, as directed in the field.

BB. Multi-Voltage Control Relays, MR-200 Series: Provide remote control relays connected to supervised ancillary circuits for control of fans, dampers, door releases, etc. Relay contact ratings shall be DPDT and rated for 10 amperes at 115 Vac. A single relay may be energized from a voltage source of 24 Vdc, 24 Vac, 115 Vac, or 230 Vac. A red LED shall indicate the relay is energized. A metal enclosure shall be provided.

CC. Wall Mounted, 1504/1505/1508/1509 Series: Provide flush, semi-flush or surface wall mounted electromagnetic door holder/releases rated at 24 Vac/dc. Finish shall be brushed zinc.

DD. STI Stopper II Lexan Guards: Manual pull stations that are provided with STI Stopper II lexan guards shall include non-audible alarms as required on the plans. They shall be surface or flush mounting, as required for each individual device.

PART III - EXECUTION

3.1 INSTALLATION

A. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer's wiring diagram. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the manufacturer, approved by the local Fire Department and specified herein.

B. All penetration of floor slabs and firewalls shall be sleeved (1" conduit minimum) fire stopped in accordance with all local fire codes.

C. End of Line Resistors shall be furnished as required for mounting as directed by the manufacturer. Devices containing end-of-line resistors shall be appropriately labeled. Devices should be labeled so removal of the device is not required to identify the EOL device.

D. All manual pull stations shall be mounted 48 inches above the finished floor, as measured to the handle.

E. All audio/visual devices shall be mounted 80 inches above the finished floor, as measured on center. Devices shall be mounted no less than 6 inches from the ceiling. All audiovisual devices shall have lexan covers in all areas.

F. No area smoke detectors shall be mounted within 36 inches of any HVAC supply, return air register or lighting fixture.

G. No area smoke or heat detector shall be mounted within 12 inches of any wall. All detectors shall be installed in strict accordance with NFPA 72 guidelines for such devices.

H. All addressable modules shall be mounted within 36 inches of the monitored or controlled point of termination. This shall include, but is not necessarily limited to, fan shutdown, elevator recall, shunt trip, sprinkler status points, or door release. Label all addressable modules as to their function.

I. New door holders shall derive their 24VAC/VDC power from a separate power supply housed in a dedicated, metal enclosure. The power supply shall have a 120VAC feed, and is to be centrally located to serve door holders on a per floor or area basis. All existing door holders shall be connected to new FACP. E.C. shall extend all existing wiring in order to make this work.

J. All low voltage wiring terminated to the fire alarm system shall be plenum rated with no exceptions and no less than No. 18 AWG in size, and solid copper.

K. All line voltage (120VAC) wiring shall be no less than No. 12 AWG in size, and solid copper. This shall include all system grounding. FACP must have a dedicated 20 Amp circuit marked back at the power panel no exceptions.

L. All wiring shall be color-coded throughout, to National Electrical Code standards.

M. Power-limited/Non-power-limited NEC wiring standards shall be observed.

N. All junction box covers shall be painted federal safety red and labeled FIRE ALARM SYSTEM ONLY in black letters.

O. Fire alarm system wiring shall not co-mingle with any other system wiring in the facility. Conduits shall not be shared under any circumstance. Only when fire alarm wiring enters the enclosure of a monitored or controlled system will co-habitation be permitted (i.e. at fan starters or elevator controllers).

P. Fire alarm control panel enclosures shall have engraved labels indicating, “FIRE ALARM SYSTEM”, and the areas of the building served by that panel.

Q. Auxiliary relays shall be appropriately labeled to indicate “FIRE ALARM SYSTEM” and their specific function (i.e. FAN S-1 SHUTDOWN).

R. All fire alarm wiring shall be continuous and unspliced. Terminations shall only occur at fire alarm devices or control panel enclosures under terminal screws. All other splicing methods are specifically disallowed (i.e. plastic wirenuts).

S. All fire alarm wiring shall be installed in conduit.

T. All fire alarm wiring shall be sleeved when passing through any wall, using conduit sleeves (1” min.) with bushings, and fire stopped in accordance with Code.

U. The system shall be arranged to receive power from one three wire 120 Vac, 20 A supply. All low voltage operation shall be provided from the fire alarm control panel.

V. All fire alarm devices shall be accessible for periodic maintenance. Should a device location indicated on the Contract Drawings not meet this requirement, it shall be the responsibility of the installing contractor to bring it, in writing, to the attention of the WMATA. Failure to bring such issues to the attention of WMATA shall be the exclusive liability of the installing Contractor.

X. The existing fire alarm system shall remain in operation until such time that approval has been granted for its removal.

Y. After acceptance of the new building fire alarm system, the installing Contractor shall be responsible for the removal of entire existing fire alarm system components and controls, upon approval of the AHJ and WMATA. WMATA reserves the right to retain any existing fire alarm system components, upon their request. All existing fire alarm system components requiring special handling for disposal (due to radioactivity) shall be the responsibility of the installing contractor. Written proof of proper disposal by the installing contractor shall be required prior to release of outstanding retainage.

3.2 FIELD QUALITY CONTROL

A. The system shall be installed and fully tested under the supervision of a trained manufacturer's representative. The system shall be demonstrated to perform all of the function as specified.

B. The installing contractor or fire alarm equipment vendor shall have no less than two (2) NICET Level III fire alarm technicians dedicated to this project.

C. The Installing Contractor and the Fire Alarm System Vendor shall, upon the request of the Consulting Engineer or WMATA attend any and all project meetings for the purpose of accurately determining progress.

D. It shall be the responsibility of the installing contractor to assure that construction debris does not adversely affect any sensing devices installed as part of this project. Should it be deemed necessary by the WMATA construction manager, the installing contractor shall be responsible for the cleaning of all smoke detectors prior to final acceptance.

3.3 TESTS

A. The fire alarm system vendor shall test the system in accordance with the manufacturer's requirements and NFPA 72. The vendor shall provide completed NFPA 72 reports to WMATA for review and approval prior to final acceptance.

B. Each individual system operation on a circuit by circuit basis shall be tested for its complete operation. The procedure for testing the entire fire alarm system shall be set forth with the consent of the code enforcement official, the Engineer and the manufacturer.

C. Provide a NFPA 72 Record of Complete Form for each part of the fire alarm system as required.

3.4 DOCUMENTATION AND TRAINING

A. The contractor shall compile and provide to WMATA a complete manual on the completed system to include site specific operating and maintenance instruction, catalog cuts of all equipment and components, as-built wiring diagrams and a manufacturer's suggested spare parts list. An operational Video, on DVD media, shall also be included.

B. In addition to the above manuals, the Contractor shall provide the services of the manufacturer's trained representative for two (2) separate calendar days for a period of four (8) **hours** per day to instruct the WMATA's designated personnel on the operation and maintenance of the entire system.

C. As-built drawings shall consist of the following:

   1. Complete revision of all previously submitted drawings
   2. Point-to-point depiction of all device wiring on the device layout floor plans.
   3. Full size, as-built drawings.
   4. All drawings should be readable and printable in 11 x 17.
   5. Provide electronic copies in CAD and PDF.
   6. Provide one copy inside PVC pipe next to FACP.

D. Turnover of all software database hard/soft copies shall be required. This shall include all possible programming software logs, diskettes or CDs containing exported project files, hard copies of all device maps, the revision number of the version of programming utility used, and all required passwords. The turnover of all database information shall occur prior to the end of the One (1) warranty period (or period as amended earlier in this specification).

END OF SECTION

SECTION 31 09 00

GEOTECHNICAL INSTRUMENTATION AND MONITORING OF EARTHWORK

PART 1 -- GENERAL

1.01 SUMMARY:

A. This section specifies the design, installation, maintenance, and removal of geotechnical instrumentation to monitor soil, rock, and structure movements during construction. This section also includes specifications for reading, analyzing, and reporting instrumentation monitoring results.

1.02 REFERENCES

A. Definitions:
   1. Geotechnical Instrumentation - Any device designed to determine change in the position or state of stress of soil, rock, and structures.
   2. Instrument Monitoring - The procurement of data obtained from the repeated optical, mechanical, or electronic observations of geotechnical instruments.
   3. Frequency of Monitoring - The number of readings obtained from a geotechnical instrument with respect to time.
   4. Initial reading- The first stable reading set obtained after instrument installation, but prior to excavation, to which all subsequent readings will be compared.
   5. Threshold Limit Values Level 1 and Level 2 - Designer-specified limits for geotechnical instrumentation which if exceeded require (1) notification of the Authority and increased monitoring frequency and (2) implementation of the contingency plan.

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

1.03 DESIGN AND PERFORMANCE CRITERIA

A. Geotechnical Monitoring System:
   1. Provide a system of geotechnical instrumentation which will allow monitoring of soil, rock, and excavation support elements, as well as adjacent structures and utilities to ensure safety and stability, confirm design assumptions, and provide a basis for establishing compliance with contract requirements.

1.04 SUBMITTALS

A. Action Submittals:
   1. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals prior to proceeding with work:
      a. Certificates:

1) Buy America Act Certification.

b. Special Procedure Submittals:
   1) Type of instrumentation system proposed, showing arrangement, location and depths of proposed system.
   2) Manufacturer's literature including descriptions and installation recommendations for all instruments, software, and read-out devices proposed for use.
   3) Instrumentation installation schedule and monitoring schedule.
   4) Contingency Plans:
      a) Submit contingency plans to stabilize soil, rock, and structures affected by adverse movements detected by instrumentation. Submit contingency plans at least one month prior to start of excavation or tunneling. At a minimum, include the following:
         (1) Names, telephone numbers, and locations of persons responsible for implementation of contingency plans.
         (2) Materials and equipment required to implement contingency plans.
         (3) Location onsite of all required materials and equipment to implement contingency plans.
         (4) Step-by-step procedure for performing work involved in implementation of the contingency plans.
         (5) Threshold limit Level 1 and Level 2 values for all instruments.
         (6) Clear identification of objectives of contingency plans and methods to measure plan success.

c. Qualification Statements:
   1) Resumes listing the qualifications of the Professional Engineer and Technicians specified in 1.02.C.

B. Informational Submittals:
   1. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
      a. Test and Evaluation Reports:
         1) Instrumentation Monitoring Data:
            a) Analyzed data to be submitted on forms approved by the Authority within 48 hours after instrument monitoring. Supply copies of field notes if requested.
            b) Immediately report to the Authority movements exceeding Level 1 limits.
            c) For each shift in which work is taking place, submit a report within 24 hours containing the following:
               (1) Shift Reports of Construction Activities:
                  (a) Detailed excavation and tunneling status at time of instrument reading.
                  (b) Excavation subgrade elevation and tunnel face station at time of instrument reading.
                  (c) Incidents of ground loss, groundwater flow, excavation support instability, or any other unusual event.
                  (d) General construction activity in the vicinity of the instruments.
                  (e) Duration and cause of delays to construction activities.
                  (f) Weather conditions.
      b. Site Quality Control Submittals:
         1) Instrument Installation Data:

a) Record of instrument installation details including date and time of installation, general soil condition at instrument site, adjacent construction activities, and remarks of unusual conditions observed during installation.
b) As-built location and elevation of installed instruments including coordinates and distance referenced to Outbound track centerline. Supply location data within 48 hours of instrument installation.

1.05 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. Qualifications of Personnel:
   1. Instrumentation Selection, Design, Layout, and Data Analysis shall be performed by a registered Professional Engineer specializing in geotechnical engineering with 5 years experience in soil stability and geotechnical design.
   2. Instrumentation installation shall be performed under the supervision of qualified technicians with at least one year experience in the installation of instruments of the type specified.
   3. Instrumentation monitoring shall be performed by qualified technicians with at least one year experience in the reading of instruments of the type specified.

C. Certifications:
   1. Buy America Act Certification:
      a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.
      b. Submit the Buy America Act Certification to the Authority Representative for approval.

1.06 JOB CONDITIONS

A. Do not disclose to third parties or publish monitoring data without the approval of the Authority.

B. The Authority may monitor any geotechnical instrument at any time. Provide and facilitate access to instruments for the Authority.

C. The instrumentation monitoring data shall be continuously reviewed and interpreted by the responsible instrumentation specialist.

D. During construction, additional instrumentation may be required beyond that proposed in the initial design. Modifications to the instrumentation plan, including proposed instrument locations, may be required due to site conditions and instrumentation results.

E. Ensure that all instrumentation installations are continuously protected and are not damaged by construction activities, including blasting. Replace or repair as necessary any instrument damaged by construction activities or adverse soil, rock, or structure movement.

F. Continuously maintain all geotechnical instrumentation in proper working condition and within manufacturer's specifications. Immediately repair or replace malfunctioning equipment. All instrumentation readout devices to be periodically tested and recalibrated within schedule as recommended by the instrument manufacturer or as approved by the Authority.

PART 2- PRODUCTS

2.01 INSTRUMENT TYPES:

A. Specify instrument types and locations in accordance with design criteria indicated in Section 1.03 A.1. and as approved by the Authority.

PART 3 - EXECUTION

PART 1
PART 2
PART 3
3.01 PREPARATION

A. Permits:
1. Prior to instrumentation installation obtain any permits from the responsible jurisdiction and pay permit costs and any associated fees at no additional cost to the Authority.

3.02 INTRUMENT INSTALLATION AND MONITORING

A. Instrument Installation Schedule:
1. Install and obtain initial readings for all surface instrumentation prior to excavation, chemical grout operations, or dewatering activities, in accordance with approved schedule. In areas to receive chemical grout, delay installation of instruments which might be damaged by chemical grout until completion of this activity.
2. For all instrumentation located within excavated areas, install and obtain initial reading as soon as practical after excavation or passage of tunnel heading in accordance with approved schedule.

B. Instrument Locations:
1. Install instruments as close as practical to locations submitted and approved. Actual conditions in field may require location adjustment. Obtain Authority approval for location adjustments.
2. After instrument installation, submit reports showing location and installation details of each instrument as specified in Section 1.04.B.1.b.1), Instrument Installation Data.
3. Ensure that all proposed instrument locations will not result in damage to utilities or other structures. Coordinate proposed instrument locations with Miss Utility and any other affected owners prior to instrument installation.

C. Instrumentation Monitoring:
1. Initial Reading:
a. At time of initial reading, verify that instrument is functioning and has been installed in accordance with contract specifications and manufacturer's recommendations.
b. Obtain at least three separate and complete sets of initial readings on each instrument which yield consistent results.
c. Should inconsistent initial readings be obtained on any instrument, reread until correct and repeatable readings are obtained.
2. Monitoring Frequency:
a. Monitoring frequency to be in accordance with schedule submitted and approved as

specified in Section 1.04 A.1.a.3).

b. Instrument readings which show significant change from previous readings shall be reread immediately.

3. Instrumentation Monitoring Threshold Values:
   a. Instrumentation system design shall establish threshold limit values for each instrument.
      1) Level 1 Limit values if exceeded require notification of the Authority within 24 hours and notification of individuals listed within the contingency plan. Monitoring frequency of affected instruments which exceed Level 1 limit will be increased to frequency as approved within the contingency plan.
      Level 2 limit values if exceeded require immediate notification of the Authority and implementation of the contingency plan. Instruments which exceed Level II limits will be monitored continuously until stability is achieved.

3.03 REPAIR / RESTORATION

A. Instrument Replacement:
   1. Repair or replace damaged instruments within 5 days at no additional cost to the Authority.

3.04 SITE QUALITY CONTROL

A. Non-Conforming Work:
   1. Non-Conforming Instrumentation:
      a. Replace at no additional cost to the Authority any instrument which does not meet specification requirements.

3.05 CLEANING

A. Removal of Instruments:
   1. Prior to final acceptance of work and subject to Authority approval, remove and dispose of all instrumentation.
      a. Remove surface instrument installations to 2 feet below ground surface. Backfill voids and casing with cement grout.
      b. Restore ground surface to original condition.
   2. Fill holes in masonry with Portland cement mortar. Restore structure surfaces to original condition.

3.06 PROTECTION

A. Instrument Protection
   1. Protect and maintain instruments. Divert surface water from instrument covers. Flush debris from instrument installations. Maintain access to all instruments.
   2. Provide barriers as required to protect instrument.
   3. Install and maintain instruments and instrument access covers in a manner which protects workers and ensures public safety.

ENDNOTES:

1. The Designer must specify the level 1 and 2 threshold values before finalizing the contract-specific specifications. Limiting Values shall refer to Table 4-1 in the latest

edition of the WMATA Adjacent Construction Project Manual.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Protecting existing trees and vegetation to remain.
2. Removing trees and other vegetation.
3. Clearing and grubbing.
4. Topsoil stripping.
5. Removing above-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site facilities in place.
7. Disconnecting, capping or sealing, and removing site facilities.

B. Related Requirements:
1. Section 02 41 00 - Demolition.
2. Section 31 20 00 - Earth Moving.
3. Section 32 90 00 – Landscaping.
4. Section 32 91 00 - Planting Preparation.

1.02 REFERENCES

A. Definitions:
1. *Topsoil*: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of weeds, roots, and other deleterious materials.
2. *Facility*: Utility structures and system components belonging to utility company including service lines which are used to provide service to utility's customers and product which these facilities convey.
3. *Utility*: Company, agency, owner or operator of facility concerned.

B. Reference Standards:
1. U.S. Government:
   a. Federal Transit Administration:
      1) 49 CFR 661 Buy America Requirements.
2. Washington Metropolitan Area Transit Authority (W.M.A.T.A.):
   a. W.M.A.T.A. Standard Drawings:
      1) ST-C-16

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Existing Facilities:
   a. Do not interrupt facility service to building connections occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements

indicated:
1) Notify the Authority Representative not less than 2 days in advance of proposed facility interruptions.
2) Do not proceed with facilities interruptions without the Authority Representative's written permission.

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
1. Certificates:
a. Buy America Act Certification.
2. Special Procedure Submittals:
a. Property owner permits and releases for debris disposal.
3. Qualification Statements:
a. Arborist's qualifications.

1.05 QUALITY ASSURANCE:

A. Regulatory Agency Sustainability Approvals:
1. Authorities Having Jurisdiction::
a. Comply with the codes and regulations of the jurisdictional authorities.
2. 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. Qualifications:
1. Arborist's Qualifications:
a. Employ a qualified arborist, licensed in the jurisdiction where the Project is located.
b. Submit the arborist's qualifications to the Authority Representative for information.

C. Certifications:
1. Buy America Act Certification:
a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.
b. Submit the Buy America Act Certification to the Authority Representative for approval.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Soil Materials:
1. Provide soil materials as specified in Section 31 20 00, Earth Moving.
2. When satisfactory soil materials are not available on-site, obtain approved borrow soil materials off-site.

B. Standard Wood Tree Guards:
1. Provide Standard Wood Tree Guards as shown on W.M.A.T.A. Standard Drawing ST-C-16, consisting of the following:
a. Wood posts: 2 inches square.
b. Wood stringers: 2 inches by four inches.

C. Standard Chain-Link Tree Guards:
1. Provide Standard Chain-Link Tree Guards as shown on W.M.A.T.A. Standard Drawing ST-C-16, consisting of the following:
a. Chain-link fencing: 9 gauge, 2-inch mesh.
b. Posts: 2.7 pounds per foot “H”, or 1-1/2 inches inside diameter.
c. Brace rails: 1-5/8-inch outside diameter.
d. Stretcher bars: 1/4-inch by 3/4-inch.

D. Temporary Enclosures and Wrapping:
1. Provide temporary enclosures and wrapping at the Contractor's option:

E. Tree Wound Paint:
1. Provide standard bituminous tree wound paint.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protection of In-Place Conditions
1. Protect and maintain benchmarks and survey control points from disturbance during construction..
2. Protect existing site improvements to remain from damage during construction.
a. Restore damaged improvements to their original condition, as acceptable to Owner.
3. Tree Protection:
a. Locate and clearly flag trees and vegetation to remain or to be relocated.
b. Erect and maintain temporary enclosures or wrappings around the drip line of individual trees, or around the perimeter drip line of groups of trees, to remain.
1) Do not store construction materials, debris, or excavated material within drip line of remaining trees.
2) Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
c. Where shown on the drawing, protect trees with standard wood or chain link tree guards.
d. Do not excavate within the drip line of trees, unless otherwise indicated in the Contract Documents.
e. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems.
1) Use narrow-tine spading forks, comb the soil to expose roots, and cleanly cut roots as close to the excavation as possible.
2) Cover exposed roots with burlap and water regularly.
3) Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

4) Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
5) Cover exposed roots with wet burlap to prevent roots from drying out.
6) Backfill with soil as soon as possible.

B. Surface Preparation:
1. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Demolition / Removal:
1. Remove existing above-grade and below-grade improvements as indicated in the Contract Documents and as necessary to facilitate new construction.
2. Locate, identify, disconnect, and seal or cap off facilities indicated to be removed.
a. The Owner will arrange to shut off the indicated facilities when requested to by the Contractor.
3. Excavate for and remove underground facilities indicated in the Contract Documents to be removed in accordance with the requirements specified in Section 31 20 00, Earth Moving.
4. Where indicated in the Contract Documents, remove slabs, paving, curbs, gutters, and aggregate base in accordance with the requirements specified in Section 02 41 00, Demolition.
a. Unless existing, full-depth joints coincide with the line of demolition, neatly saw-cut the length of the existing pavement to remain before removing existing pavement.
1) Saw-cut faces vertically.

3.02 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
1. Removal includes digging out stumps and obstructions and grubbing roots.
2. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below the exposed subgrade.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated in the Contract Documents.
1. Place fill material in horizontal layers not exceeding 8-inch loose depth, and compact each layer to a density equal to adjacent original ground.

3.03 SELECTIVE TREE AND SHRUB REMOVAL AND TRIMMING

A. Do not remove trees, shrubs, and other vegetation indicated in the Contract Documents to remain or to be relocated.
1. Use only hand methods for grubbing within the drip line of remaining trees.
2. Cut minor roots and branches of trees indicated in the Contracdt Documents to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.

B. Remove tree branches which extend over structure neat lines, and are less than 20 feet above the top of rail or existing surface, whichever is higher.

C. Remove tree branches which create a hazardous condition.

D. Remove branches so the tree presents a balanced appearance.

E. Treat scars resulting from removal of tree branches with a heavy coat of tree wound paint.

3.04 EARTH STRIPPING AND STOCKPILING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered so intermingling the topsoil with the underlying subsoil or other waste materials is prevented.
   1. Strip surface soil of unsuitable topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from the edge of excavations without intermixing it with the subsoil.
   1. Grade and shape stockpiles to drain surface water.
   2. Limit the height of topsoil stockpiles to 72 inches.
   3. Do not stockpile topsoil within the drip line of remaining trees.
   4. Stockpile surplus topsoil, and allow for respreading deeper topsoil in accordance with the requirements specified in Section 32 90 00, Landscaping.
   5. Cover to prevent windblown dust.

3.06 REPAIR / RESTORATION

A. Damaged Trees and Vegetation:
   1. In a manner approved by the Authority Representative, repair or replace trees and vegetation that the Contract Documents indicate are to remain, but that have been damaged by construction operations,.
      a. Have the Arborist submit details of proposed repairs to the Authority Representative for approval, and after approval repair damage to trees and shrubs.
      b. Replace trees that cannot be repaired and restored to full-growth status, as determined by the Arborist.

B. Topsoil, Seeding, and Sodding:
   1. Repair areas requiring topsoil, seeding, or sodding in accordance with the requirements specified in Section 32 91 00, Planting Preparation.

3.07 CLEANING

A. Remove tree protection enclosures or wrapping when construction is complete.

B. Waste Management:
   1. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.
   2. 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.

a. Obtain permits and releases from each owner of property where debris will be deposited that absolve the Authority of responsibility in connection with such disposal, and submit the permits and releases to the Authority Representative.

3. Burning and burying debris on site is prohibited.

3.08 PROTECTION

A. Trees, Shrubs, and Plants:

1. Nurture protected and replaced trees, shrubs, and plants during the period of this Contract.

END OF SECTION

SECTION 31 20 00

EARTH MOVING

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies grading, excavating and backfilling for structures and utility facilities.

B. Related Work Specified Elsewhere:

1. Section 02 41 00 – Removal of existing construction and facilities.
2. Section 02 42 13 – Deconstruction of Structures.
3. Section 31 12 00 – Site Clearing.
4. Section 31 23 19 – Dewatering.
5. Section 31 50 00 – Excavation Support and Protection.
6. Section 31 40 00 – Shoring and Underpinning.
7. Section 33 00 00 - Utilities.

C. Salvage:
1. Materials shown to be salvaged in accordance with Section 02 42 13, Deconstruction of Structures and the Special Provisions.

1.02 REFERENCES

A. Definitions:
1. *Grading*: Shaping earth and rock through the removal or filling of earth and rock materials.
2. *Earth Excavation*: Excavation of materials of whatever nature, except rock as defined below.
3. *Rock Excavation*: Excavation of material in place which cannot be loosened or broken down by ripping using earth excavating equipment and which requires blasting or rock excavating equipment for its removal.
4. *Approved Material*: Earth which meets specified measurable requirements for use as embankment, fill or backfill.
5. *Surplus Excavated Material*: Approved excavated material which is not used in embankments or as fill on site.
6. *Unsuitable Material*: Material which does not meet specified requirements for use in situ or as embankment, fill or backfill and is prohibited for use in the work.
7. *Authorized Excavation*: Excavating to neat lines and limits shown and specified; excavating unsuitable material.
8. *Unauthorized Excavation*: Excavating materials which would otherwise be left in place; excavation which is not specified as authorized excavation, such as excavation beyond neat lines and bottoms of footings as shown.
9. *Excess Excavation*: Excavating materials beyond or below cross section shown, as well as unavoidable over breakage in rock.
10. *Controlled Low Strength Materials (CLSM)*: Fill.

B. Reference Standards:
1. U.S. Government:

a. Federal Transit Administration:
1) 49 CFR 661 Buy America Requirements.
2. American Association of State Highway and Transportation Officials (AASHTO)
a. AASHTO: M147-65-UL – Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
3. ASTM International (ASTM)
a. ASTM C33/C33M – Standard Specification for Concrete Aggregates
b. ASTM D75/D75M – Standard Practice for Sampling Aggregates
c. ASTM D698– Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600kN-m/m^3))
d. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
e. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
f. ASTM D6938 – Standard Test Methods for Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.03 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and the additional requirements as specified for each:
1. Samples:
a. Submit sample 21 days in advance of desired date of approval. Two one- cubic-foot samples are required of each material proposed for fill, backfill and embankments.
b. Obtain, identify and ship soil and aggregate samples in accordance with ASTM D75.
2. Certificates:
a. Buy America Act Certification.
3. Special Procedure Submittals:
a. Property owner permits and releases for disposal of excavated material.
b. Plan for tunneling or jacking of utility facilities.
4. Test and Evaluation Reports:
a. Certified Test Reports: With samples of materials proposed for fill, backfill and embankment, submit certified test reports of tests performed by an approved Independent Testing Agency for all tests required to demonstrate compliance with specified requirements.

1.04 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
1. Jurisdictions Having Authority:
a. Comply with codes and regulations of the jurisdictional authorities.
b. 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.

B. Certifications:
1. Buy America Act Certification:
a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

b. Submit the Buy America Act Certification to the Authority Representative (AR) for approval.

1.05 JOB CONDITIONS

A. Existing Drainage:
1. Preserve, protect and maintain existing operable drains and sewers during grading operations.
2. Keep excavations dry.

B. Accident Prevention and Safety:
1. Perform work in accordance with specified safety requirements and PROTECTIVE DEVICES article of the Special Provisions.

C. Location of Underground Facilities and Structures:
1. Locations shown for utility facilities are approximate.
2. Utility facility locations and site investigations are listed in the Special Provisions.
3. Contact Miss Utility to have utilities located before beginning excavation.

D. Toxic and Combustible Substances:
1. During excavation, provide detection and testing equipment and carry out necessary tests to detect the presence of toxic and combustible substances.
2. Take action to safeguard persons and property in accordance with the rules and regulations of the jurisdictional agencies and utility owners.
3. Promptly notify utility owners when problems concerning their facilities become apparent.

E. Ramps:
1. Construct temporary ramps as necessary to provide access to work area.
2. Locate such access ramps in Contractor's storage, operations and access areas or within excavation for subway structure and maintain traffic as specified.
3. Support ramp excavation in accordance with Section 31 50 00.
4. When ramps are in use, station flag persons equipped with red flags at ramp entrances to keep unauthorized vehicles or persons from entering work area.
5. When work necessitating entrance or exit of vehicles via ramps is not being performed, protect entrances and exits of ramps by warning signs, barricades and fences in accordance with the Special Provisions.
6. Upon completion of the work needing ramps, remove the ramps in accordance with Section 31 50 00; backfill excavated ramp areas, if necessary.

F. Excavation Near Buildings:
1. Control excavation in areas near buildings or structures to maintain stability of buildings or structures. If underpinning is necessary, perform excavation work in accordance with Section 31 40 00, so that condition of surrounding area remains unimpaired.

PART 2 - PRODUCTS

PART 1

PART 2

PART 1

PART 2

2.01 EQUIPMENT

A. Use appropriate equipment in sufficient quantity and sizes to perform the work as specified and shown.

PART 1

PART 2

2.02 MATERIALS

A. Embankment, Fill or Backfill Materials:
   1. Composition:
      a. Well-graded soil-aggregate mixture, as defined by ASTM D2487, comprised of stone, gravel, sand, silt, clay or combinations of such materials.
      b. Prohibited material: Organic matter, debris, cinders and frozen material.
   2. Additional requirements:
      a. Particle size: Four inches maximum, but not exceeding one inch within one foot of finished grade.
      b. Liquid limit: Forty maximum, determined in accordance with ASTM D4318.
      c. Plasticity index: Ten maximum, determined in accordance with ASTM D4318.
      d. Maximum dry density: Not less than 100 pounds per cubic foot.

B. Select Material: AASHTO M147-65-UL, with the following gradation requirements:

Sieve Designation	Percentage Passing By Weight
Two inch	100
One inch	70 - 95
3/8 inch	35 - 75
Size 4	25 - 60
Size 10	15 - 45

Size 40	10 - 30
Size 200	0 - 15

C. Pervious Material:
   1. Natural, clean, free draining sand conforming to the requirements of ASTM C33/C33M except the following:
      a. Material passing Size 100 sieve not to exceed eight percent.
      b. Material passing Size 200 sieve not to exceed five percent.
   2. Drainage Material: Clean, crushed, rock, gravel, with 1-1/2 inch maximum particle size and maximum two percent by weight passing Size 4 sieve.
   3. Below concrete walks and slabs: ASTM C33/C33M, Size No. 67, except maximum two percent by weight passing Size 4 sieve.

D. Impervious Material:
   1. Silt-clay material minimum 35 percent by weight passing Size 200 sieve.
   2. Plasticity index: 11 minimum, determined in accordance with ASTM D4318.

2.03 SOURCE QUALITY CONTROL:

A. Use materials for embankment, fill or backfill from this Contract if they meet specified requirements. If sufficient material meeting these requirements is not available from this Contract, obtain material meeting specified requirements.

B. Use only material whose quality, source and zone of placement in the fill have been approved.

C. Dress and shape borrow areas provided by the Authority to ensure positive drainage when borrow operations are completed.

PART 3 - EXECUTION

3.01 EARTH EXCAVATION

A. Excavate in sequences and stages as specified, and in a manner which will not impair permanent or temporary structures, installations or surfaces.

B. Excavate to neat lines or set back lines for mixed face conditions and grades shown. If approved, slopes may be flattened as a matter of expediency.

C. Support sides of excavation as specified in Section 31 50 00, Excavation Support and Protection.

D. Protect, support and maintain utility facilities as specified in Section 33 00 00, Utilities.

E. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to the facility owner.

F. Control runoff so that water does not run through excavation area. Keep excavation free of water.

G. Remove excavated materials to fill, embankment, stockpile or disposal locations. Keep haul routes clean in accordance with the Special Provisions.
   1. Permits for disposal of excavated material:
      a. Obtain written permits and releases from owners of property where material will be deposited, and submit the permits and releases to the Authority Representative.
      b. Each permit and release from each property owner will absolve the Authority from responsibility in connection with such disposal of the material.

H. Fill excess excavations with approved materials and compact as specified.

I. Unauthorized excavation for the purpose of obtaining materials for resale or for use at another job site is prohibited unless otherwise approved by the Engineer.

3.02 REMOVAL OF SUBSURFACE OBSTRUCTIONS

A. Permanent Closure walls:
   1. Prior to removal of parts of vaults or areaways which extend into Contract limits, build permanent closure walls where shown in such vaults or areaways to separate areas to be left intact from areas to be removed.
   2. Obtain the Engineer's approval of permanent closure wall design prior to its installation.

B. Remove vaults, areaways and foundation walls as shown.

3.03 EMBANKMENT, FILL AND BACKFILL

A. Place embankment, fill and backfill in eight-inch loose layers, unless otherwise shown, for entire width so that each layer can be uniformly and properly compacted.

B. Compaction Adjacent to Structures:
   1. Compact embankment, fill or backfill materials within five feet of retaining walls, abutments or other structures using lightweight compactors.
   2. Do not overstress structures.
   3. Backfilling against new structures without approval is prohibited.

C. Avoid accumulation of large pieces of material at one location. Fill voids and interstices with finer materials.

D. In confined areas, use approved power-actuated compactors to achieve required density.

E. Prior to compaction, adjust moisture content of material within required limits by drying or watering either at material source or on fill.

F. Leave struts, braces, lagging and timber sheathing in place as long as needed to support excavation and adjacent facilities and structures.

G. Where utility facilities and structures are supported in place, use special equipment and techniques as required to achieve specified compaction under and around them.

H. Do not place backfill on subway structures until requirements for curing and waterproofing have been complied with and, if required, until test cylinders for particular structure indicate that concrete has attained specified compressive strength.

I. When backfilling against structures, place material approximately simultaneously on both sides of structures to equalize opposing horizontal pressures.

J. When backfilling on tops of structures, place material in six-inch lifts over full area.

K. Under concrete floor and other slabs on grade, place drainage material directly on prepared subgrade which meets density and elevation requirements. Compact with hand-operated plate-type vibratory compactor.

L. Prior to placing embankment against slope greater than one vertical to four horizontal, cut benches into existing slope. Height of bench not to exceed two feet unless otherwise approved.

M. Maintain embankment, fill and backfill in stable, well-drained condition.

N. Where approved, dispose of surplus excavated material by widening embankments and flattening slopes.

O. Where pervious material will be exposed to erosion, cover it with 12-inch layer of approved impervious material compacted in place.

3.04 EXCAVATION OF UNSUITABLE MATERIALS

A. Remove unsuitable materials from the site.

B. Replace unsuitable material with approved material and compact as specified.

3.05 PREPARATION OF GROUND AS SUBGRADE

A. Where the subgrade is on original ground or in cut or where embankment or fill is less than one foot, fulfill compaction requirement for 12 inches minimum below final subgrade.

B. If necessary, scarify original ground and adjust moisture content prior to compacting.

3.06 TUNNELING FOR OR JACKING OF UTILITY FACILITIES

A. Location of facility, method of construction, type of equipment and procedures: As approved by the Authority Representative.

B. Submit a tunneling plan, prior to tunneling.
   1. Include in the plan the location of the facility, the method of construction, the types of equipment and the procedures proposed.

2. Procedure for field determination of soil bearing capacity, including description of the equipment to be used, and any calibration curves for the various soil types to be encountered, details of field test procedures, forms for reporting of test data/results and details of minimum number of tests required for each footing/base area.

3.07 SITE QUALITY CONTROL

A. Allowable Tolerances:
   1. Construct finished subgrade to vary not more than 0.05-foot above or 0.10-foot below elevation shown.
   2. Complete embankment slopes to plus-or-minus 0.5 foot of slope line shown.
   3. Maintain moisture content of embankment, fill or backfill material within plus-or- minus three percent of optimum moisture content of material.
   4. Compact each layer of embankment, fill or backfill to 95 percent of maximum dry density as determined in accordance with ASTM D698, at moisture content within tolerance specified, except the following:
      a. From upper surface of fill or backfill to a plane 12 inches below subbase level of vehicular pavement, sidewalks, trackbeds and structural foundations to 100 percent of maximum dry density at moisture content within tolerance specified.
      b. In areas of 95-percent compaction where utility facilities are located in fill and are not supported on concrete cradles, compact material for a depth of one foot directly below bottom of facility to 100 percent of maximum dry density at moisture content within tolerance specified.

B. Site Tests and Inspection:
   1. Determine the maximum dry density and the optimum moisture content in accordance with ASTM D698.
   2. Determine in-place density and moisture content in accordance with ASTMD6938, or other test methods acceptable to the Authority Representative.

3.08 CLEANING

A. On completion of work, clean ditches and channels.

B. Slope and shape borrow areas to provide positive drainage.

C. Remove unsuitable and surplus excavated materials to locations outside the Authority's right-of-way in accordance with article 3.01 paragraph G sub-paragraph 1.b. of this section.

D. Leave site in neat, presentable condition.

END OF SECTION

THIS PAGE

INTENTIONALLY

LEFT BLANK

SECTION 31 23 19

DEWATERING

PART 1 – GENERAL

1.01 SUMMARY

A. This section specifies general dewatering systems for control of groundwater and removal of surface water during construction.

1.02 REFERENCES

A. Reference Standards:
   1. U.S. Government:
      a. Federal Transit Administration:
         1) 49 CFR 661 Buy America Requirements.
   2. ASTM International (ASTM):
      a. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      b. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
      c. ASTM D2564 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. The Contract Specifications govern requirements for access to areas outside Contract limits.
   2. Coordinate installation and operation of dewatering system and piezometers with others concerned and with other Authority contractors if applicable.
   3. If an adjoining Authority contract requires installation of portions of the adjoining contract dewatering system or piezometers within Contract limits, allow access for installation.

1.04 DESIGN AND PERFORMANCE CRITERIA

A. Provide dewatering system which will reduce hydrostatic pressure and lower groundwater levels below excavation levels excluding mined tunnels, as necessary for safe and proper prosecution of the work and which will result in obtaining stable, substantially dry subgrade for prosecution of subsequent operations.

B. For mined earth tunnels, provide dewatering system which will reduce hydrostatic pressure and control groundwater in soil surrounding each tunnel to prevent the following:
   1. Heaving of the invert, hazardous seepage, and flow of soil in tunnel face.
   2. Loss of ground and surface subsidence.

C. For mined earth tunnels in pervious soils, lower groundwater to two feet below invert or reduce hydrostatic pressure to a point where tunneling proceeds without groundwater related delay and loss of ground.

D. For mined earth tunnels where impervious soils extend above invert, lower groundwater level to two feet above top of lowest impervious soil layer or reduce hydrostatic pressure to a point where tunneling proceeds without groundwater related delay and loss of ground.

1.05 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Type of dewatering system proposed, showing arrangement, location and depths of proposed system, complete description of equipment and materials to be used, installation procedure, well and piezometer development procedures, maintenance plan for dewatering system and piezometers, standby equipment and standby power supply (if required), and proposed location of points of discharge of water and settlement measuring procedure.
      b. Obtain approval of jurisdictional agencies prior to installation of system.
   2. Certificates:
      a. Buy America Act Certification.
   3. Special Procedures Submittals:
      a. Submit Falling Head Test Reports to the Authority Representative as specified in this section.
      b. Submit Rising Head Test Reports to the Authority Representative as specified in this section.
      c. Submit Static Water Level Readings to the Authority Representative as specified in this section.
      d. Observe and record average flow rate and time of operation of each pump used in dewatering system. Provide appropriate devices, such as totalizing flow meters for observing flow rates. Provide interior dewatering well drop tube and exterior filter piezometer to observe and record operating levels and filter levels. Submit data on approved form and in approved format during period dewatering system is in operation.
      e. Observe and record elevation of groundwater in the piezometers, including those previously installed, on approved form and in approved format, during the period that dewatering system is in operation. Sound depth to bottom of each piezometer monthly to ensure that soil particles are not building up in standpipe. Submit observation records promptly, regularly and as directed by the Authority Representative.
      f. During dewatering, make observations daily. After dewatering levels have stabilized, observations frequency may be reduced as approved by the Authority Representative.
      g. Submit to the Authority Representative a maintenance schedule for piezometers and dewatering system. Record and submit to the Authority Representative maintenance records for each piezometer and dewatering well or dewatering system component weekly or as approved by the Authority Representative.
      h. Provide drill logs and installation details of all dewatering system components, and piezometers, to the Authority Representative 24-hours after installation.

1.06 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
   1. Authorities Having Jurisdiction:
      a. Comply with codes and regulations of the jurisdictional authorities.
   2. 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. Qualifications:

1. Dewatering System Specialist:
    a. For mined earth tunnels, have the design, implementation, evaluation, and maintenance of the dewatering system under the supervision of a specialist with a minimum of five years experience in responsible control of work similar to that proposed.

C. Certifications:
1. Buy America Act Certification:
    a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.
    b. Submit the Buy America Act Certification to the Authority Representative for approval.

1.07 SITE CONDITIONS

A. Existing Conditions:
1. Subsurface Conditions:
    a. Reports of subsurface investigations are available as listed in the Special Provisions.

1.08 JOB CONDITIONS

A. Permits:
1. Prior to discharging water, obtain permit from jurisdictional agency and submit the permits to the Authority Representative.
2. Control discharge of water in accordance with the Special Provisions.

B. Responsibilities:
1. Design and install dewatering system to accomplish groundwater control as specified.
2. Monitor, and report as required, discharge from dewatering system to determine if water quality meets the requirements of jurisdictional agency. Modify dewatering system as necessary to meet the requirements of jurisdictional agency.
3. Measure to determine if movement occurs in adjacent areas by dewatering operations; take approved measures to minimize movement and prevent damage to affected properties, buildings, structures, utilities or facilities. Establish criteria for acceptable tolerances.
4. Take measures to prevent damage to properties, buildings, structures, utilities and facilities resulting from groundwater pumping.
5. Modify system if it causes, or threatens to cause, damage to properties, buildings, structures, utilities or facilities.
6. Contract Drawings may designate locations where lowering of groundwater will not be permitted.
7. Locations of dewatering system elements and piezometers may be adjusted in field to suit job conditions, as approved.
8. Operate dewatering system without interruption until directed otherwise.

PART 2 – PRODUCTS

2.01 PIEZOMETERS

A. See Soil & Geological Standard Drawing Piezometer Details as shown.

B. Piezometer construction shall use ASTM-specified materials and procedures (D2466, D1785, and D2564).

PART 3 – EXECUTION

3.01 PREPARATION

A. Piezometers:
   1. Prior to dewatering operations, install piezometers at locations shown or as approved and to the depths shown or approved.
   2. Verify installed piezometer tip elevation. Reinstall piezometers which do not comply with requirements at no additional cost to the Authority.
   3. 48 hours after completion of each piezometer installation, prove proper functioning of piezometer by performing Falling Head Tests. Within 24 hours of test completion, submit Falling Head Test records to the Authority Representative.
   4. Take static water level readings prior to energizing dewatering system. Within 24 hours of observation, submit water level readings to the Authority Representative.

3.02 SURFACE DRAINAGE:

A. Intercept and divert surface drainage away from excavations, piezometers and dewatering wells by use of dikes, curb walls, ditches, pipes, sumps or other means.

B. Design surface drainage systems to prevent erosion.

C. Remove surface drainage system when no longer required.

D. Remove debris and restore site to original conditions.

3.03 DRAINAGE OF EXCAVATED AREAS:

A. Provide and maintain ditches of adequate size to collect surface and subsurface water and divert it into sump for draining or pumping into channels or storm sewers, as approved.

B. Install settling basins, tanks or other approved apparatus as necessary to bring the discharge into compliance with permit requirements.

C. When no longer necessary, backfill and seal drainage ditches, sumps and settling basins with approved material.

3.04 DEWATERING:

A. Coordinate dewatering installation to prevent conflict with other construction activities.

B. Install dewatering system in accordance with approved drawings and procedures. If site conditions require modification of the dewatering system, implement modifications to achieve specified design criteria prior to excavation.

C. Demonstrate by approved methods that discharged sand content from each well meets the requirements specified in article 1.04, Design Criteria.

D. Discharge subsurface water clear of the work area.

E. Maintain continuous and complete effectiveness of the installation through regularly scheduled maintenance of well screens, pumps, piezometers, electrical and piping systems.

F. Maintain water level so that no damage to structure can occur.

G. During backfill operations, the extent of dewatering may be reduced when approved, provided water level does not result in uplift pressure in excess of 80 percent of downward pressure produced by weight of structure and backfill in place.

H. At locations of piezometers in mined earth tunnel sections, reduce water level to specified criteria at least 48 hours in advance of tunnel excavation.

I. Maintain dewatering operations until permanent tunnel lining has been installed.

J. Piezometers:
   1. While dewatering system is in operation, prove continued proper functioning of each piezometer by performing rising head tests. Submit test records within 24 hours of test completion.
   2. Operate dewatering system so that groundwater level in piezometers is maintained continuously within prescribed limits.
   3. Protect and maintain piezometers in good operating condition until completion of Contract.
   4. Replace promptly any piezometer or dewatering well that is damaged or destroyed.
   5. Terminate piezometer readings when approved by the Authority Representative.

3.05 REPAIR / RESTORATION

A. Repair as approved, damage, disruption or interference to properties, buildings, structures, utilities or facilities resulting from dewatering operations.

3.06 CLEANING

A. Portions of System to be Left in Place:
   1. When specified, leave portions of dewatering system in place.

B. Portions of System to be Removed:
   1. Upon completion of Contract, remove piezometers and well casings, unless otherwise specified, to a depth of two feet minimum below ground surface.
   2. Backfill voids, well and piezometer casings with bentonite-cement grout.
   3. Backfill remaining space with compacted earth and restore ground surface to its original condition.

END OF SECTION

SECTION 31 40 00

SHORING AND UNDERPINNING

PART 1 – GENERAL

1.01 SUMMARY

A. This section specifies underpinning, supporting and restoring of structures.

B. Related Work Specified Elsewhere:
1. Section 01 53 00 – Temporary Construction.
2. Section 03 10 00 – Concrete Forms and Accessories.
3. Section 03 20 00 – Concrete Reinforcing.
4. Section 03 30 00 – Cast-in-Place Concrete.
5. Section 05 12 00 – Structural Steel.
6. Section 31 08 13 – Pile Load Test.
7. Section 31 09 00 – Geotechnical Instrumentation and Monitoring.
8. Section 31 20 00 – Earth Moving.
9. Section 31 23 19 – Dewatering.
10. Section 31 50 00 – Excavation Support and Protection.

1.02 REFERENCES

A. Definitions:
1. Underpinning:
   a. *Underpinning*: Permanent supporting structure designed to transmit foundation loads to lower bearing levels necessary to securely maintain structure being underpinned. Also includes temporary support necessary to safely perform underpinning work and restoration of structure upon completion of work.
   b. *Temporary support:* Construction required and designed to support structures during underpinning or other construction work.
   c. *Restoration:* Correction by repair or replacement of structure which is damaged, removed or altered by the Contractor in furtherance of his operation equivalent to condition existing prior to start of Contract work unless otherwise shown or specified.
2. Structure categories:
   a. *Category 1 Structures*: Structures for which underpinning is necessary and has been designed.
   b. *Category 2 Structures*: Structures which, because they are likely to be affected by construction operations, the Contractor has the option of supporting temporarily, underpinning or both. The decision rests solely with the Contractor who is entirely responsible for results.

B. Reference Standards:
1. ASTM International (ASTM):
   a. ASTM D1056 – Standard Specification for Flexible Cellular Materials; Sponge or Expanded Rubber.
   b. ASTM D1149 – Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment.

c. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

2. U.S. Government:
   a. Federal Transit Administration:
      1) 49 CFR 661 Buy America Requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Structure Owners:
      a. Prior to starting work on structure, confer with owner or his authorized representative and obtain concurrence with underpinning procedures and sequence of operations including:
         1) Means of access to the construction area.
         2) Permitted areas of operations.
         3) Time restrictions for performance of work which may disturb occupants.
         4) Scheduling of time and durations of outages of utilities and other services to premises as well as of operation of systems within premises.
      b. Notify the Authority Representative three days prior to intended conferences with owner.

1.04 SUBMITTALS:

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Prepare working drawings showing method, staging and necessary details, including computations for construction of underpinning and temporary support of each structure on which work is to be accomplished as well as method of transferring structural load to piles.
      b. Have drawings and computations certified by a registered professional engineer who is licensed to practice in the jurisdiction where the work is to be performed and who is qualified to substantiate extent and design of underpinning work
   2. Certificates:
      a. Buy America Act Certifications.
   3. Special Procedures Submittals:
      a. Obtain written understandings with each structure owner with owner's signature signifying their agreement, and submit written understandings to the Authority Representative.

1.05 QUALITY ASSURANCE:

A. Regulatory Agency Sustainability Approvals:
   1. Authorities Having Jurisdiction:
      a. Comply with codes and regulations of the jurisdictional authorities.
   2. 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. Qualifications:
   1. Licensed Professionals:

a. Registered professional engineer to provide continuous supervision of underpinning operations as specified in sub-paragraph 1.05.B.5.

C. Certifications:
1. Buy America Act Certification:
a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

1.06 JOB CONDITIONS

A. Consents, Permits and Approvals:
1. The Authority will obtain necessary rights from owner for Contractor to occupy construction areas for Category 1 Structures as shown.
2. The Contractor is responsible for obtaining in his own name, other agreements, rights, permits and consents necessary to effect underpinning work, which are to provide for and constitute agreement as to interdependent unitized system of underpinning support, when such system is feasible in the Contractors' opinion. Obtain permits required by jurisdictional agencies. Permits to name property owner and the Authority as co-applicants, when applicable, and the Contractor as their agent. Transmit copies of these instruments to the Authority Representative before starting work on each affected structure.
3. Additional requirements for permits, consents and approvals are contained in the General Provisions. Where plans for existing structures are available, they may be reviewed as specified in the Special Provisions.

B. Responsibilities:
1. Maintain safety, stability and integrity of structures of whatever nature regardless of location which may be affected by the work.
2. Perform underpinning operations in accordance with applicable codes and regulations of the jurisdictional agencies.
3. Perform underpinning operations with qualified personnel under continuous supervision of a registered professional engineer experienced in such work.

PART 2 – PRODUCTS

2.01 PRODUCTS AND MATERIALS

A. Piling: Section 31 08 13.

B. Concrete: Section 03 30 00 Cast-in-Place Concrete, Class 3500 or better.

C. Reinforcement: Section 03 20 00.

D. Structural Steel: Section 05 12 00.

E. Vibration-Isolation Materials:
1. Closed-cell neoprene isolation board conforming to ASTM D1056, Grade 2C5.
2. Self-extinguishing when tested in accordance with ASTM D635.
3. No cracks after exposure to air containing 100 ppm of ozone for 100 hours at 104F with samples under 20 percent strain tested in accordance with ASTM D1149.
4. Water absorption: Not exceeding one percent by weight.

F. Bonding Adhesive: As recommended by the vibration-isolation material manufacturer.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verification of Conditions
   1. Verify by field investigation foundation loads, locations, sizes and conditions of existing structures and footings requiring underpinning and temporary protection.

3.02 DETECTION OF MOVEMENT

A. In accordance with the Special Provisions, provide, install and maintain monitoring equipment to detect horizontal or vertical movement of structures as specified in Section 02291.

B. Inscribe or firmly affix on each column, pile cap, or wall to be underpinned or supported and at additional locations directed by the Engineer, visual methods of determining movements. Method used is optional but to be capable of being read to within 0.005 foot.

C. Take readings daily or more often if necessary during progress of underpinning or support operations and for a period of four weeks after completion of such operations. Frequency of readings may be reduced at specific location(s) with prior approval.

3.03 TEMPORARY PARTITIONS AND CLOSURES

A. Build where shown and as required by property owner, closed, dustproof, weatherproof and burglarproof temporary partitions and closures of suitable materials to isolate work site from remainder of the structure. Comply with local building code requirements.

B. Provide emergency exits, with appropriate hardware.

C. Provide temporary protection against dust and damage from underpinning operations.

3.04 INSTALLATION

A. Excavation:
   1. Excavate underpinning pits in accordance with Section 31 20 00, Earth Moving.
   2. Support excavated surfaces in accordance with Section 31 50 00, Excavation Support and Protection.
   3. Provide and maintain protective fencing and decking in accordance with Section 01 53 00, Temporary Construction.
   4. Dewatering: In accordance with Section 31 23 19, Dewatering.

B. Underpinning:
   1. Perform needling, shoring, cribbing and posting as necessary to ensure that movements damaging to the structure do not occur prior to and during underpinning operations.
   2. Place dry pack mortar, concrete and reinforcing steel in accordance with Section 03 10 00 Concrete Forms and Accessories, Section 03 20 00 Concrete Reinforcing and Section 03 30 00 Cast-in-Place Concrete.
   3. Install structural steel shapes in accordance with Section 05 12 00.
   4. Install piling where shown in accordance with Section 31 08 13.

5. When jacking piles, establish adequate controls to detect movement of structure being underpinned. Maintain suitable equipment and methods continuously available to contain movement should it occur.
6. Remove obstructions encountered when installing steel shell piling by drilling or spudding. Blasting is prohibited.
7. Test installed piling where shown and take remedial action necessary to obtain loading.
8. Use underpinning piles for underpinning purposes only, unless approved.
9. Transfer structural load to piles in accordance with approved procedures.
10. When transfer of loading has been completed and approved, clean pits of foreign matter.

C. Vibration Isolation:
1. Place vibration-isolation material where shown using boards supplied in lengths sufficient for one-piece installation. Apply bonding adhesive at rate recommended by manufacturer of board.

D. Backfill:
1. Place concrete backfill to limits shown.
2. Place and compact earth backfill in accordance with Section 31 20 00, Earth Moving.

3.05 REPAIR / RESTORATION

A. Repair damage to structures caused by work necessary to restore structures to condition existing prior to start of work.

3.06 CLEANING

A. Remove temporary protective installations upon completion of work and restore area to original condition.

B. Restore ground and building surfaces to their original condition.

C. Remove debris and construction materials. Leave site in a neat presentable condition.

END OF SECTION

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 – GENERAL

1.01 SUMMARY

A. This section specifies support for cut-and-cover, open-cut excavation, trench excavation and shafts.

B. Related Work Specified Elsewhere:
1. 01 53 00 – Temporary Construction.
2. Section 03 20 00 – Concrete Reinforcement.
3. Section 03 30 00 – Cast-in-place Concrete.
4. Section 31 09 00 – Geotechnical Instrumentation and Monitoring.
5. Section 31 20 00 – Earth Moving.
6. Section 33 00 00 – Utilities.

1.02 REFERENCES

A. Reference Standards:
1. American Petroleum Institute (API):
   a. API 13A – Specification for Drilling Fluid Materials.
   b. API 13B-1 – Recommended Practice for Field Testing Water-based Drilling Fluids.
2. ASTM International (ASTM)
   a. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.
   b. ASTM A709/A709M – Standard Specification for Structural Steel for Bridges.
   c. ASTM A722/A722M – Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete
3. EPA.
4. U.S. Government:
   a. Federal Transit Administration:
      1) 49 CFR 661 Buy America Requirements.

1.03 DESIGN AND PERFORMANCE CRITERIA

A. Contractor's Options:
1. System of support to consist of soldier piles and lagging, sheet-piling or slurry-trench concrete walls, secured in place by means of bracing members such as wales, struts, shores and ground anchors. Other methods of support permitted only when approved.

B. Design support of excavation in accordance with design criteria shown and specified. Criteria are the minimum acceptable.

C. Design component members of system to support temporary decking system, earth and rock pressures, unrelieved hydrostatic pressures, utility loads, applicable traffic and construction loads and other surcharge loads. Use loading combinations shown. Prepare design for staged removal of bracing to suit sequence of concrete placement.

D. Design support system for nonpenetration of station and entrance surfaces visible to public. Temporary penetration permitted only where location of penetration is eventually to be hidden by elements such as acoustical panels or similar items.

E. Design sheeting and bracing for sides of excavations for underground structures in a manner permitting safe and expeditious construction of permanent structures, minimizing movement or settlement of the ground and preventing damage to adjacent buildings, structures and utility facilities. Locate and design the bracing system such that it will not interfere with the reinforcement and construction of the permanent structure.

F. For support systems in which struts are installed between opposite sides of the excavation, design and construct support of both sides to obtain comparable rigidity.

G. Choose location of soldier piles to allow for expected deviations from true line during driving procedure without encroaching on future permanent structures.

H. Approval of Contractor's plans and methods of construction does not relieve the Contractor of the responsibility for adequacy of support.

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
   1. Product Data:
      a. Concrete mix design for slurry trench walls.
   2. Shop Drawings:
      a. Details,arrangement and method of assembly of proposed system, including construction sequence.
      b. Method of preloading and bracing.
      c. Elevations and sections showing full excavation depth from top grade to bottom of soldier piles or subgrade, whichever is deeper.
      d. Loads for various stages of bracing removal and concrete placement.
      e. Anticipated equipment load.
      f. Maximum design load to be carried by various members of support system and preloads.
      g. Depths below main excavation to which support system will be installed.
      h. Methods of resolving difficulties arising from misalignment of soldier piles exposed during excavation and criteria for implementation of those procedures.
      i. Methods of controlling and monitoring vibrations caused by driving of soldier piles to prevent damage to structures and utility facilities.
      j. If proposed support system includes tieback anchors, show geologic profile or section for which each anchor is intended, design load for full depth of the excavation, maximum design and proof load and criteria proposed for deformations under proof loads.
      k. Ground anchors and rock bolts:
         1) Prior to starting work, submit support system tieback and rock bolt details including design calculations, installation and load test procedures, grouting materials, grouting methods and detailed working drawings of the proposed rock bolt system.
         2) Show geologic profile or section for which each ground anchor or rock bolt is intended and design load of ground anchor and rock bolt for full excavation condition.

l. Include design calculations and maximum theoretical deflections of support members. The maximum allowable deflections of support members are as follows:
Soldier beams: 1/2-inch
Walers: 1/4-inch
This does not include the movement of support due to creep in tieback.
m. Include existing utility facilities. After checking their locations by field investigations, revise drawings to show actual locations of facilities, location of excavation supports, interference with proposed work and measures proposed to overcome such interferences.

3. Certificates:
   a. Buy America Act Certification.
4. Delegated Design:
   a. Calculations:
      1) Design calculations as applicable. Do not proceed with work prior to approval of applicable design calculations.
5. Special Submittal Procedures:
   a. Property owner permits for the installation of excavation support system tieback anchors or rock bolts.
   b. Submit copies of permits with drawings.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
   1. Authorities Having Jurisdiction:
      a. Comply with codes and regulations of the jurisdictional authorities.
   2. 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:
   1. Buy America Act Certification:
      a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

1.06 JOB CONDITIONS

A. Provision for Contingencies:
   1. Monitor performance of components of support system, both vertical and horizontal movement in accordance with Section 31 09 00 – Geotechnical Instrumentation and Monitoring, at regular intervals not to exceed three days.
   2. Provide contingency plan or alternative procedures to be implemented if unfavorable performance is evidenced.
   3. Keep on hand materials and equipment necessary to implement contingency plan.

B. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to utility owner.

C. If existing utility facilities interfere with proposed method of support, modify or relocate such facilities with the approval of the appropriate utility owner. If relocation of the utility is not possible, obtain the Authority Representative's approval for field changes to the approved support scheme of the excavation.

D. Do not splice elements of support system unless approved.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Steel Sheet Piles:
1. Continuous interlocking type with cross section selected for intended use.

B. Cast-In-Place Structural Concrete:
1. Provide Cast-in-Place Structural Concrete as specified in Section 03 30 00 – Cast-in-Place Concrete, Class 3500 unless otherwise shown.

C. Provide Timber Lagging:
1. Structural grade, minimum allowable flexural stress of 1,100 psi.

D. Concrete Reinforcement:
1. Provide Concrete Reinforcement as specified in Section 03 20 00 – Concrete Reinforcement.

E. Structural Steel:
1. Provide Structural Steel as specified in Section 05 12 00 and in accordance with ASTM A36 or ASTM A709, Grade 36, minimum.

F. Grout:
1. Provide Grout in accordance with Section 03 30 00.

G. Bentonite Powder:
1. Provide Bentonite Powder in accordance with API 13A.

H. Other Materials:
1. Provide other materials as required which are best suited for intended use, and as approved by the Authority Representative.

I. Concrete Mixes:
1. Lean Concrete: Portland cement and mineral or soil aggregate proportioned so that concrete retains its shape during excavation operations.
2. Concrete for Slurry Trench Walls:
   a. Tremie concrete of 3500 psi strength or higher if necessitated by design, with the following additional requirements:
      1) Minimum cement factor: Seven bags per cubic yard.
      2) Water-cement ratio: As necessary for strength and durability.
      3) Sand proportion: As necessary to produce optimum results.
      4) Rounded gravel aggregate: 1-1/2 inch maximum.
      5) Slump: Six inches plus-or-minus one inch.
      6) With water-reducing or fluidizing agents as necessary.
   b. Submit mix design to the Authority Representative for approval.
3. Bentonite Slurry:
   a. Stable suspension of powdered bentonite, or equal, and natural silts and clays in water.
   b. Density: 64 pcf minimum, 85 pcf maximum.

c. Marsh funnel flow rate: 40 seconds minimum, 80 seconds maximum viscosity.
d. Fluid loss: 25-cc maximum in 30 minutes
e. pH: 7.0 to 11.0
f. Shear strength:
   1) By shearometer: 1.4 to 10 N/M.
   2) By fan viscometer: 4.0 to 400 N/M.

PART 3 – EXECUTION

3.01 INSTALLATION OF EXCAVATION SUPPORT SYSTEM

A. Sheeting, Shoring and Piling:
   1. Install soldier piles by driving, pre-boring or other pre-excavation methods. Drive soldier piles only in those areas where shown or approved. Install piles vertically within tolerance of one foot per each 100 feet for full depth of each pile.
   2. Where piles are installed by pre-boring or other pre-excavation methods, take appropriate measures to stabilize excavation to preclude loss of ground.
   3. Provide pre-bored holes for soldier piles adequate to accommodate pile section shown on approved shop drawings. Extend hole to necessary depth below top of subgrade.
   4. Carry bottom of support system to depth below main excavation, adequate to prevent lateral movement. In areas where additional excavation is required below main excavation subgrade, make provisions to prevent movement of main excavation supports.
   5. Multiple-Layered Horizontal Bracing:
      a. At locations where top of weathered bedrock is above the subgrade of main excavation, install soldier piles so that tips are at least two feet below top of subgrade.
      b. At locations where top of weathered bedrock is five feet or more below subgrade of main excavation, install soldier piles so that lower tip is at least five feet below bottom of excavation.
      c. If weathered bedrock is encountered at elevation between subgrade elevation and five feet below subgrade, install soldier piles so that lower tip is five feet below subgrade or two feet into rock, whichever is higher.
   6. After seating soldier piles in pre-excavated holes, encase piles with Class 3500 concrete up to lowest point of excavation adjacent to pile location. Fill remainder of hole with lean concrete, completely encasing pile.
   7. Use timber lagging, steel sheeting or precast reinforced concrete members secured in place for sheeting of excavations.
   8. Follow excavation closely with placement of sheeting and lagging. Do not allow maximum height of un-sheeted or un-lagged face of excavation to exceed five feet in rock or predominantly clayey soils and three feet in sandy soils.
   9. Do not permit height of un-lagged face to exceed 15 inches if water flows from face of excavation or if soil in face moves toward excavation area.
   10. Carefully perform excavation for installation of sheeting to minimize formation of voids. Separate sheeting members only to extent necessary to permit packing behind them.
   11. Pack behind sheeting as installation progresses to establish tight contact between excavation face and sheeting. Pack openings between sheeting members with straw or other suitable material to allow free drainage of water without loss of soil or sand packing.
   12. If unstable material is encountered during excavation, take suitable measures to contain it in place and prevent ground displacement which may cause damage.
   13. Maintain sufficient quantity of material on hand for sheeting, shoring, bracing and other operations for protection of work and for use in case of accident or emergency.

B. Slurry Walls:

1. Slurry Trench Equipment:
   a. Use equipment capable of removing from trench foreign materials embedded in soil as well as natural materials, including boulders, where necessary. Arrange equipment to permit free vertical passage of slurry within trench and to prevent development of suction or pressure.
   b. Furnish trench inspection tools adequate to ensure that trench has been excavated to dimensions shown on approved shop drawings and that cuttings and foreign material have been removed.
   c. Use slurry mixing equipment capable of producing, with mechanical agitation, a stable suspension of bentonite and water. Transport slurry to panels by temporary pipe line or other approved methods.
   d. Furnish slurry circulation equipment to provide circulation and agitation of the slurry throughout full depth of excavated panels. Do not agitate slurry by air.
   e. Use slurry reclaiming equipment which will remove detrimental quantities of excavated material from slurry to ensure use of clean slurry in trenches. Recirculate reclaimed slurry to trenches in a continuous operation regardless of slurry density. Monitor slurry and control its capability of retaining solid particles in suspension.

2. Construction:
   a. Perform preparatory work to discover, protect, maintain, relocate and restore utility facilities and other obstructions in vicinity of slurry walls.
   b. Construct slurry trench walls by displacement of bentonite slurry with tremie concrete.
   c. Construct walls of reinforced concrete or plain concrete embedded with structural steel. Where soldier piles are used in construction of walls, it is permissible to consider piles as reinforcement.
   d. Provide sufficient embedment of walls below subgrade of excavation to prevent loss of ground due to piping under wall or lateral movement of wall.
   e. Use construction methods ensuring that slurry materials employed during trench excavation and placing of tremie concrete are contained and controlled to prevent leakage and spillage of slurry and excavated materials into basements, vaults, utilities and other facilities.
   f. Excavate slurry wall trenches in panels of width and depth shown on approved working drawings with maximum panel length of 18 feet. Reduce panel length when excavating adjacent to facilities sensitive to settlement.
   g. Maintain level of slurry in panels no more than five feet below top of trench during excavation operations and until tremie placement is essentially completed.
   h. Progress construction with no less than one unexcavated panel and one tremie-filled panel with concrete cured at least 72 hours, between two slurry panels under active excavation.
   i. Keep slurry circulated or agitated during drilling and excavating and immediately prior to concreting. Continuously maintain slurry requirements even during nonworking periods and stoppages. If stoppage occurs in the operation causing slurry in panel to remain uncirculated and unagitated for more than 24 hours, backfill panel until operation can be resumed.
   j. Place concrete by tremie methods either by gravity flow or by pumping. As soon as possible after placement of concrete is commenced, position bottom of pipe not less than five feet below upper surface of concrete being placed and maintain it in this position throughout operation. Equip tremie pipe with bottom valve or other device to prevent mixing of slurry with concrete inside tremie pipe. Aluminum pipe is prohibited.
   k. Inspect trenching in the presence of the Authority Representative prior to concreting. Ensure that settled cuttings and excavated material have been removed.

l. Start placement of concrete in panels within 12 hours after completion of panel excavation and proceed continuously until concreting is completed.
m. When wales are used, obtain tight bearing between wales and wall and ample bearing area with wedges and dry pack for load transfer.
n. Preload braces at each level to computed maximum compressive force to be encountered at that level. Base calculations of this computed force upon pressure diagrams shown. Take into consideration increased strut loads that may develop because of removal of bracing as structure is built.
o. Accomplish preloading by approved procedures. Transfer load by jacking applied symmetrically to braces without introducing eccentricity.
p. Introduce jacking load into braces immediately after each tier of braces has been installed and before excavation has progressed more than two feet below bottom of bracing tier. Make provision to fix preload into each brace by shim plates, wedges, blocking or other approved device.
q. After concrete invert slab has been placed and attains sufficient strength to receive loads from slurry walls, remove tiers of bracing above invert level, provided the following conditions exist:
    1) Remaining tiers are capable of resisting total load calculated from trapezoidal pressure diagrams shown.
    2) Calculated deflection of the walls between tiers of bracing, assuming forces indicated by the trapezoidal pressure diagrams, does not exceed 1/2 inch.
r. Construct tight joints between adjacent pours of concrete in slurry wall to minimize loss of fines from retained earth. Take necessary care to accomplish this in terms of properly excavating trench and cleaning abutting face of hardened concrete or surfaces of structural members if used. Provide approved method of water stopping.
s. Seal leaks encountered in walls as excavation progresses, if leaks are of sufficient size to permit penetration of fines and loss of ground. Procedures may include grouting outside or through wall.
t. Dispose of unsuitable excavated material and debris in accordance with Section 31 20 00, Earth Moving.
u. Dispose of slurry waste offsite by means of sealed tanks and in accordance with EPA regulations.

C. Primary Support:
1. Use wales, struts, tieback anchors and rock anchors as necessary to provide primary support of excavation faces retained by soldier piles, sheeting, sheet piles or concrete slurry walls. For excavation depths greater than eight feet, primary support or supports are required.
2. Provide struts with intermediate bracing as needed to enable them to carry maximum design load without distortion or buckling.
3. Provide diagonal bracing as needed to maintain stability of system.
4. Include web stiffeners, plates or angles as needed to prevent rotation, crippling or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.
5. Install and maintain primary support members in tight contact with each other and with surface being supported.
6. Design primary support members to support maximum loads occurring during excavation or removal stages.
7. Preloading:
    a. Except for ground anchors and slurry wall bracing, preload primary bracing members including struts, shores, wales carrying axial load, and similar members at installation to 50 percent of design load, which for this purpose is maximum load that

bracing member will have to carry. Preload tiebacks and slurry walls as specified for those installations.

b. Use procedures that produce uniform loading of bracing member without appreciable eccentricities or overstressing and distortion of members of wall system.
c. Make provisions for permanently fixing load in each member using steel shims or wedges welded into place.
d. Accomplish preloading by jacking support in place against soldier piles or wales.
e. Do not use wooden wedges to preload bracing member.
f. Include in preloading system means to determine within five percent amount of preload induced into bracing members.

8. If decking beams are not required or if decking beams are not designed for support of excavation loads, install uppermost tier of bracing at vertical distance of not more than six feet below top of excavation.
9. Install tiers of primary support with no greater vertical distance between them than 16 feet.
10. Reduce maximum vertical distance to 12 feet at locations where ground movement and settlement must be minimized to prevent damage, where shown and as directed.
11. Excavate to no more than two feet below point of support about to be placed. Install support and preload immediately after installation and prior to continuing excavation.

D. Support System with Tiebacks:
1. Install tieback system in accordance with approved shop drawings. Install anchorage in soil no closer than a plane extending upward at an angle of 45 degrees to the horizontal from outer limit of lowest depth of excavation.
2. Proof Loading:
a. Stress tiebacks to proof loads equal to 140 percent of maximum design load and maintain proof load for 30 minutes prior to reducing to design load. Reject tiebacks which lose more than five percent of proof load during 30-minute period.
b. Apply proof loads in increments of five tons at one-minute intervals and provide means to measure load application within accuracy of plus-or-minus five percent.
3. After reducing tieback load to design load, encase anchors in grout maintaining design load until anchors are fixed in place.
4. In transfer of loads from jacks to support system, use fixation method which will limit load loss to no more than five percent of design load.
5. Provide and maintain convenient access and appropriate means to accomplish these observations.
6. Preliminary And Creep Tests On Tiebacks:
a. Reapply proof loads equal to 140 percent of design load at each level of support in excavation on first installation on each side of excavation at horizontal intervals not exceeding 500 feet and wherever there is significant difference in soil in which tiebacks are installed.
b. As specified for proof loading, apply proof loads in increments of five tons at one-minute intervals. Provide means to measure load applications with an accuracy of plus-or-minus five percent of design load. Maintain proof load for 24 hours prior to reducing it to design load.
c. Make records of axial movement with incremental applications of load as well as amount and time of load fall-off with no pumping of jack or axial movement during 24-hour period that proof load on tieback is maintained. If during 24-hour period axial deformation of tieback system exceeds 0.02 inch or decrease in jack pressure without pumping is more than five percent after correcting for temperature changes during the test period, redesign tieback system to satisfy requirements.
7. Rock Bolts:

a. Tension rock bolts to their design load as approved to permit checking of each loading by the Engineer.
b. If grouted rock bolts are used, after loading has been approved, pressure-grout each permanent rock bolt in place using methods and equipment which will ensure elimination of air from bolt hole.
c. If fully resin-encapsulated bolts are used, use slow-setting resin to allow the Authority Representative sufficient time to approve loading prior to gelation.

8. Vertical Support System With Tiebacks:
   a. Install piles or other vertical support system members incorporated in a system utilizing tiebacks so that they are capable of resisting vertical components of tieback loads without significant settlement during excavation and construction.
   b. Install vertical support members so that settlements will not be caused by construction. In general, install members to be end bearing in stratum below maximum depth of excavation and capable of carrying total vertical loads without assistance of skin friction at depth of excavation.
9. Adjoining Properties:
   a. Where proposed system of tieback anchors or rock bolts projects beyond vertical projection of property lines shown onto adjoining property, obtain permission of owner in writing, and submit written permissions to the Authority Representative.

E. Lagging:
1. Unless otherwise shown or specified, provide timber lagging of three inches minimum thickness where it spans soldier piles placed at distances five to seven feet on centers and for excavation depths up to 25 feet. Increase minimum lagging thickness to four inches for excavation below 25 feet in depth.
2. For other conditions and types of lagging, submit design details for approval.

F. Trench Excavation:
1. Perform sheeting, shoring and bracing for trench excavation for utility facilities and other purposes in accordance with specified safety requirements.
2. Provide sheeting, shoring and bracing for trench excavation in subgrade of subway excavation to prevent movement of main excavation support system.

G. Interface with Other Work:
1. Support of Excavation at Interfaces:
   a. Design, construct, maintain and remove all or parts of support system at limits of the Contract at interface with the Authority's adjacent contracts, as may be necessitated by construction schedules and sequence of operations of respective contracts.
   b. In the event excavation is commenced at an interface prior to the commencement of excavation on adjacent contract, design, construct and maintain end support system making provisions as follows:
      1) Install near face of cofferdam on line separating contracts. Allow no part of support system to project into the next contract except thickness of supporting wall, e.g. soldier piles and lagging, and tiebacks if approved.
      2) Provide support system adequate to support backfill and restoration loads with installation of a reasonable bracing system by adjacent contractor during excavation for his contract.
      3) Design and construct support system so that it will be supported against vertical settlement when adjacent contractor removes lower portion of the cofferdam to effect connection of structures at juncture of two contracts.
   c. If excavation has commenced on adjacent contract at interface prior to excavation on this Contract, make provisions as follows:

1) Coordinate removal of such portions of cofferdam which have been installed in adjacent contract and support and maintain remainder as necessary to effect juncture of contracts.

3.02 SITE QUALITY CONTROL

A. Site Tests and Inspections:
   1. Where system of tiebacks or rock bolts is proposed in conjunction with or in lieu of struts, bracing and shores, undertake approved number of on-site tests to demonstrate adequacy of tiebacks or rock bolts for typical subsurface conditions.
   2. Conduct tests and obtain approval prior to use of tieback system for excavation support.
   3. The Authority Representative may furnish and install certain instruments to monitor performance of tieback or rock-bolt system.
   4. Slurry for Trench Walls:
      a. Make tests on samples of in-place slurry to determine density, viscosity, filtration and sand content in accordance with API 13B-1.
      b. Maintain quality of bentonite slurry compatible with soil characteristics of trench walls.

B. Remove components of support system which inadvertently penetrate or encroach on permanent structure without endangering stability of support.

C. Welding: In accordance with Section 05 12 00.

3.03 CLEANING

A. Removal of Supporting System:
   1. When removing support of excavation system, wholly or in part, do not disturb or damage adjacent buildings, structures, construction or utility facilities. Fill voids immediately with lean concrete or with approved backfill compacted to density specified in Section 31 20 00, Earth Moving.
   2. During strut removal stages, design soldier piles or slurry walls for increased vertical spacing of supports. For the removal of the first level support immediately above the invert slab, the slab can be considered a support for the soldier piles or slurry walls if it is poured directly against the sheeting and shoring and the invert slab is in place for at least 48 hours and is adequate to safely support the support of excavation, adjacent structures and the works. Leave support immediately above top of intermediate structure element, such as walls, slabs, or other horizontal members, until they are placed and are in place for at least seven days and are adequate to carry the loads from the support of excavation and other loads imposed on them. Leave support immediately above top of roof slabs of structure in place for at least seven days after placement of roof slab concrete.
   3. Remove other supports above roof structure only after backfill has been placed and compacted to required density to within three feet of bottom of support.
   4. Except as specified below, remove supporting system to a depth of six feet below surface. Remove supporting systems of intersections of streets and at temporary access ramps to a depth of eight feet.
   5. Where top of Authority structure extends into six-foot or eight-foot limit, remove adjacent supporting systems to a depth flush with top of the Authority structure or one-foot below surface, whichever is greater. Increase removal depths where necessary to accomplish work in this Contract.
   6. Remove material of supporting system from site immediately.

END OF SECTION

SECTION 32 11 23

AGGREGATE BASE COURSES

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies furnishing, placing, shaping and compacting aggregate base on previously constructed subgrades.

B. Related Work Specified Elsewhere:
   1. Section 03 30 00 – Cast-in-Place Concrete.
   2. Section 31 20 00 – Earth Moving.
   3. Section 32 13 13 – Concrete Paving.

1.02 REFERENCES

A. Reference Standards
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M147 – Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
      b. T180 – Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
      c. T191 – Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.

1.03 QUALITY ASSURANCE

A. Regulatory Agency Sustainability:
   1. Jurisdictions Having Authority:
      a. Comply with codes and regulations of the jurisdictional authorities.
   2. 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.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Aggregate Base Materials: AASHTO M147, Materials for Aggregate and Soil- Aggregate Base and Surface Courses, as amended in this section.

B. Use material which is free from frozen material

C. Grading requirements

Sieve Designation	Percentage By Weight Passing Square Mesh Sieves
2 inches	100

1 inch	70 - 100
3/4 inch	60 - 95
No. 4	40 - 75
No. 10	25 - 65
No. 40	10 - 45
No. 200*	2 - 15

*Fraction passing the Size 200 sieve to be not greater than 2/3 of the fraction passing the No. 40 sieve.

2.02 SOURCE QUALITY CONTROL

1. Not less than 10 days prior to the beginning of work, inform the Authority Representative of source of material to be used.
2. Once approved, do not change source of supply.
3. Do not construe approval as approval of the entire location but as approval only insofar as material continues to conform to specified requirements.
4. Cooperate with the Authority Representative so that the Authority Representative may take samples and make tests as often as he deems necessary.
5. The Authority Representative has the right to reject material at the job site by visual inspection, pending sampling and testing.

PART 3 - EXECUTION

3.01 PREPARATION

A. Subgrade Preparation:
   1. Prepare subgrade in accordance with Section 31 20 00, Earth Moving.
   2. Prior to placing the material, check the subgrade, make necessary repairs, and secure the Authority Representative's approval of the subgrade.

3.02 EQUIPMENT

A. Place material using equipment designed for the purpose. Use equipment of size and weight necessary to shape material as shown and to compact material to specified minimum density.

B. Provide sufficient equipment to achieve specified compaction at rate consistent with rate of placement of base material.

C. Obtain approval of equipment prior to use on the work.

D. Maintain equipment in first class operating condition while in operation.

E. At the Authority Representative discretion, the Authority Representative may permit the use of graders for touching up and for working materials into areas not amenable to placing by other equipment, providing there is continuing conformance to the requirements.

F. Use approved mechanical tampers to compact material to the required density in areas that are not accessible to rollers.

3.03 PLACING MATERIAL

A. Do not place on frozen subgrade. Do not dump the material directly on the subgrade.

B. Place material in its final location so as to provide uniformity of grading throughout work.

C. Use graders for touching up and for working materials into areas which do not permit use of other equipment providing there is continuing conformance to specified requirements and providing approval is obtained.

D. Place material in uniform layers so that each layer has compacted lift thickness of six inches maximum and three inches minimum.

E. Where thickness is shown or specified is more than six inches, place material in two or more layers of equal thickness so that specified requirements are met.

3.04 COMPACTION

A. During placing and compacting, obtain moisture content and dry density within the allowable tolerances specified.

B. Compact each layer to required density before placing next layer.

C. Compact areas not accessible to rollers to required density by means of approved mechanical tampers.

D. Puddling or jetting is prohibited.

E. Density:
   1. Compact material under curbs and gutters, gutters, curbs and pavement to 98 percent of maximum density at proper moisture content.
   2. Compact material under sidewalks to 95 percent of maximum density at proper moisture content.

3.05 SITE QUALITY CONTROL

A. Allowable Tolerances:
   1. Construct base to the following tolerances:
      a. Thickness of base: Plus zero or minus 3/8 inch.
      b. Surface of base:
         1) Plus 1/8 inch or minus 3/8 inch of elevation shown.
         2) Deviation not more than 3/8 inch from steel straightedge as specified in Section 32 13 13 – Concrete Paving, 03 30 00 – Cast-in-Place Concrete.
   2. Maintain moisture content within two percent of optimum moisture content.

B. Site Tests and Inspections:
   1. Determine optimum moisture content and maximum density in accordance with AASHTO T180, Moisture and Density Relations of Soils Using a 10-lb. Hammer and an 18-inch Drop, and tested in accordance with AASHTO T191, Density of Soil In-Place by the Sand-Cone Method.

C. Non-Conforming Work:
   1. Where directed, repair or remove and replace, with new material, pavement base that does not meet requirements.

3.06 MAINTENANCE

A. Throughout placing and compacting, and until the placing of the succeeding pavement course, maintain base for pavement in specified condition.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies providing asphaltic surface, binder and base courses on prepared subgrade or previously constructed base course in conformance with sections, lines and grades shown.

B. Related Work Specified Elsewhere:
   1. Section 32 11 23 – Aggregate Base Courses.

1.02 REFERENCES

A. Reference Standards:
   1. American Association of Transportation and State Highway Officials:
      a. M6 – Standard Specification for fine Aggregate for Hydraulic Cement Concrete
      b. M29 – Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
   2. M43 – Standard Specification for Sizes of Aggregate for Road and Bridge Construction
   3. M45 – Standard Specification for Aggregate for Masonry Mortar
   4. M76
   5. M79
   6. M82 – Standard Specification for Cutback Asphalt (Medium-Curing Type)
   7. M140 – Standard Specification for Emulsified Asphalt
   8. M156 – Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
   9. M208 – Standard Specification for Cationic Emulsified Asphalt
   10. T30 – Standard Method of Test for Mechanical Analysis of Extracted Aggregate
   11. T164 – Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot-Mix Asphalt (HMA)
   12. T165 – Standard Method of Test for Effect of Water on Cohesion of Compacted Bituminous Mixtures
   13. T168 – Standard Method of Test for Sampling Bituminous Paving Mixtures
   14. ASTM International
   15. ASTM D3515 – Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

1.03 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
   1. Product Data:
      a. Job-mix formula:
         1) For each mix to be supplied submit job-mix formula based on expected production averages.
         2) In formula establish:
            a) Weight percent of total aggregate and of aggregate finer than each required sieve size.
            b) Weight percent of total mix of asphalt cement.

c) Temperature of mix when placed.
3) Maintain job-mix formula once approved.
b. Weight ticket: For each load of bituminous mixture delivered to the site, submit weight ticket showing the following:
1) Mix type.
2) Mix temperature.
3) Identification of the truck.
4) Tare weight of truck.
5) Loaded weight of truck.
6) Net weight of load.
7) Time of leaving mix plant.
8) Signature of the Authority Representative's plant representative.
2. Certificates:
a. For each delivery of asphaltic material, submit certificate stating type and amount of asphalt and results of specified tests.

1.04 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
1. Jurisdictions Having Authority
a. Comply with codes and regulations of the jurisdictional authorities.

B. Sources of Supply:
1. Not less than 20 days prior to beginning the work, inform the Engineer of the source of the materials to be used and obtain approval.
2. Once approved, do not change source of supply.
3. Do not construe approval as approval of entire location but as approval only insofar as material continues to meet specified requirements.
4. Maintain quality of material. Material may be sampled and tested by the Engineer as often as the Engineer deems necessary.
5. The Engineer has the right to reject material at the job site by visual inspection pending sampling and testing.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery Trucks:
1. For transporting bituminous, mixtures use trucks which show no leakage of oil or grease, have solid metal dump-type beds which are clean and smooth with tight fitting rear gate to prevent loss of materials in transit.
2. Prior to loading, spray inside surface of truck beds with minimum amount of approved thin oil or mixture of lime and water proportioned 50 gallons of water to 100 pounds of lime necessary to prevent adhesion of the mixture. Do not use kerosene, gasoline or excessive amount of oil.
3. Equip trucks with coverings to protect loads from weather and with suitable insulation to prevent undue heat loss during transit at temperatures below 40F.

B. Weighing of Bituminous Mixtures:
1. Provide approved truck scales having both dial and automatic printer or use public scales.
2. Use scales complying with applicable laws, ordinances and regulations governing use of scales.
3. Have scales tested and sealed by authorized public official as often as directed to ensure their accuracy.

4. At least once a week, check tare weight of each truck with full load of fuel and fitted with its equipment.

1.06 JOB CONDITIONS

A. Environmental Requirements:
   1. Do not place bituminous pavement on wet surfaces.
   2. Place bituminous pavement when temperature of air and base exceed 40F.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Asphalt Cement: AASHTO, Table 2, with no requirement for maximum loss on heating.

B. Cut-Back Asphalt, AASHTO M82, Note 4 option applies.

C. Emulsified Asphalt for Tack Coat: SS-1, SS-1h, CSS-1, or CSS-1h, diluted one-part water to one-part emulsified asphalt. Prior to dilution, emulsified asphalt to comply with AASHTO M140 or AASHTO M208. Apply at rate of 0.05 to 0.15 gallons per square yard.

D. Aggregate: Coarse and fine aggregate to be free from substantial portions of serpentine or talc materials or carbonate aggregates containing less than 25 percent by weight insoluble residue retained between Size 10 and Size 200 sieves as determined by leaching samples with 6N hydrochloric acid.
   1. Coarse aggregate: Crushed stone, AASHTO M79 and AASHTO M76 except for grading. Weight loss not to exceed 15 percent by weight when subjected to five alterations of magnesium sulfate soundness test.
   2. Fine aggregate for hot asphaltic concrete: Consisting of one or a combination of the following materials:
      a. Material conforming to AASHTO M6 with the following additional requirements:
         1) When the material is subjected to five alternations of the magnesium sulfate soundness test, weighted loss not exceeding 12 percent by weight; amount of deleterious substances not exceeding following maximum permissible percent limits by weight:
            a) Clay lumps: 0.5.
            b) Coal and lignite: 0.25.
            c) Material passing size 200 sieve: 3.0.
            d) Other deleterious substances, such as shale, alkali, mica, coated grains, soft and flaky particles: 2.0.
      b. Material conforming to specified requirements for No. 10 coarse aggregate in accordance with AASHTO M43.
   3. Fine aggregate for sheet asphalt binder: AASHTO M45, with the following additional requirements:

Sieve Designation	Percentage By Weight Passing Square Mesh Sieves
8	100
50	15 - 40
100	0 - 10

200	0 - 5

4. Fine aggregate for sheet asphalt surface: AASHTO M29, with the following additional requirements:

Sieve Designation	Percentage By Weight Passing
4	100
10	95 - 100
40	55 - 80
80	15 - 40

5. Mineral filler:

Sieve Designation	Percentage By Weight Passing
30	100
50	95 - 100
200	70 - 100

E. Mixes:
1. Provide mixes in accordance with ASTM D3515 and as specified.
2. Proportion constituents of job mixes within limits specified in Table 32 12 16-1.
3. Submit mixes as directed for evaluation of job-mix formula, with bulk specific gravity determined in accordance with AASHTO T165.

F. Temperature of Mixes:
1. Maintain temperature of mixes within plus-or-minus 25F of that given in job-mix formula. Temperature ranges as specified in Table 32 12 16-2.

PART 3 - EXECUTION

3.01 EQUIPMENT

A. Equipment for Preparing Bituminous Material:

1. Use bituminous paving material prepared in mixing plant conforming to AASHTO M156.

B. Equipment for Spreading and Finishing Bituminous Material:
   1. Use equipment capable of placing material at widths ranging from eight to twelve feet by increments of one foot and at varying thickness.
   2. Use machines which spread bituminous mixture without tearing surface. Achieve finish that is smooth, true to cross section, uniform in density and texture and free from hollows, corrugations and other irregularities.

C. Equipment for Compacting:
   1. Provide approved equipment capable of compacting materials to specified Marshall density.

3.02 BASE PREPARATION

A. Prior to placing bituminous mixture, check line, grade and cross section of underlying course. Repair defective areas.

B. Have base approved, prior to placement of surface course.

C. Aggregate and Soil Aggregate Bases:
   1. Apply cut-back asphalt primer at rate of 0.2 to 0.5 gallons per square yard when base is damp but with no standing water.

   2. Allow 24 hours for base to entirely absorb primer. Blot excess primer with just enough sand to prevent pickup under traffic. Sweep loose sand from base before placing base course.

D. Portland Cement Concrete, Bituminous and Brick Pavement Bases:
   1. Apply tack coat using equipment designed for that purpose.
   2. Apply tack coat uniformly to clean dry base at rate of 0.05 to 0.15 gallons per square yard.
   3. Ensure that surface has cured and is satisfactorily tacky before placing mix.

E. Immediately prior to placing mix, apply thin coat of hot asphalt cement to contact surfaces of curbs, gutters, manholes and similar structures.

3.03 PLACING MIX

A. Place base course mixture in one or more lifts with asphalt paver or spreader to provide nominal compacted thickness as shown. Place surface course mixture with asphalt paver to provide nominal compacted thickness as shown. Minimum lift thickness at least two times maximum particle size. Maximum lift thickness to be that which can be demonstrated to be laid in a single lift and compacted to required uniform density and smoothness. Place material in continuous operation. Correct irregularities before final compaction of mixture.

B. If equipment being used produces tracks, pulling, indented areas or other permanent blemishes in material being spread, remove such equipment from site and substitute other approved spreading and finishing equipment.

C. Do not permit direction of movement of paving equipment to be changed by turning on newly completed base, binder or surface courses.

D. Adjacent to headers, gutters, manholes and similar structures, place surface course so that

finished surface is 1/4-inch above edge of structure.

E. When the Engineer considers it impractical to place mix with two machines, one machine will be permitted. Treat joints created by such operation as cold joints.

F. Rake joints to eliminate seams between lane passes.

3.04 COMPACTION

A. Compact immediately after placing. Initial rolling with steel-wheel tandem roller, steel three-wheel roller, vibratory roller, or pneumatic-tire roller following paver as closely as possible, oriented with drive wheel closest to paver. If intermediate rolling is needed, use pneumatic-tire roller immediately behind initial rolling. Final rolling to eliminate marks from previous rolling. Use vibrating plate compactor or hand tamper to achieve thorough compaction in areas too small for roller. Keep steel wheel rollers wet while rolling.

3.05 COLD JOINTS

A. Longitudinal: Apply tack coat to cold material before joining new work.

B. Transverse: Place bulkhead full depth of course or cut back minimum of three inches from sloping surface with masonry saw. Apply tack coat to cold material.

3.06 BULKHEADS

A. Where placement of mix is to be discontinued for such period of time that material will fall below specified street temperature, place suitable bulkhead.

B. Construct cold joint as specified when work is resumed.

3.07 HANDWORK

A. When approved, perform bituminous paving work by hand in areas inaccessible to machines.

B. Undertake handwork using equipment designed and approved for purpose.

C. Perform handwork so that resulting paving meets specified requirements.

3.08 SITE QUALITY CONTROL

A. Allowable Tolerances:
   1. Thickness: Place bituminous pavement to within tolerance of plus-or-minus 1/8 inch of thickness shown.
   2. Surfaces: Construct surfaces to the following tolerances:
      a. Base courses to within plus-or-minus 3/8 inch of elevation shown.
      b. Surface courses to within plus-or-minus 3/16 inch of elevation shown.
      c. Surfaces to deviate no more than 1/4 inch in the length of 10-foot steel straightedge, not cumulative.
      d. During compacting, screed surface using straightedge as specified in Section 32 13 13. Adjust rolling procedures so that tolerances are met.
   3. Densities required:
      a. Base courses: 95 percent of Marshall density.
      b. Surface courses: 96 percent of Marshall density.

B. Testing:
   1. Mixes:
      a. During course of the work submit mixes as directed for testing of gradation and bitumen content in accordance with AASHTO T30 and AASHTO T164 on random samples selected in accordance with AASHTO T168.
   2. Determine density of base and surface courses by the following methods:
      a. Test base and surface courses for density by taking test cores at designated locations for testing by the Engineer, number of cores not exceeding one core per 500 square yards of bituminous pavements or three cores per shift, whichever is greater.
         1) Wherever deficient pavement is discovered take such additional cores as directed.
         2) Repair core holes promptly using the same mix that was cored; where cores are taken through both base course and surface course simultaneously, use surface course mix for repair work.

3.09 PROTECTION OF BITUMINOUS PAVEMENT

A. Obtain approval for use of pavement by public and construction traffic.

B. Do not permit traffic to cross uncompleted longitudinal joints.

3.10 DEFICIENT PAVEMENT

A. Where directed, replace with new material or repair bituminous pavement that does not meet specified requirements.

B. Pavement is considered deficient if the densities of three cores from one day's work are below 95 percent or if the density of one core is below 90 percent.

TABLE 32 12 16-1 CONSTITUENT PROPORTIONS			
GRADING OF TOTAL AGGREGATE (COARSE, FINE, MINERAL FILLER: AS NECESSARY) AMOUNTS FINER THAN LABORATORY SIEVE (SQUARE OPENING) WEIGHT PERCENT			
SIEVE	)T ASPHALTIC CONCRETE . CO. P2 BASE	 P.G. CO. SN SURFACE	* JOB-MIX FORMULA TOLERANCE: ALL MIXES
1-1/2 inch	100	- -	±7
1 inch	93 - 100	- -	±7
3/4 inch	82 - 95	100	±7
3/8 inch	60 - 78	90 - 100	±7
# 4	40 - 58	65 - 85	±7
# 8	- -	48 - 68	±4
# 10	23 - 40	- -	±4
# 16	- -	34 - 54	±4
# 20	14 - 29	- -	±4
# 30	- -	22 - 42	±4
# 40	9 - 21	- -	±4
# 50	- -	10 - 32	±4
# 80	5 - 13	- -	±4
# 100	- -	5 - 24	±4
# 200	2 - 6	3 - 12	±2
	ASPHALT CEMENT, WEIGHT PERCENT OF TOTAL MIXTURE		
	4.5 - 6.5	5.0 - 11.0	+0.4
* Notwithstanding tolerances, supply mixes within specified grading limits.			

TABLE 32 12 16-2 MIX TEMPERATURE RANGES				
MIX	TEMPERATURES, DEGREES F			
	PLANT			STREET
	AGGREGATE	ASPHALT CEMENT	TOTAL MIX	
Sheet Asphalt Binder	250 - 325	250 - 325	250 - 325	250 - 325
Sheet Asphalt Surface	300 - 375	250 - 350	300 - 375	275 - 350
Hot Asphaltic Concrete	250 - 325	250 - 325	250 - 325	250 - 325

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies providing portland cement concrete pavement, plain or reinforced or both, in conformance with the sections, lines and grades shown.

B. Related Work Specified Elsewhere:
   1. Section 32 11 23 – Aggregate Base Courses.
   2. Section 03 20 00 – Concrete Reinforcement.
   3. Section 03 30 00 – Cast-in-place structural concrete.

1.02 REFERENCES

A. Reference Standards:
   1. American Association of State Highway and Transportation Officials:
      a. M33 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
      b. M74 –
      c. M81 – Standard Specification for Cutback Asphalt (Rapid-Curing Type)
      d. M148 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
      e. M153 – Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
      f. M171 – Standard Specification for Sheet Materials for Curing Concrete
      g. M182 – Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
      h. M194/M194M – Standard Specification for Chemical Admixtures for Concrete
      i. M220 – Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
      j. M227 –
      k. T51 – Standard Method of Test for Ductility of Bituminous Materials
      l. T148 – Standard Method of Test for Measuring Length of Drilled Concrete Cores
   2. ASTM International
      a. ASTM A185/A185M – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
      b. ASTM A370 – Standard Test Methods and Definitions for Mechanical Testing of Steel Products
      c. ASTM A615/A615M – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
      d. ASTM C33/C33 – Standard Specification for Concrete Aggregates
      e. ASTM C294 – Standard Descriptive Nomenclature for Constituents of Concrete Aggregates
      f. ASTM C920 – Standard Specification for Elastomeric Joint Sealants
      g. ASTM D6690 – Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
   3. U.S. Government:

a. Federal Specifications:
   1) TT-P-86
   2) TT-S-00227

1.03 SUBMITTALS:

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Joint devices.
   2. Certificates:
      a. As specified in Section 03 30 00 – Cast-in-Place Concrete, including design mixes.

1.04 QUALITY ASSURANCE:

A. Regulatory Agency Sustainability:
   1. Jurisdictions Having Authority:
      a. Comply with codes and regulations of the jurisdictional authorities.
   2. Buy America Act:
      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. Concrete: Conform to quality assurance requirements as specified in Section 03 30 00 – Cast-in-Place Concrete and this section.

C. Testing: Subject concrete for pavements to test procedures specified in Section 03 30 00, Cast-in-Place Concrete.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Aggregates and Cement: As specified in Section 03 30 00, Cast-in-Place Concrete.

1.06 JOB CONDITIONS

A. Environmental Requirements:
   1. Do not place concrete on frozen soil base.
   2. Apply joint sealer when the air temperature is 50F or higher.

   Refrain from placing concrete while the temperature is lower than 40F or when by the National Weather Service forecast it may be expected to reach 40F or lower during the 24-hour period following placement of concrete.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Subgrade Paper: AASHTO M74.

B. Polyethylene sheet and tape: AASHTO M171, white opaque for curing.

C. Wire Fabric: Welded steel-wire fabric, ASTM A185.

D. Bituminous Paint: AASHTO M81, Grade RC-250.

E. Joint Devices:
1. Tie bars: ASTM A615, Grade 60.
2. Tie rod assemblies: Tensile requirements of AASHTO M227, Grade 80 based on measured cross-sectional area of unthreaded portion of bar when tested in assembled condition in accordance with ASTM A370.
3. Dowels:
   a. Plain round bars, AASHTO M227, Grade 80 coated with paint, FS TT-P-86, Type I.
   b. Dowel sleeves in accordance with the following:
      1) Snug fit with dowel bar.
      2) Closed end.
      3) Limit stop for dowel approximately one inch from closed end.
      4) Sufficient rigidity to prevent entry of fresh concrete and collapse during construction.
4. Hook bolt:
   a. Material: As specified for dowels.
   b. Fabrication: As shown.

F. Grease for Dowels: Approved water-resistant grease. G. Expansion Joint Materials:
1. Preformed expansion joint fillers:
   a. Bituminous: AASHTO M33.
   b. Cork: AASHTO M153, Type II.
   c. Preformed joint seals: AASHTO M220.
2. Expansion joint sealing compounds:
   a. Hot-poured: ASTM D3405 and when tested in accordance with AASHTO T51 having ductility not less than 40 centimeter and flow at 140F not greater than one centimeter. Use of ground rubber scrap is prohibited.
   b. Cold-applied: Single-component type, ASTM C920.
   c. Elastomeric: FS TT-S-00227, Type 1, Class A.

G. Burlap: AASHTO M182, Class 3 or 4.

H. Waterproof paper: AASHTO M171.

I. White burlap-polyethylene sheet shall conform to AASHTO Designation M171.

J. Liquid Membrane Forming Curing Compounds: AASHTO M148, Type 1, resin base, wax- free.

K. Concrete: Section 03 30 00, Class 3500, air-entrained, with the following additional requirements:
1. Portland cement: Type I.

2. Minimum cement content: Six bags per cubic yard of concrete.
3. Maximum water content: Water/Cement ratio of 0.45 by weight.
4. Air content: 6-1/2 percent plus-or-minus 1-1/2 percent by volume.
5. Slump: 2-1/2 inches plus-or-minus 1/2 inch.
6. Water reducing admixture: AASHTO M194, Type A or D as directed.
7. Coarse aggregate:
8. Size: ASTM C33 and as follows: 57; 67; 57 and 67; 57 and 4; 67 and 4; or 57, 67 and 4.
9. Deleterious materials: Maximum amount of soft fragments, 2.0 percent by weight; maximum amount of coal and lignite 0.25 percent by weight; and material passing Size 200 sieve 0.5 percent by weight.
    a. Maximum abrasion loss: 40 percent by weight.
10. Fine aggregate:
    a. Deleterious material: Maximum amount of friable particles, 0.5 percent by weight; maximum amount of coal and lignite 0.25 percent by weight; material passing Size 200 sieve three percent maximum by weight.
11. For bridge decks and bridge sidewalks: Use only crushed trap rock aggregate, trap rock to be diabase rock, ASTM C294.

L. High-Early-Strength Concrete: As specified for concrete and modified to produce high-early-strength concrete by one or a combination of the following methods.

M. Substitution of Type III or Type I cement in approved mix.

N. Addition of Type I cement to the approved mix, but so that the total cement does not exceed eight bags per cubic yard of concrete.

O. Addition of an approved accelerating admixture to approved mix as specified in Section 03 30 00, Cast-in-Place Concrete.

PART 3 - EXECUTION

3.01 EQUIPMENT

A. Provide appropriate equipment in sufficient quantity and sizes to perform work as specified and shown.

B. Maintain machinery and equipment on site in first class working condition. Provide necessary tools and supplies for maintenance.

C. Straightedges and Templates:
   1. Use metal straightedges, 10 feet long, rigidly constructed so as to prevent vertical deflection exceeding 1/32 inch and fitted with handles for ease of use.
   2. Use templates, constructed so as to extend from form to form and to ride on form, having adjustable tines spaced at six-inch intervals and rigidly constructed so as to prevent vertical deflection exceeding 1/32 inch.

3.02 BASE

A. Check previously placed base for grade and crown with templates and straightedges for compliance with tolerances specified in Section 32 11 23.

B. Correct deficiencies in grade, contour and compaction.

C. Obtain approval of base prior to placing forms and impervious material.

3.03 SETTING FORMS

A. Unless concrete is placed against abutting structures, use steel forms to maintain concrete within required tolerance and to support paving equipment.

B. Use flexible steel forms for curve radii less than 250 feet. For small radius curves and non- standard closures, use approved wood forms. Provide properly drilled forms to accommodate tie rod assemblies.

C. Set forms accurately and firmly to line and grade throughout entire length of approved base.

D. Set forms sufficiently ahead of other work to avoid conflict during operations.

E. Concurrent with setting of forms, cover base with layer of impervious material of either subgrade paper or polyethylene sheet.
   1. Subgrade paper: Overlap adjacent strips at least four inches and ends not less than 12 inches.
   2. Polyethylene sheet: Overlap sides at least 12 inches.
   3. Maintain cover intact until concrete is placed.

F. Apply one coat of bituminous paint to contact areas of abutting structures and previously placed slabs.

3.04 JOINT DEVICES:

A. General:
   1. Place and secure joint devices to ensure that deviation does not exceed specified tolerances. Finish joints to such tolerances.
   2. Provide acceptable means of splicing.
   3. Provide satisfactory gages for checking position of joint devices.
   4. Where joints are to be completed after placing concrete, mark location of joint devices so as to permit installation of joint to tolerances specified.

5. Where options for construction are permitted, use approved method.
6. Do not disturb joint devices. Do not permit workers to step on joint devices. Realign devices immediately if displaced.
7. Hold initial installation of devices firmly in place by tap bolts installed in holes drilled in forms. If holes in forms have been formed by method other than drilling, use steel washers in addition to tap bolts. After removal of forms replace tap bolts until adjoining subgrade is ready for concrete placement. Remove tap bolts and install remainder of tie devices prior to placing adjoining slab. Apply heavy coating of bituminous paint prior to placing concrete for adjacent slab.

B. Construction Joints:
1. Make transverse construction joints at locations shown; use joint device applicable to particular type of joint.
2. Install dowels at transverse construction joints, spaced as shown but clearing pavement edges and longitudinal joints by a minimum of six inches. Align dowels both vertically and horizontally to tolerance specified.

C. Contraction Joints:
1. Provide longitudinal contraction joints between previously placed slabs and new slabs and between slabs and abutting curbs and gutters.
2. Tie longitudinal contraction joints together by installation of 1/2-inch tie rods or tie-rod assemblies 30 inches long placed across longitudinal contraction joint and spaced as shown. Do not install tie rods or tie-rod assemblies closer than 18 inches to transverse joints.
3. Make groove for contraction joints by formwork or using an approved joint tooling device. When latter method is used saw joint to one third depth of slab within 24 hours of concrete placement.

D. Expansion Joints and Joint Filler: Make grooves for expansion joints by forming. Where grooves are made by device, use approved device of such design that work can be properly performed.
1. Prepare preformed expansion joint filler in greatest length possible and no less than ten feet.
2. Cut filler for joints transverse to the slab in a single piece of the required shape.
3. Cut pieces for curb and gutter as directed to exact size, from larger pieces.
4. When splicing joint filler, butt tightly to prevent penetration of concrete between adjacent strips of joint filler.
5. For longitudinal joints, except at curb and gutter sections, use preformed tongue and groove filler as shown.
6. Where dowels or other approved load-transfer devices have to penetrate joint filler, properly locate and drill holes of correct size or diameter through filler at required intervals to receive bars and to achieve tight fit.
7. Make groove for cement pavement for surface course by forming, sawing or leaving preformed joint in place.
8. Protect preformed joint filler during placing of concrete.

3.05 PLACING REINFORCEMENT:

A. Install welded steel wire fabric in flat sheets where shown in accordance with Section 03 20 00, Concrete Reinforcement.

B. Unless otherwise noted, use wire fabric as follows:

C. Place wire fabric to clear vertical surfaces and joints by two inches and within tolerances specified. Lap sheets distance equal to spacing of wires and tie securely.

D. Place two layers of wire fabric in concrete pavements over trench cuts, each layer to be of weight and type as specified for thickness of concrete. Position each layer two inches clear of top and bottom surfaces of slab and within tolerance specified. Extend each layer nine inches beyond sides of trench.

E. Where other structures, such as manholes, penetrate concrete pavements, place wire fabric on one inch centers in each direction so that there is a minimum of two feet of fabric extending horizontally around perimeter of structure. Install layer of fabric one inch clear of top surface of slab and within tolerance specified.

F. In surface courses, place wire fabric two inches clear of top surface of slab and within tolerance specified.

G. Install layer of wire fabric to serve as top layer over trenches. Install additional fabric around penetrations.

H. Except for pavements over trench cuts and around penetrations, do not place wire fabric in base course.

3.06 PLACING CONCRETE:

A. Supply and place portland cement concrete as specified in Section 03 30 00, with the following additional requirements:
   1. Place concrete only during daylight unless otherwise approved. If placement is authorized during darkness provide adequate lighting system.
   2. Prior to placing concrete around poles, manholes or other structures projecting through pavement, coat such structures heavily with bituminous paint.
   3. Place concrete to the full thickness, deposited in successive batches for full width of slab by means of discharging device which does not cause segregation of materials.
   4. Compact concrete thoroughly during placement.
   5. When spreading by hand, employ sufficient work force for leveling, spading and spreading concrete in front of screed. Do not use rakes for handling concrete.
   6. Deposit concrete as near as practicable to joints but not touching expansion and contraction joint devices. Shovel concrete to height approximately two inches more than depth of the joint. As soon as forms are removed, clean ends of expansion joints of concrete and expose full width of preformed joint filler for full depth of slab. Place concrete against previously constructed slabs only after ends of preformed joint filler have been so cleaned and ends of performed joint filler in slab being poured have been neatly and firmly butted.
   7. Where wire fabric is required, place concrete in layers so that wire fabric may be properly placed. Requirements for machine placing and for vibration apply for each layer. Place layers and wire fabric, large wires running in longitudinal direction in such rapid sequence that monolithic slab will result.
   8. Compact concrete both by internal and surface vibration. Vibrators may be combined with spreading and finishing machines. Compact concrete adjacent to forms, joints, existing concrete or other structures by use of spud vibrator. Insert vibrator in concrete

and work along entire length. Avoid contact with joint devices or underlying base. Evidence of honeycomb or lack of compaction constitute basis for rejection of concrete pavement as deficient.

9. Construction Joints:
   a. Form construction joints where it is necessary and approved to stop concreting for 30 minutes or longer, by staking in a bulkhead and finishing the concrete to the bulkhead.
   b. If, due to an emergency, concreting must be stopped within less than ten feet of a previously formed joint of any type, remove the concrete to the joint prior to resuming the placing of the slab.

3.07 INITIAL FINISHING, FLOATING AND FINAL FINISHING:

A. Give concrete initial finish by use of finishing machines operated so as to minimize formation of laitance and to give required uniformity of surface and compaction. Remove laitance in approved manner.

B. Avoid prolonged operation over a given area. Operate the machine over each area of pavement as directed and only as many times and at such intervals as required to give the proper compaction and uniformity of surface.

C. Keep tops of forms clean to permit true and accurate movement of machine.

D. On completion of screeding, bring surface to smooth finish by use of floats, eight inches wide and a minimum of four feet long, with handles at least four feet longer than width of slab and not less than 16 feet long.

E. Operate float transversely with combined longitudinal and transverse motion for sufficient number of passes to smooth ridges and fill depressions.

F. On completion of floating operations, screed top surface of concrete with deviation not exceeding 1/8 inch from straightedge and within tolerance specified for required elevation. Correct deficiencies by handwork if approved.

G. After floating and verifying that surface is within specified tolerances, drag surface in longitudinal direction with longitudinal and crosswise motions using burlap so to prevent edges digging into surface of concrete or working crown out of pavement.

H. Brooming:
   1. Upon completion of burlap dragging, broom finish top surface of pavement. Use street brooms made for the purpose with split bamboo bristles or metal bristles
      a. Broom width: 14 inches.
      b. Broom handle: At least one-half slab width.
   2. In general make brooming perpendicular to centerline of paving unless otherwise shown. Prior to brooming, obtain the Authority Representative's approval of the direction of brooming for each area.
   3. Pull broom gently over surface of pavement from edge to edge walking back and forth on bridge over pavement, holding handle almost vertical and allowing broom to drag lightly over surface without interruption, leaving slight ridges in concrete perpendicular to centerline of pavement.

4. Overlap ridging. Ridging not more than 1/8 inch in depth with corrugations of uniform character and width.
5. Complete brooming before rounding edges of pavement and joints.

I. Round joints and edges to radius shown.

J. To form flow line for gutters, trowel smooth 12-inch width of pavement adjacent to curbs unless otherwise shown.

K. Joint Work and Edging: Where there is an option of method for doing joint work, secure approval for the method elected and use only that method.
1. Perform joint work and edging when condition of concrete permits.
2. Ensure that joints are within tolerances specified and that there is no perceptible lip or depression other than rounding.
3. Prepare clean grooves rounded to 1/4-inch radius with smooth even walls.
4. Make grooves for expansion joints by forming. See requirements above for expansion joints.
5. For joints to be sealed with poured sealer, prepare grooves with dimensions as shown and within tolerance specified. For joints to be sealed with preformed elastomeric seals, leave grooves of dimensions and within tolerances shown. Provide suitable gauges for checking dimensions.
6. Where joints in surface course are sealed with cold-poured joint sealer, break bottom bond by placing polyethylene tape full width of groove, laid flat along top of preformed joint filler prior to joint sealing.
7. When using hot-poured or cold-applied joint sealer, use only equipment designed for purpose. Hand-pouring pots are prohibited. Maintain material within temperature range recommended by manufacturer. Apply sealer when air temperature is as specified. Construct so that resulting stripe is straight, neat, of uniform width and joint is filled to 1/4 inch from top surface of pavement.
8. When placing elastomeric joint seals, use equipment and methods recommended by manufacturer.

3.08 CURING:

A. Allow finished concrete to cure by one of the following methods for seven days or until concrete has developed flexural strength of 500 psi:
1. Wet burlap: Cover pavement with double thickness of thoroughly wet burlap, overlapping adjacent sheets by at least six inches. Maintain burlap in saturated state by sprinkling until it is removed. Use only clean material free from holes.
2. Waterproof paper, polyethylene sheet or white burlap-polyethylene sheet: Place material so that adjacent sheets overlap by at least 12 inches. Secure material along side and ends so as to maintain reasonably airtight seal.
3. Use approved liquid-membrane curing compounds as recommended by manufacturer, using equipment designed for purpose.

3.09 REMOVAL OF FORMS:

A. Remove forms as soon as condition of concrete permits, but in no case sooner than 12 hours after placement.
B. When the temperature is below 40F, leave forms in place for at least 48 hours or as directed.

3.10 COLD WEATHER CONSTRUCTION:

A. Whenever, by the National Weather Service forecast for the locality, the temperature may be expected to reach 50F or lower during the 24-hour period following placement concrete mix, include an approved accelerating admixture in the concrete mix as specified in Section 03 30 00, Cast-in-Place Concrete.

B. Place concrete when temperature conditions are as specified, unless otherwise directed. If placing of concrete is so directed, in addition to adding an accelerating admixture heat aggregates, water or both, so that mix when placed is not less than 55F nor more than 90F. Do not exceed 140F for mixing water and 150F for aggregates.

C. As soon as concrete has hardened sufficiently to prevent marring, cover pavement surface and edges with dry burlap, building paper or other approved material and subsequent layer of at least six inches of dry hay, straw or other approved material. Maintain such protection for at least three days or until field tests indicate that concrete has attained required strength.

D. During low temperatures, install truck-mixed concrete immediately upon delivery.

E. When temperature by National Weather Service forecast will be 40F or lower during the 72-hour period following placement of concrete, do not use membrane curing compound.

3.11 HOT WEATHER CONSTRUCTION:

A. When by National Weather Service forecast, temperature will be 90F or higher during the 24-hour period following placement of concrete, cover pavement by wet-burlap method for first 24 hours, after which curing may be completed by one of the specified methods.

3.12 PROTECTION OF CONCRETE PAVEMENT:

A. Obtain approval prior to permitting use of completed pavement by public and construction traffic.

3.13 SITE QUALITY CONTROL:

A. Allowable Tolerances:
   1. Joints and joint devices: Maximum deviation of 1/4 inch from position shown and 1/8 inch from ten-foot steel straightedge.
   2. Dowels: Aligned to tolerance of not more than 1/8 inch in 12 inches.
   3. Fabric reinforcement:
      a. Clearance from vertical surfaces and joints: Minus 1/4 inch or plus 1/2 inch.
      b. Clearance from top and bottom surfaces: Plus-or-minus 1/4 inch.
      c. Clearance from top surface of additional reinforcing at penetrating structures: Plus-or-minus 1/8 inch.
   4. Top surface of concrete: Maximum deviation of 1/8 inch from ten-foot steel straightedge and within plus-or-minus 1/8 inch of the required elevation.
   5. Grooves for joints: Within minus 1/16 inch or plus zero inch of dimensions shown.
   6. Thickness of concrete pavement: Within minus 1/8 inch of the thickness shown, in accordance with AASHTO T148.

B. Testing of Concrete:
   1. Conform to requirements specified in Section 03 30 00.

C. Non-Conforming Work:
   1. Deficient Pavement:
      a. Where directed, remove and replace with new materials or correct concrete pavement that does not meet requirements.

END OF SECTION

SECTION 32 16 00

CURBS, GUTTERS AND WALKS

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies providing curbs, gutters, curb and gutters and walks.

B. Related Work Specified Elsewhere:
1. Section 03 20 00 – Concrete Reinforcement.
2. Section 03 30 00 – Cast-in-place structural concrete.
3. Section 31 20 00 – Earth Moving.
4. Section 32 11 23 – Aggregate Base Courses.
5. Section 32 13 13 – Concrete Paving.

1.02 REFERENCES

A. Reference Standards:
1. ASTM International
   a. ASTM C979/C979M – Standard Specification for Pigments for Integrally Colored Concrete.
2. U.S. Government:
   a. Federal Transit Administration:
      1) 49 CFR 661 Buy America Requirements.

1.03 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
1. Product Data:
   a. Where stone curb is provided by street or highway jurisdiction, submit bill of stone curb materials prior to picking up materials at designated storage facility and transporting to site.
2. Certificates:
   a. Buy America Certificate.

1.04 QUALITY ASSURANCE

A. Regulatory Agency Sustainability:
1. Jurisdictions Having Authority:
   a. Comply with codes and regulations of the jurisdictional authorities.
2. 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:
1. Buy America Act Certification:
   a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the

products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

b. Submit the Buy America Act Certification to the Authority Representative for approval.

1.05 DELIVERY, STORAGE AND HANDLING

A. Handle stone so as to maintain curb intact with exposed faces unmarred.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Concrete: Section 32 13 13 and as specified in this section.

B. Carbon Black:
1. Emulsified: At least 25 percent by weight standard carbon-gas black colloidally dispersed in liquid medium so that when one part of product is stirred into ten parts of water, resulting liquid, after standing undisturbed for 72 hours, is uniformly colored and contains no fillers nor other material that would adversely affect quality or appearance of concrete.
2. Powder:
   a. Concrete grade carbon black, meeting the requirements of ASTM C979
   b. Carbon black powder to disperse in water without floating and to be capable of uniform dispersion in plastic concrete.

C. Joint Devices:
1. In accordance with Section 32 13 13, with the following additional requirements:
   a. Dowels: 14 inches long, 3/4-inch diameter for curb and gutter and 1/2-inch diameter for sidewalk.
   b. Plates for construction joints and planes of weakness: 14-gauge galvanized sheet metal cut to section as necessary.

D. Expansion Joint Materials:
1. In accordance with Section 32 13 13, with the following additional requirements:
   a. Preformed joint filler for stone curb, 1/4-inch thick; otherwise, 1/2-inch thick, subject to specified construction requirements.

E. Granite Curb: (.

F. Polyethylene Tape: Section 32 13 13.

G. Mixes
1. Mix exposed aggregate surface course concrete comprising by volume, one part portland cement to three parts granite aggregate or gravel, crushed gravel or crushed stone aggregate as shown, with sand added to form workable mix.
2. Where concrete walks are shown to be darkened, add 1/2 pound of emulsified carbon black or 1/3 pound of carbon powder per bag of portland cement.

H. Fabrication and Manufacturing:
1. Fabrication of Granite Curbing:
   a. Drill holes are prohibited, unless otherwise specified.
   b. Straight granite curbstone:
      1) Width: Eight inches plus-or-minus 1/8 inch at top surface.
      2) Front face: Between 12 inches and 14 inches deep.

3) Batter: One-inch per foot to depth equal to reveal plus two inches.
4) Length: Random, three feet minimum.

c. Radius curb up to and including 100 feet: Radius to have same cross section dimensions as straight curb and cut true to radius ordered. Radius curb to be not less than three feet in length measured on arc.
d. Radius curb greater than 100 feet through 200 feet: Radius to consist of straight sections not exceeding five feet in length with the ends cut to form radial joints.
e. The top surface of curbstone to be finished with four-cut or 550-shot finish, but not both, to approximately true plane, with no projection or depression greater than 1/8 inch. Front face finished same as top surface for depth of reveal plus two inches, except that sawn finish will be acceptable alternate, with no projection or depression greater than 1/8 inch. Remaining depth of front face may be rough cut with depressions or projections not exceeding 1-1/2 inches.
f. Arris line between top and face to have 1/4-inch bullnose.
g. Bottom surfaces to have no projection or depression greater than 1-1/2 inches.
h. Back surfaces to be sawn or split approximately at right angles to plane of top surface. No projection or depression greater than 1/4 inch will be allowed for a distance of four inches from top. Remaining distance to have no projection or depression greater than 1-1/2 inches. Drill holes will be permitted in back surface if they do not show in top arris line.

PART 3 - EXECUTION

3.01 BASE

A. Ensure that previously placed base is satisfactorily compacted and free from loose material.

B. Have base approved prior to placing forms and base covering.

C. Correct deficiencies in grade, contour and compaction.

3.02 FORMS

A. Place forms as specified in Section 32 13 13.

3.03 JOINT DEVICES AND CONTRACTION JOINTS

A. General Requirements:
1. Place joint devices and contraction joints as specified in Section 32 13 13.
2. Where work abuts concrete pavement, adjust spacing of joints so that joints of same type coincide with transverse joints of concrete pavement.
3. Width of preformed expansion joint filler: Same as thickness of concrete pavement minus 3/4 inch.
4. Concrete curb, gutter and curb and gutter:
a. Place two dowels in each joint between eight and twelve inches apart; for curb and gutter place one of the dowels four inches from back of curb. For curb and gutter abutting concrete pavements, complete partial tie rod assemblies in slab. Place preformed expansion joint filler in single piece depressed 1/2-inch below finished surface.
b. For curves of 100 feet radius or less, space expansion joints equally at intervals of approximately 15 feet; for radii greater than 100 feet space expansion joints at intervals of 45 feet, with contraction joints at intervals of 15 feet. Form contraction joints, with plates left in place, depressed 1/2-inch below finished surface.

c. Where placed in curves of 100 feet radius or less, stop reinforcing steel two inches clear of expansion joints.

5. Sidewalk:
   a. Place 1/2-inch preformed expansion joint material between sidewalks and curb where sidewalks are constructed between permanent structure and curb.
   b. Place transverse expansion joints at intervals of 45 feet.
   c. Provide dowels in expansion joint spaced at two-foot intervals, clearing edges of sidewalk by one foot. Where sidewalks intersect, place expansion joints in each sidewalk for full width along extension of back edges.
6. Uniform Joint Spacing: For the entire length of each straight or curved run of sidewalk or curb to be placed, lay out the work and adjust joint spacing to provide intervals of equal dimension between joints, including grooves, unless otherwise shown.

3.04 CONCRETE AND WIRE FABRIC

A. Place concrete and wire fabric in accordance with applicable requirements of Section 32 13 13 except that top layer of fabric over trench-cuts to clear top surface by 1-1/2 inches, plus-or-minus 1/4-inch tolerance.

B. Place pipe for weep holes through curbs for rain leaders from building downspouts where shown.

3.05 STONE CURB

A. Excavating and backfilling in accordance with Section 31 22 00.

B. Place no-slump concrete as setting bed.

C. Ram stone curb into proper position in setting bed and set to line and grade.

D. Where stone curb ties into existing curb, align exposed abutting surfaces.

E. Place preformed expansion joint filler at each joint.

3.06 FINISHING CONCRETE CURB, GUTTER AND CURB AND GUTTER

A. Remove curb and face forms as soon as condition of concrete permits and perform finishing work on exposed surfaces.

B. Finish face edge of curb to one-inch radius. Finish other edges to 1/4-inch radius.

C. Provide steel troweled finish followed by brushing with fine-hair brush.

D. Remove other forms when condition of concrete permits, but no sooner than 12 hours after placing. Rub surfaces with carborundum stone where necessary.

3.07 FINISHING SIDEWALK

A. Work on Authority Property:
   1. Strike off and screed top surfaces so that resulting surface is smooth and within specified tolerances.
   2. As soon as condition of work permits, perform joint work, edging and marking.
   3. Finish edges to 1/4-inch radius.

4. Scoring pattern: Unless otherwise shown, as follows:
   a. Expansion joints: Install on 45-foot centers. For the entire length of each straight or curved run of sidewalk to be placed, layout the work and adjust joint spacing to provide intervals of equal dimension between joints, including grooves, unless otherwise shown.
   b. Contraction joints: Make transverse grooves 1/3 depth of the concrete at approximately nine-foot equal intervals between expansion joints perpendicular to longitudinal grooves.
   c. Control joints: Make transverse grooves 1/2-inch deep at approximately three foot equal intervals between contraction joints perpendicular to longitudinal grooves.
   d. Make longitudinal grooves 1/2-inch deep at approximately three foot equal intervals between and parallel to sides of sidewalk.
5. Finish surface with final light broom finish with fine-hair broom.
6. Construct wheel chair ramps at locations shown.
7. Remove forms when condition of concrete permit, but no sooner than 12 hours after placement. Rub surfaces with carborundum stone where necessary.

B. Non-Authority Work:
   1. In accordance with codes and regulations of the jurisdictional authorities.

3.08 CURING

A. In accordance with Section 32 13 13, except that liquid membrane curing compounds not to be used on curb of curb and gutter when temperatures tend to go lower than 40F within 24 hours after application.

B. Do not use liquid membrane curing compounds on exposed aggregate concrete or darkened concrete surfaces.

3.09 SEALING JOINTS

A. Immediately prior to sealing joints, place polyethylene tape width of groove flat on preformed expansion joint filler.

B. Seal expansion joints in concrete curb, gutter and curb and gutter with poured joint sealer in conformance with Section 32 13 13. Do not seal expansion joints in sidewalk and stone curb.

3.10 HIGH EARLY STRENGTH CONCRETE

A. Use high-early-strength concrete in accordance with Section 32 13 13 when approved.

3.11 CORES

A. Where directed, provide test cores in accordance with Section 32 13 13.

3.12 SITE QUALITY CONTROL

A. Allowable Dimensional Tolerances:
   1. Concrete surfaces constructed in accordance with the following:
      a. Plus-or-minus 3/16 inch of elevation shown.
      b. Deviation: 1/8-inch maximum from steel straightedge as specified in Section 32 13 13.

B. Non-Conforming Work:

1. Remove and replace with new materials or correct as directed work which does not meet specified requirements.

3.13 PROTECTION OF THE WORK

A. Protect new work in accordance with Section 32 13 13.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies providing pavement markings and striping.

1.02 REFERENCES

A. Reference Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M249 – Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form)
   2. ASTM International
      a. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
   3. U.S. Government
      a. Federal Standards:
         1) FED STD 595.
         2) Federal Test Method Standard 141.
         3) FS: TT-P-85.
         4) TT-B-1325.
      b. Federal Transit Administration:
         1) 49 CFR 661 Buy America Requirements.
      c. Federal Highway Administration (FHWA)
         1) Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD).

1.03 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
   1. Samples:
      a. Paint: One quart of each color.
      b. Spheres: Two pounds.
      c. Thermoplastic compound: Ten pounds of each color.
      d. Preformed plastic markings: Five each of plain and reflective, each three inches wide by one-foot long.
   2. Certification:
      a. Buy America Act Certification.

1.04 QUALITY ASSURANCE

A. Regulatory Agency Sustainability:
   1. Jurisdictions Having Authority:
      a. Comply with codes and regulations of the jurisdictional authorities.
   2. 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:
   1. Buy American Act Certification:

a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.
b. Submit the Buy America Act Certification to the Authority Representative for approval.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in factory-sealed containers plainly marked as follows:
1. Manufacturer's name and address.
2. Location of plant.
3. Material.
4. Color of material.
5. Amount of contents.
6. Date of manufacturer and lot number.

1.06 JOB CONDITIONS

A. Environmental Requirements:
1. Traffic zone paint:
a. Apply only when ambient air temperature is above 40F and temperature of surface to be painted is above 45F.
b. If pavement is wet, allow surface to dry for eight hours minimum after surface appears dry.
c. Do not apply glass spheres in strong windy conditions.
2. Extruded thermoplastic compound:
a. Apply by extrusion at 400F minimum, 440F maximum, when air temperature is more than 35F and pavement temperature is above 50F.
b. If pavement is wet, delay application until the pavement has been exposed to at least two hours of direct sunlight after surface appears dry.
3. Preformed plastic traffic markings:
a. Apply on dry pavement when ambient temperature and temperature of pavement surface is above 60F.
b. When temperature of pavement surface is less than 60F and when approved, apply surface heating to degree necessary for application of plastic marking.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Traffic Zone Paint:
1. Primer: If recommended by paint manufacturer or required by jurisdictional authorities, type as recommended by paint manufacturer.
2. Paint: Traffic, FS TT-P-85, white and yellow.

B. Glass Beads: Retroreflective glass spheres, FS TT-B-1325, with the following additional gradation requirements:

US Sieve Size	Percentage Passing
40	100
50	80 - 100

80	35 - 80
100	20 - 50
200	0 - 15

C. Extruded Thermoplastic Compound: Hot-applied alkyd thermoplastic per AASHTO M249-79 and as follows:
   1. Thermoplastic compound:
      a. Mixture of thermoplastic resins and other substances compounded for use in traffic markings which, when extruded hot in place and cooled to ambient temperature, will produce stark white or yellow reflective marking stripe.

      b. Permanently white or yellow, without blemish or discoloration, with straight, clean cut, sharply defined, parallel edges and of uniform cross section.
      c. Shaped to minimize tire impact and adhere permanently to road.
      d. Set to solid, non-tacky, non-slippery line of sufficient elasticity to resist cracking and chipping caused by weather and temperature changes, traffic action, as well as pavement crawl and lift in freezing weather.
      e. After curing, does not react with nor deteriorate in contact with snow removal chemicals, oil and other substances common to roadway surfaces.
      f. Chemically stable and emitting no dangerous fumes.
      g. Especially compounded for traffic markings, with no change in color and brightness characteristics after prolonged exposure to sunlight.
      h. No breakdown or deterioration when held at plastic temperature for extended periods of time nor when repeatedly reheated to plastic temperature.
      i. No change in temperature versus viscosity characteristics through repeated re-heatings and from batch to batch.
   2. White thermoplastic compound:
      a. Pure white, free from dirt or tint after drying.
      b. Maximum allowable compound deviations from magnesium oxide standard when tested by standard color difference meter, Gardner Color Difference Meter, Gardner Laboratories, Inc. Bethesda, Maryland or equal, with the following minimum requirements:

Scale	Definition	Magnesium Oxide Standardized	Sample
Rd	Reflectance	100	70 minimum
a	Redness - Greenness	0	Minus five to plus five
b	Yellowness - Blueness	0	Minus 10 to plus 10

      c. The white compound pigment containing not less than six-percent titanium dioxide (TiO_2).
   3. Yellow thermoplastic compound:
      a. After drying, yellow, FED STD 595, Color 33538, tested in accordance with Federal Test Method Standard 141, Method 4252.
      b. Pigmented binder well dispersed and free from skins, dirt, foreign objects or

ingredients that will cause bleeding, staining or discoloration and consisting of mixture of non-drying synthetic resins at least one of which is solid at room temperature.

c. Total binder content of thermoplastic compound: 15-percent minimum, 35- percent maximum by weight.

d. Filler incorporated with resins or binder: White calcium carbonate with compressive strength of 5,000 psi.

D. Preformed Plastic Traffic Markings:

1. Composed of preformed plastic, smooth on top surface, undersurfaces factory- coated with pressure-sensitive adhesive coating overlaid with protective paper, polyethylene or other suitable material which remains in place until plastic is ready for application to pavement.
2. Plain or reflectorized.
3. White or yellow.
4. Composition:
   a. Nonreflectorized plastic material: Consisting of basic plastic and plasticizers, 50-percent minimum by weight.
   b. Reflectorized plastic material: Consisting of 40-percent minimum by weight of basic plastic and plasticizer and 30-percent minimum by weight of clear, reflective glass spheres, thoroughly and uniformly dispersed throughout plastic.
5. Pigmentation:
   a. White plastic markings: Pure white, free from tint and containing not less than six-percent titanium dioxide.
   b. Yellow plastic markings: Yellow, FED STD 595, Color 33538, Federal Test Method 141, Method 4252.
   c. Uniform coloring throughout cross section of plastic.
6. Low-temperature stress resistance: No indication of breaking, chipping or cracking when sample of specified thickness is abruptly bent to right angle after being immersed in water at 32F for 30 minutes.
7. Resistance to wear: Endure not less than 2,500 cycles of a Taber Abraser, using CS-17 wheels under a load of 1,000 grams, when each 0.001-inch thickness of plastic is tested at 21C.
8. Tensile strength: Non-reflectorized markings not less than 1500 psi; reflectorized markings not less than 750 psi when tested in accordance with ASTM D638.
9. Bond strength: Withstand 50-pound static shear load for 15 seconds average at 21C before complete parting of bond when pair of two-inch wide strips are overlapped two inches and adhesive faces placed together.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protection:

1. Provide traffic protective devices and methods of protection to comply with requirements of the jurisdictional authorities.
2. Provide and maintain traffic cones, barricades, lights and other protective devices necessary to protect traffic, workmen and completed pavement marking and striping. Remove such devices when marking and striping, including painted sections of curbing and raised traffic bars, have sufficiently cured for intended use.

B. Surface Preparation:

1. Traffic Zone Paint:
   a. Schedule marking and striping operations to permit paint to set and harden before roadway is opened to traffic.
   b. Allow hot laid bituminous material to cool, prior to beginning striping operations.

c. Remove foreign matter from surfaces prior to painting.

2. Extruded Thermoplastic Compound:
   a. Application of binder-sealer:
      1) Before applying binder-sealer or thermoplastic compound, prepare roadway surface by buffing and cleaning or other appropriate method.
      2) Where thermoplastic stripe is to be installed, spray surfaces with binder sealer consisting of two parts epoxy and one-part hardener-catalyst immediately prior to installation of compound.
      3) Mix binder-sealer fresh each day. Do not premix.
3. Preformed Plastic Traffic Markings:
   a. Prepare roadway surface by removing dirt, dust, oily substances and other foreign matter before installing plastic markings.
4. Painting of Curbing and Raised Traffic Bars:
   a. Clean surfaces to be painted of dirt, dust, laitance, oil or other foreign substances.

3.02 APPLICATION

A. Traffic Zone Paint:
   1. Equipment:
      a. Use equipment suitable for mechanical application of paint and glass spheres.
      b. Apply paint with atomizing spray machines designed for striping to apply stripes of uniform cross section, and thickness, at specified coverage with clean-cut edges permitting easy and accurate adjustment of width and rate of application as well as immediate shutoff.
         c. Use automatic mechanical equipment designed and constructed to distribute glass spheres in uniform pattern and at prescribed coverage regardless of variation in speed of travel. Equipment may be integral part of striping machines or self-contained unit designed for attachment to striping machines, so that glass spheres will be applied immediately following application of paint. Use equipment designed and constructed to permit adjustment of coverage rate.
   2. Method of application:
      a. Apply pigmented binder and glass spheres, mix and thin pigmented binder in accordance with manufacturer's recommendations.
      b. Apply glass spheres uniformly, immediately following application of paint. Do not premix paint and spheres.
      c. Apply pavement markings accurately with straight, clean-cut, sharply defined parallel edges and of uniform cross section.
      d. Clean striping machines as often as necessary to ensure application of markings of specified quality and physical requirements.

B. Extruded Thermoplastic Compound:
   1. Equipment:
      a. Master kettle:
         1) Minimum capacity: 800 pounds of melted compound.
         2) Double oil jacket.
         3) Thermostatic controls.
         4) Approved heating device.
         5) Temperature gauges for oil and compound.
         6) Integrally mounted chopping device to chop and drop solid compound into kettle.
      b. Liner:
         1) Use liners with self-contained heat source, such as propane heater, capable of maintaining compound at drawing temperature of not less than 420F as well as radiant heater installed over die for same purpose.
         2) For installation of crosswalk lines, stop lines and solid center lines, use liner

with capacity of approximately 150 pounds and automatic sphere dispenser capable of distributing reflective spheres on surface of line while still plastic.

3) For centerline and lane line installation, use mobile unit equipped to automatically install dashed lines in combinations of line and skip up to 40 feet and for application of reflective spheres as specified for smaller liner.

4) Provide for varying die widths in liner to produce specified line widths, including shaping die cutoff device to provide clean, square ends at beginnings and ends of lines.

2. Application of thermoplastic compound:
   a. Apply compound in colors shown and at locations shown.
   b. Do not use pans and aprons to control width of lines.
   b. Use equipment including extrusion dies capable of maintaining compound at specified extrusion temperature and density and capable of producing stripe of specified width.
3. Application of glass spheres:
   a. Perform reflectorizing of thermoplastic compound by immediate application of glass spheres to specified density.
   b. Perform reflectorizing so that completed line registers not less than 55 on Hunter Nite Visibility Meter.

C. Preformed Plastic Traffic Markings:
1. Do not install plastic marking on wet or damp pavement.
2. Make installations in neat, workmanlike manner with ends and edges of successive strips of material even.
3. Position center and lane markings using chalk as guides.
4. Installation on sheet-asphalt surfaces:
   a. When plastic markings are to be installed on new sheet-asphalt surfaces, install while asphalt is still hot and immediately before final rolling is performed.
   b. As part of final rolling operation, position and embed plastic marking into surface.
   c. To install plastic markings on existing sheet asphalt, accurately locate and press marking into place and obtain final bond by at least two longitudinal passes of ten-ton roller.
5. Installation on asphaltic-concrete surfaces:
   a. Install as specified for sheet-asphalt surfaces except apply prime coat recommended by manufacturer of plastic markings to pavement surface prior to installation of markings.
6. Installation on portland-cement concrete pavement:
   a. Seal surface of concrete pavement with quick-setting primer to reduce capillary action and improve bond between marking and pavement surface.
   b. Otherwise install as specified for sheet-asphalt pavement.

D. Painting of Curbing and Raised Traffic Bars:
1. Paint curbing and raised traffic bars with traffic-zone paint.
2. Allow 14 days minimum after installation of portland-cement concrete before painting.
3. Curbing:
   a. Paint top and front of curbing in locations shown with one coat of nonreflectorized traffic-zone paint as specified.
4. Raised traffic bars:
   a. Paint surfaces, except bottom of raised traffic bars with one coat of white traffic-zone paint and apply glass spheres before paint has hardened.
   b. Apply paint and glass spheres as specified.

3.03 FIELD QUALITY CONTROL

A. Layout of Work:
1. Lay out lane widths, parking spaces and crosswalks in accordance with regulations of

jurisdictional authorities and as shown.

B. Letters and Symbols:
   1. Unless otherwise shown or specified, apply letters, directional arrows and other pavement markings of size and configuration in accordance with referenced USDOT/FHWA Manual on Uniform Traffic Control Devices for Street and Highways.
   2. Apply letters, directional arrows and other markings in color shown.

C. Width and Color of Lines for Pavement Striping:
   1. Apply lines for pavement striping as follows:
      a. Width: 32 17 23
         1) Continuous centerline striping and parking space markings: Four inches.
         2) Dashed lane striping: Four inches.
         3) Solid crosswalk lines: Six inches.
         4) Solid stop lines: Twelve inches.
      b. Lines:
         1) Dashed lane lines: White stripes nine feet in length separated by 15 feet of unmarked surface.
      c. Color:
         1) Stripes:
            a) Solid centerline stripe: White or yellow as shown.
            b) Lane striping, parking space marking, crosswalk and stop lines: White, unless otherwise shown.

D. Allowable Tolerances:
   1. Traffic-zone paint:
      a. Width of lines not to vary from specified width by more than 1/8 inch in each linear foot.
      b. Lengths of skip or lane lines and unpainted surface between skip lines not to vary by more than three inches from specified length.
      c. Coverage rate maximum: 100 square feet minimum and 110 square feet maximum of surface coverage per gallon of paint, yielding wet-film thickness of 0.015 inches minimum.
      d. Coverage rate of glass spheres: Ten pounds per gallon of paint minimum.
   2. Extruded thermoplastic compound:
      a. Thickness of stripe: 90 to 125 mils.
      b. Rate of application of binder-sealer: Between 800 linear feet and 1,000 linear feet per gallon for four-inch wide lines. For lines of other widths, apply in proportion based on such rate.
   3. Preformed plastic traffic markings:
      a. Thickness: 0.095 inch, minus 0.005 inch or plus 0.010 inch.
      b. Width: Four inches, plus-or-minus 1/8-inch per 12-inch length.
   4. Painting of curbing and raised traffic bars:
      a. Wet-film thickness: 0.015 inches minimum.

END OF SECTION

SECTION 32 32 23

MODULAR CONCRETE RETAINING WALL

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. The work specified in this section consists of designing, furnishing, and construction of a modular concrete retaining wall system in accordance with these specifications and the lines, grades, designs, and dimensions indicated on the Construction Documents. Work shall include preparation of foundations, furnishing and installing leveling pad, unit drainage fill, and backfill to the lines and grades shown on the Construction Documents.

1.02 RELATED SECTIONS

A. Section 31 00 00 Earthwork

1.03 REFERENCES

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

B. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASHTO M 252 Corrugated Polyeththylene Drainage Pipe.

C. National Concrete Masonry Association (NCMA)
   1. NCMA SRWU-1 Test Method for Determining Connection Strength of SRW
   2. NCMA SRWU-2 Test Method for Determining Shear Strength of SRW

D. American Society for Testing Materials Standards (ASTM)

   1. ASTM C140 Sampling and Testing Concrete Masonry Units
   2. ASTM C1372 Specification for Dry-Cast Segmental Retaining Wall Units
   3. ASTM D422 Particle Size Analysis of Soils
   4. ASTM D698 Laboratory Compaction Characteristics of Soil – Standard Effort
   5. ASTM D1557 Laboratory Compaction Characteristics of Soil – Modified Effort
   6. ASTM D3034 Polyvinyl Chloride Pipe (PVC)
   7. ASTM D4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils
   8. ASTM D4475 Horizontal Shear Strength of Pultruded Reinforced Plastic Rods
   9. ASTM D4476 Flexural Properties of Fiber Reinforced Pultruded Plastic Rods
   10. ASTM D6638 Connection Strength – Reinforcement/Segmental Units
   11. ASTM D6916 Shear Strength Between Segmental Concrete Units

1.04 DELIVERY, STORAGE, AND HANDLING

A. Handling, Storage, and Shipping: All units shall be handled, stored, and shipped in such a manner as to avoid chipping, cracking, fracturing and excessive bending stresses.

B. Inspect wall components upon delivery for damage. Minor damages may be repaired provided finish items are equal to new work and acceptable to the Engineer. Remove and replace damaged items as directed.

C. Backfill material shall be handled and stored in a manner to prevent deleterious materials from mixing with the material prior to placement behind the walls.

1.05 ENVIRONMENTAL REQUIREMENTS

A. All materials used in the construction of the retaining wall, including backfill, shall meet the safety requirements, in accordance with local, state, and Federal regulations.

1.06 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals:

1. Contractor shall submit a Manufacturer's certification, prior to start of work, that the submitted retaining wall system and components meet the requirements of this specification and the structure design.
2. Contractor shall submit two sets of the Calculations, and the Construction and Fabrication Drawings for all retaining walls on the project stamped by a registered Professional Engineer in the State of Maryland The Drawings shall include: i) retaining wall layout and heights; ii) plan, elevation, and typical sections; iii) type, location and properties of all drainage materials, appurtenances and special installation requirements not covered in this specification.
3. The Contractor shall submit manufacturer's product data and installation procedures for review.
4. Certification:
    a. Buy America Act Certification

1.07 QUALITY ASSURANCE

A. Contractor shall submit a list of three (3) previous projects of similar size (or larger) by the wall installer where the submitted retaining wall system has been successfully constructed.

B. Contractor shall provide quality control testing and inspection of earthwork and wall construction operations.

C. Regulatory 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.

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

1.08 STRUCTURAL CAPACITY

A. The Wall shall be designed to withstand the retained soil pressure, any surcharge load (HVAC unit) above the wall, and hydrostatic forces, if applicable.

1.09 GLOBAL STABILITY

A. Factor of safety against sliding shall be at least 1.5.

B. Factor of safety against overturn shall be at least 2.0

PART 2 – PRODUCTS

2.01 MATERIALS

A. The precast modular retaining wall shall be one of the following systems:
   1. Keystone Retaining Wall Systems
   2. Redi-Rock
   3. Approved Equal

B. The concrete units shall have face color of concrete gray with sculpted rock face finish.

C. Running with bonds nominally located at midpoint of vertically adjacent units.

D. Exposed surfaces shall be free of chips, cracks, or other imperfections when viewed from a distance of 10 feet.

E. Concrete materials shall conform to requirements of ASTM C1372.

F. Concrete units shall conform to the following in accordance with ASTM C140, ASTM D6916 and ASTM D6638.

   1) Minimum compressive strength 3000 psi
   2) Absorption less than 6% for standard weight aggregates

G. Provide 90 degree corners, finished on two sides where required.

H. Provide solid cap units with parallel sides for straight walls.

I. Vertical setbacks and fastening systems between members shall be as per the manufacturer's recommendations.

J. Leveling Pad: Shall conform with approved wall manufacturer's recommendations.

K. Drainage Fill shall consist of clean 1" crushed gravel meeting ASTM D422 and shall be installed in locations indicated on the manufacturer's drawings.

L. Drainage Pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D3304 or AASHTO M252.

M. Geotextile Filter Fabric shall be as required by the wall manufacturer and conform with the wall manufacturer's recommendations.

N. Backfill shall be No. 57 stone.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Examination:

1. The Contractor shall verify the locations of utilities and existing structures prior to excavation.

2. Examine the Project site and evaluate conditions where the retaining wall will be constructed. Notify the proper supervising authority in writing of any conditions that may interfere with the proper construction of the wall or result in delay in construction.

3. Promptly notify the wall design engineer of the site conditions, which may affect wall performance, soil conditions observed other than those assumed, or other conditions that may require a re-evaluation of the wall design.

B. Excavation: Contractor shall excavate to the lines and grades shown on the Construction Drawings. The foundation for the retaining wall shall be excavated and graded level for a width equal to or exceeding the length of the wall stem using the top of the leveling pad as the grade elevation or grade to the appropriate slope for a battered wall. The Contractor shall be careful not to disturb base beyond the lines indicated and shall be responsible for slope stability and protection of the open excavation.

1. If unsuitable foundation soil is encountered, the Contractor shall contact the Engineer immediately prior to implementing any remediation. Typically, unsuitable material shall be over-excavated to a limited depth. Over-excavated areas shall be filled with suitable base or backfill material and compacted to 95% modified proctor. However, all remediation must be approved by the Engineer prior to commencing.

2. The excavated material shall become the property of the Contractor and shall be disposed at an acceptable location.

3. Excavation and access shall comply with applicable OSHA regulations.

C. Foundation Preparation: Foundation soil shall be evaluated by the Geotechnical Engineer to ensure that the bearing soils meet or exceed the design conditions or assumptions. The Geotechnical Engineer, prior to installation of the retaining wall, shall approve the soil foundation preparation. At each unit foundation level, a leveling pad shall be provided as required by the wall manufacturer and as shown on the Plans.

1. The foundation shall be sufficiently embedded to prevent frost-heave-related problems.

D. Wall Installation shall be according to the approved wall manufacturer's recommendations.

E. Repairs: Repairs to the units in the field are possible only with a pre-approved repair procedure and prior to permission of the Engineer and the Manufacturer.

F. The Contractor shall be responsible for the proper installation and quality control of the wall components and appurtenant materials.

1. The Owner may retain a qualified professional to monitor and perform quality assurance checks of the installer's work, if desired.

2. Quality assurance shall include foundation soil inspection, frequency of backfill compaction testing, verification of geotechnical design parameters, and compliance with Construction Drawings, and Project Specifications.

G. Backfill placement shall closely follow the installation of each course of wall units as per the wall manufacturer's recommendations. The backfill lift should be uniform in thickness and compacted within the limits shown on the Plans. Each lift shall be compacted to at least 95% of maximum laboratory dry density in accordance with ASTM D-698. Placement and compaction of the backfill shall be accomplished without displacement of the wall units.

1. Conduct sampling and testing at a minimum frequency listed below:
Compaction Test: Each course of units at each of the three locations.

2. If the backfill material is predominantly gravel, little sand, and insignificant fines, it may not be practical to perform compaction testing with a nuclear gauge or sand cone penetrometer. In such case, visual observation with the minimum passing of the compacting equipment shall be used to accept the level of compaction.

H. Cleaning: After completion of wall installation, remove construction debris and restore any adjacent finished areas affected by wall construction to their preconstruction state. Wash the wall face to remove soiling and stains. Do not use acid or detergents that may "burn" or discolor face.

END OF SECTION

SECTION 32 90 00

PLANTING

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies providing and maintaining landscape plantings, edge plantings and related accessories. It also specifies existing tree pruning and removal requirements.

B. Related Work Specified Elsewhere:
   1. Section 02 42 13 – Deconstruction of Structures.
   2. Section 31 10 00 – Site Clearing.
   3. Section 32 91 00 – Planting Preparation.

1.02 REFERENCES

A. Definitions:
   1. Landscape Plantings (Outside Reforestation areas and in Median strips): Designed planting of trees and shrubs within lawn or established areas, as shown. Landscape plantings are indicated on the Drawings with a square symbol as shown on the key in the Drawings.
   2. Edge Plantings: Planting of trees and shrubs along edge of reforestation areas, as shown. Edge plantings are indicated on the Drawings with a triangular symbol as shown on the key in the Drawings.
   3. Reforestation: Planting of trees and shrubs within designated reforestation areas. These reforestation areas are outside the limits of existing woodlands and wetlands and of landscape and mow areas, as shown. Reforestation planting areas are indicated on the Drawings with small circles as shown on the key in the Drawings.
   4. Plants or Plant Material: Vegetation, including trees, shrubs, ground cover, vines, and seasonal flowers.
   5. Size: The factor controlled by dimensions representing caliper, height or spread. For standard quality a dimension is given for caliper, height or spread, whichever is a typical characteristic of the plant. For specimen quality, all dimensions may be specified.
   6. Condition: The factor controlled by vitality and ability to survive and thrive and be comparable with normal plants of the same species and variety in the vicinity, at the same season of the year, free from physical damage or adverse condition that would prevent thriving, whether dormant or growing.
   7. Foliage line: Maximum dimension measured from ground to lowest part of body of plant.
   8. Quality: Structure and form as evidenced by density and number of canes and branches, compactness, symmetry and general development, without consideration of size or condition.
      a. Standard: The least acceptable quality, good average uniform growth, absence of irregularities, typical characteristics of the species and variety, nursery-grown, well-formed, and uniformly branched, sound, healthy, vigorous and free of disease and insects, and having healthy, well-developed root systems, and having the minimum number of canes specified or conforming to minimum quality index. Plant materials below specified standard will be considered unacceptable culls and are not acceptable.
      b. Specimen: An exceptionally heavy, symmetrical, tightly knit plant, trained or favored in its development and appearance so as to be An unquestionably and outstandingly superior in form, of the designated species or cultivar number of branches,

compactness and symmetry.

9. Spread: Single dimension that represents the minimum acceptable width. Where range is shown between two spread dimensions, the lesser is the minimum acceptable.
10. Root Protection Zone (Area): The root protection area is an area equal to a radius of 1.5 feet for each inch of diameter at breast height (dbh) (i.e.; a 10-inch dbh tree will require protection 15 feet from the main trunk in every direction.
11. Diameter at Breast Height (DBH): The DBH is the trunk diameter measured at a point 4.5 feet (Maryland State Standard) above the average ground level. If the trunk divides into several smaller trunks at a point lower than 4.5 feet (Maryland State Standard) from the ground, the tree size is the diameter measured at the highest point on the single trunk.
    a. If a tree falls between sizes as listed in the bid schedule, the tree is placed in the next larger size. For example, a 17-1/2 inch diameter tree is placed in the 18-inch to 23-inch size.
12. Tracing: Careful cutting of bark along the line of sap flow to encourage wound closure and to smoothly outline the wound area.
13. Girdling Roots: Surface roots whose circular growth around the base of a tree trunk or around other roots applies pressure to the bark thereby restricting the sap flow.
14. Stumps: Stumps include the base of the trunk and visible surface roots attached to the trunk no more than three feet high, measured from the average ground level. Stump size is the diameter of the cut wood surface as measured across the narrowest portion.
15. B&B: Balled and burlapped.
16. NIC: Not in Contract.
17. Other Terms: The following in accordance with ANSI Z60.1:
    a. Height.
    b. Cane.
    c. Caliper: Determine caliper measurement by taking the average of two trunk caliper measurements at right angles six inches above the root crown.
18. Height of branching.

B. Reference Standards: Keep always available at the work site a copy of each of the cited references.
    1. American National Standards Institute (ANSI):
        a. Z60.1 – American Standard for Nursery Stock
        b. Z133.1 – Safety Requirements for Pruning, Trimming, Repairing, Maintaining and Removing Trees and Cutting Brush
    2. American Joint Committee on Horticultural Nomenclature (AJCHN):
        a. Standardized Plant Names.
    3. ASTM International:
        a. A36/A36M – Standard Specification for Carbon Structural Steel
        b. A48/A48M – Standard Specification for Gray Iron Castings
        c. A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
        d. A153/153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
        e. A307 – Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
        f. A501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
        g. C51 – Standard Terminology Relating to Lime and Limestone
        h. D448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction
        i. D2729 – Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and

Fittings
j. F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
4. U.S. Government:
a. Federal Specifications:
1) FS: O-F-241
b. Federal Transit Administration:
1) 49 CFR 661 Buy America Requirements.
c. United States Department of Agriculture (USDA):
1) USDA-SCS
5. L.H. Bailey
a. Bailey's Standard Cyclopedia of Horticulture.
b. Hortus III

1.03 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meetings:
1. Pre-Planting Conference: Hold a pre-planting conference prior to planting landscaped areas.
2. Set a time, date, and location agreeable to the Authority Representative and personnel of the Contractor, and jurisdictional agency, including but not limited to, NPS and MNCPPC, who are responsible for the contractual obligations of these parties. Participation of these parties at this conference is mandatory prior to beginning planting.
3. Have discussion topics include, but not limited to, confirmation of exact plant substitutions previously accepted by the Authority Representative.
4. Make notations on plans to document direction received from the jurisdictional agency, including but not limited to, NPS and MNCPPC, and send record copies to attendees.
5. After conference, notify the Authority Representative 48 hours prior to beginning landscape planting work. Notify MDNR through the Authority Representative.

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
1. Product Data:
a. Equipment list: A list of the equipment anticipated for use, including the make and model, year manufactured, tag number if applicable, and date of last inspection. If requested by the Authority Representative, submit a list of the equipment to be used for each delivery order. Have the listed equipment on the job site when necessary during the execution of the delivery order.
2. Shop Drawings:
a. Location list: Within 10 calendar days after receipt of NTP, submit a complete list of locations of plant material subject to inspection. Should plant material be exhausted from these sources, the Contractor is responsible to locate elsewhere, at no additional cost to the Authority.
b. Work routes and details: Submit plans of entire project site clearly marked to show proposed work routes of crews and equipment, turning radii, and locations of temporary protective markers, barriers and storage areas, coordinated with details of methods to distribute concentrated loads so as not to compact soil unacceptably (above 75% maximum density). Do not route through zones designated for planting.
3. Samples:
a. Samples of each required type of material specified in Table 32 90 00-1. Samples failing to meet specified requirements are unacceptable. Resubmit new samples of

satisfactory material until approved.

4. Certificates:
   a. Complete, certified reports attesting that proposed materials comply with specified requirements. Furnish certificates of inspection of plant materials by state or federal agency prior to delivery.
      1) Topsoil: As specified in Section 32 91 00, Planting Preparation.
      2) Antidesiccant: Submit certificate from the antidesiccant manufacturer as evidence that the antidesiccant material can be safely used on both deciduous and evergreen plants. Mandatory use, if any plants installed outside the specified planting period.
   b. Copies of each license and certificate necessary for complying with Federal, State, and municipal laws, codes, and regulations prior to delivery.
   c. Packing slips: Certified plant materials packing slips with each delivery.
   d. Buy America Certificate
5. Special Procedure Submittals:
   a. Request for Substitutions: Submit requests for plant material substitutions, if necessary, within 10 days of NTP.
      1) If a substitute is to be used on and jurisdictional agency, including but not limited to, NPS property, it requires approval by the Authority Representative and the NPS, or applicable agency.
      2) The Authority Representative will approve substitutions only after thorough evaluation has been made concerning the need for such a change based upon the unavailability of plant material specified. If size changes are made, the Authority Representative will require equal total caliper inches for trees as bid, or if limited by space, extra numbers of plants equitable to unit cost bid price; at no additional cost to the Authority.
6. Qualification Statements:
   a. Personnel qualifications: A list of the qualifications and experience of the workers, and qualifications and experience of the Landscaping Superintendent, Arborist and Tree Crew Supervisor, as attested by knowledge and experience in supervising contracts of similar size and scope in the past.
7. Test and Evaluation Reports:
   a. Soil Density Tests: Submit soil proctor tests made by a qualified independent soil-testing agency, acceptable to the Authority Representative, stating soil density. Perform tests where directed by the Authority Representative. Compaction by rolling or operating heavy equipment is not permitted within planting locations. Maximum density of subgrade in planting locations is 75 percent. Disc or rototill bottom of plant beds to remove hard pan that may exist and remove rocks and debris off site, at no extra cost to the Authority.
      1) Before beginning work: Furnish one pre-construction soil proctor test to 24- inch depth for each 100 square feet of approved work routes and storage areas.
      2) After completing work: Furnish one post-construction soil proctor test to 24-inch depth for each 100 square feet of approved work routes and storage areas.
      3) Perform additional soil proctor tests if correcting soil density is required.
   b. Topsoil pH Tests: Submit soil pH tests made by a qualified independent soil-testing agency, acceptable to the Authority Representative, stating soil pH. Report suitability of pH for growth of target crop in each area. State recommended quantities of soil amendments to be added to produce a satisfactory Ph.
      1) Furnish one test for each 500 square feet of each planting area, and not less than one test for each area.
      2) After adjusting pH, furnish one test for each 300 square feet of each pH-

adjusted areas, and not less than one test for each area.

3) Confirming orders: Within 10 calendar days after receipt of NTP, submit confirming orders from the nursery for plant material.

c. Reports: Furnish copies of the following reports to the Authority Representative either on a daily or weekly basis as requested.

1) Daily Work Log: Maintain a daily work log recording the quantities of trees and shrubs installed, and their locations.

d. Maintenance Reports:

1) Prepare monthly reports describing the work of the previous month and work scheduled for the following month.

2) At the end of maintenance period, submit maintenance schedules and instructions for future maintenance.

1.05 QUALITY ASSURANCE

A. Regulatory Agency Sustainability: Keep always available at the work site a copy of each of the cited references.

1. Authorities Having Jurisdiction:
   a. Codes and regulations of jurisdictional authorities, including but not limited to NPS, MNCPPC and MDNR.
   b. Wherever specific reference is made to NPS, MNCPPC and MDNR, it applies to work performed on or affecting the property governed by these agencies.
2. 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. Source Quality Control:

1. Verification of availability: Before bidding, verify sources of supply of the plants on the plant schedule, including requirements for size, species, variety and quality shown and specified.
2. Furnish plant materials certified by state or federal Department of Agriculture to be free from disease or infestation.
3. Obtain plants climatized to the Project area. Acclimate plants for a minimum of 3 months. Supply plants only from nurseries within U.S.D.A. Plant Hardiness Zone 6 or 7, and not more than 500 miles from the Project site.
4. Pre-select and tag at the nursery the large plants of quality and number indicated, prior to inspection by the Authority Representative.
5. Inspection of plant material:
   a. Inspection: Have plant material inspected and trees seal-tagged by the Authority Representative at the nurseries prior to digging. Have representative samples of shrubs and miscellaneous plants sealed.
      1) To be approved, remaining plants are to be equal to sealed samples. Obtain approval of plants after delivery and before planting.
      2) Inspection and approval of plants at the nursery or at delivery is for quality, size and variety only and will not abolish or abrogate the right of rejection for failure to meet other requirements discovered during the progress of the work.
   b. Travel expenses: In the bid price, include related Authority-incurred expenses for the Authority Representative's travel. Allow sufficient time for travel advance to be processed, minimum 2-weeks.
      1) Appropriate expenses include the costs associated with meals, lodging and transportation; i.e., airfare, auto rental, parking, tolls, and privately owned

vehicles at the rate per mile currently in effect under Federal Travel Regulations. Daily lodging and meal expenses may not exceed the per diem limits allowed under the provisions of the Federal Travel Regulations in effect at the time the expenses are incurred. Air travel is limited to regularly scheduled airline flights, coach class, whenever possible

2) In these costs allow for maximum 8-hour work days, including suitable inspection time and round-trip travel time.
3) No costs are borne by the Contractor for Authority-furnished labor. c. The NPS and MNCPPC, as applicable to the planting location, have the right to inspect, select and tag plants before delivery to the job site. If this inspection is made, it will be at the nursery at no additional cost to the Contractor.

6. Inspection of topsoil.
   a. Make arrangements with the Authority Representative for inspection at the source. Furnish travel expenses as specified for Inspection of Plant Material.
   b. Obtain representative topsoil samples for submittal as specified in Section 32 91 00.

C. Contractor is liable and responsible for any deleterious soil material brought on site, and subsequent pollution abatement clean-up.

D. Qualifications:

1. Superintendent: Use a Landscaping Superintendent with previous knowledge and verifiable experience in supervising landscaping work and grounds maintenance of similar size and scope. Have the Superintendent present whenever work is being performed and have the Superintendent responsible for controlling the quality of work and inspecting completed work to ensure that Contract requirements are met. The Superintendent is the primary contact person with the Authority Representative regarding landscaping work.
2. Arborist: Perform tree pruning and removal work under the direction and general supervision of an Arborist certified by the International Society of Arboriculture, PO Box 908, Urbana, IL 61801, telephone 217/328-2032; or by a Maryland-licensed Tree Expert; who has verifiable experience and technical competence in tree physiology, identification, diagnosis of disorders, and current tree care and safety practices in accordance with accepted industry standards. The Arborist is responsible for controlling the quality of pruning and removal work and for inspecting such completed work.
3. Tree Crew Supervisor: Have tree pruning and removal work performed under the full-time supervision of an experienced Tree Crew Supervisor to accompany each tree crew while work is being preformed. Ensure that the Tree Crew Supervisor has verifiable work experience as a full time direct supervisor of shade tree pruning and climbing work crews.
4. Workers: Have the work performed only by experienced workers, who through related training and verifiable previous on-the-job experience, are familiar with the technical aspects of landscape planting, grounds maintenance, with the hazards of tree pruning and removal work, and with equipment used for each of these operations as applicable. Have each worker abide by the code of ethics or professional conduct established by the Landscape Contractors Association MD-DC- VA, the National Arborist Association and the International Society of Arboriculture.

E. Certifications:
   1. Buy America Act Certifications:
      a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

b. Submit the Buy America Act Certification to the Authority Representative for approval.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery:
1. Notify the Authority Representative at least 48 hours before each delivery. Describe in writing the method of shipment and include an itemized list of quantity and sizes. Do not deliver plants until the areas for planting are prepared as required, and approved by the Authority Representative.
2. With each delivery, include certified packing slip for the shipment listing types and sizes of plants, types of materials, and quantities of each shipped. Inspect received materials against packing slip promptly upon arrival at the job site.
3. Deliver materials and products to the job site in their original unopened containers or wrappings, clearly labeled with the manufacturer's name and address, material components, trademark, chemical analysis, species, age and source. Materials and supplies are subject to inspection and sampling for testing.
4. Allow no agronomic materials or supplies on site other than those for the project.
5. Protect plants from weather and adequately pack them to provide protection against climate and breakage during transit. When shipment is made by open vehicle, tie and cover plant materials to prevent wind-shipping and dehydration. When shipment is made by closed vehicle, carefully pack and adequately ventilate plants to prevent condensation on or overheating of plants during transit.
6. Spray evergreen and deciduous plants in leaf with an anti-transpirant in accordance with manufacturer's instruction to protect from drying.
7. Protect roots of bare-root plants with approved nursery packing. Keep damp during delivery and storage. If planting is delayed, heel-in plants in topsoil or wet straw and keep moist.
8. Do not expose fertilizer to weather until used. Completely protect fertilizer before use and do not store in direct contact with the ground.

B. Plant Identification Labels: Mark plants with identification before delivery to the site. Make labels durable and legible stating the correct botanical name and size/caliper in weather-resistant ink or embossed letters. Securely attach labels to each plant in a manner that will not restrict growth. Maintain labels until they are removed by the Contractor at final acceptance or when directed otherwise by the Authority Representative.

C. Move plants marked B&B on plant list with root systems as intact solid units and with root balls of earth firmly wrapped.

D. Exercise care during every handling operation so as to prevent damage to bark, branches, roots and stem, and to preclude cracked root balls. Use platforms under balls whenever hoisting plants. Do not use plants with cracked, broken or loosely wrapped root balls. Handle plants only by root balls. Plants handled by tops will be rejected. Protect plant roots, root balls and tops from sun or drying winds until planted.

E. Do not stack root balls. This will mean that for a 40-foot flat bed trailer, the number of 1.75-inch to 2-inch B&B plants may not exceed 130.

F. Do not handle soil in a frozen or muddy condition.

1.07 JOB CONDITIONS

A. Conduct planting operations only under favorable seasonal conditions throughout the period of the Contract as determined by the Authority Representative. Install no plants during adverse weather or during periods when soil conditions are unfavorable as determined by the Authority Representative. Do not plant when ground is frozen.

B. Daily Work Log: Coordinate daily work log with work performed, recording numbers of plants planted and their locations.
   1. To indicate progress, attach color-coded survey tape in the planting areas, with a different color tape per month and marked with the date of installation in weather-resistant ink, keyed to the Plant Schedule shown.
   2. Securely attach tape to each plant in a manner that will not restrict growth. Maintain tape on plants until removal is directed by the Authority Representative.

C. Protection: During progress of operations, protect walls, walks, curbs, benches, lawn areas, plant material, and other site improvements by adequate means acceptable to the Authority Representative.
   1. Existing Vegetation: Preserve and protect existing vegetation such as trees, shrubs, and grass on or adjacent to the site which do not reasonably interfere with the construction. Box and protect trees and shrubs that may be subject to construction activities within the root protection area with chain link or wood fencing as directed by the Authority Representative.
   2. Weight Restrictions: Do not overload entrance paving, sidewalks and curbs. These areas are limited to a maximum load of 1,250 pounds per square foot.
   3. Existing Utilities and Structures: The existence and location of underground utilities on the plans are not guaranteed. Investigate and verify locations in the field before starting work. The Contractor will be held responsible for damages to, and for maintenance and protection of existing utilities and structures.
      a. Obtain copies of available as-built utility drawings from the Authority Representative for reference.
      b. Contact the local utility companies concerned to inform them of excavation plans.
      c. To locate utilities in the field, contact Miss Utility at 800/257-7777, 48 hours in advance of work.
      d. Perform excavation in vicinity of existing structures and utilities with great care.
   4. Pollution: Take necessary and adequate measures to prevent soil erosion, air pollution and water pollution by the materials and equipment used during construction.
   5. Repairs: If damage by the Contractor should occur, it is the Contractor's responsibility to repair or replace per the Authority Representative 's direction, as acceptable to concerned parties, and at no additional cost to the Authority. Perform work so that damaged areas make smooth, satisfactory, and imperceptible transitions to existing adjacent work. Use materials and methods conforming to current standards for the area damaged, matching adjacent materials in appearance, and meeting approval of jurisdictional authorities and the Authority Representative.
      a. Replace damaged existing turf areas with approved sod per Section 32 91 00.

D. Root Protection Zone (Area): Do not permit heavy equipment or vehicles or the stockpiling of materials in the root protection area without advance permission of the Authority Representative. Where such activity is allowed within the root protection area, provide an ample mitigation plan to prevent the possibility of damage to the tree trunk and roots, or to increase soil compaction.
   1. If the Authority Representative approves construction activities within the root protection area, protect tree trunks and shrubs with chain link fence or wooden fencing as directed, cover the entire root protection area with landscape fabric and weed barrier as approved, and mulch with four inches of mulch prior to construction. Placing metal plates, tree

pruning, fertilization, aeration and irrigation may also be required as directed by the Authority Representative.

2. If damage by the Contractor should occur, it is the Contractor's responsibility to repair or replace per the Authority Representative's direction, as acceptable to the applicable regional jurisdictions, including, but not limited to NPS, MNCPPC, and at no additional cost to the Authority.
3. For pruning or removal of existing trees, obtain approval by the NPS or the MNCPPC, as applicable, through the Authority Representative. Tree pruning and removal, except as shown, is NIC. and at no additional cost to the Authority.

E. If, at any time, the Authority Representative determines that work is unsatisfactory or being conducted in an unsafe manner, immediately cease such work activities upon notification.

1.08 SCHEDULING AND COORDINATION

A. General:
1. Perform planting operations according to Contractor's detailed and updated plan of the work as approved by the Authority Representative.
2. Schedule and arrange work so as not to interfere with normal activities of the applicable regional jurisdictions including, but not limited to NPS and MNCPPC land and adjacent properties. Advance notice will be given to the Contractor if a conflict is expected. Remove plant debris, personnel and equipment that could interfere with an activity or event prior to the activity.

B. Planting Seasons: The times of year in which planting is permitted is limited by the planting seasons for plant types as stipulated by the appropriate regional jurisdictional agency. Authority planting seasons are as follows. These time periods also include the time required, after initial planting, for staking, pruning and mulching operations.
1. Evergreen material:
   a. Fall planting: September 15 through November 30.
   b. Spring planting: March 1 through May 15.
2. Deciduous material:
   a. Planting period: October 15 through April 30.
   b. White and Willow Oaks, Ironwood, dogwoods and other species as specifically directed, may be planted in spring only: March 1 through April 30.
3. Subject to the Authority Representative's approval, extend or reduce planting season as required by weather and soil conditions. Preparations for planting may begin earlier than the specified seasons if weather permits and if the staking of plant locations has been approved.

1.09 WARRANTY

A. Six months in addition to the requirements of the General Provisions for a total of 18 months, commencing the day the landscaping is accepted.

B. Contractor has the responsibility for plant material locations that may be considered by the Contractor to be affected by adverse conditions, such as undesirable soil pH, water table factors, or poor drainage. Contractor also has responsibility during and following adverse weather conditions such as periods of excessive precipitation, extreme temperatures, wind and drought.

C. As specified in Part 3, Concurrent Maintenance and Warranty Period, seasonally replace dead plants and plants that have died back beyond normal pruning lines as determined by the

Authority Representative and at no additional cost to the Authority.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Plants and Plant Materials:
1. Provide plants meeting the requirements of the plant schedule as shown, identified by botanical and common names and in accordance with applicable standards of quality, size, condition and type listed.
2. Supply only plants free from disease, well-branched, in full foliage when in leaf and with healthy normal root systems. Have plants freshly dug, nursery-grown, and meeting the other specified requirements. Cold storage plants are unacceptable.
3. Plants in marked cans, pots, or other containers on the plant schedule are to have been grown in the containers for a minimum of three months and a maximum of two years. Ensure that plant roots filling the containers show no evidence of being or having been root-bound.
4. B&B plants: Use B&B plants that meet the Recommended Balling and Burlapping Specifications of ANSI Z60.1. Specifically: freshly dug by hand or with a mechanical tree digger in good condition, free of hydraulic leaks, with blades aligned and free of damage; roots wrapped firmly with untreated burlap, and bound carefully with untreated sisal or jute twine, cord or ungalvanized wire mesh; in a manner so as not to damage the bark, break branches, or destroy the natural shape.
5. Root ball: Dig trees so that the root crown is at the top of the root ball. Make diameter and depth of root balls sufficient to encompass fibrous and feeding root systems.
6. Provide genus, species and cultivar names which agree with the nomenclature of the most current edition of Hortus III by L.H. Bailey, Hortorium, Cornell University.

B. Topsoil:
1. Weathered surface soils or natural friable loam obtained from approved sources, free of subsoil, hard fragments and stones larger than one-half inch across greatest dimension, objectionable salts, noxious weeds and plants, debris and other materials inferior to surface soils or that would be toxic or harmful to growth; containing not less than 1.5-percent organic matter as determined by the Walkley-Black Method; capable of sustaining normal, healthy growth and development of seed and sod scheduled and specified.
2. Grading analysis:
   a. All material must pass through a two-inch screen. Remove all material larger than two inches from the site.

SIEVE	MINIMUM PERCENT PASSING
2 inches	100
½ inch	90
¼ inch	80
No. 10	70

3. Test and analysis of proposed topsoil material: Performed by local state agricultural experiment station or agricultural laboratory recommended by U.S. Department of

Agriculture and meeting the following requirements:

a. Soil pH range: Between pH 5.0 and pH 7.6 inclusive.
b. Soil salinity by electrical-conductivity measurement: 500-ppm soluble salt maximum.
c. Soil fertility: Rated high in natural nutrients in pounds-per-acre based on the standard soil test in laboratory.
d. Soil texture: Classification consisting of 5 to 25-percent clay, 20 to 60- percent sand, and 15 to 45-percent silt as determined by hydrometer or pipette method. Sand, silt and clay as defined by USDA-SCS.

C. Fertilizer:
1. Commercial fertilizer: FS O-F-241, Type I, of grade noted, Level B, composite and bearing manufacturer's guaranteed statement of analysis. Unless otherwise shown or specified, use 10-10-10 , slow-release, meeting the following minimum requirements:
a. Nitrogen content: Ten percent; slow-release, 50-percent organic.
b. Available phosphoric acid: Ten percent.
c. Potash content: Ten percent.
2. Soluble fertilizer: Standard commercial grade, 15-30-15 or higher analysis, Rapid- Gro or equal.
3. Packet tree and shrub fertilizer, minimum two-year time release: Root-Contact Packet, Sando Products, Inc., Prairie du Chien, Wisconsin 53821; Eeesy Grow, Specialty Fertilizer, Inc., Suffern, New York, 10901; 21 Gram, Planting Tablets, 200- 10-5 Agriform International Chemicals, Inc.; or equal.

D. Stable manure: Well-rotted cow manure. Free from fresh manure, sawdust, wood chips, tanbark, long straw, stones, chemicals used to hasten decomposition artificially, or other substances injurious to plants.

E. Perlite: Granules, sterile, uniform gradation, insoluble, high water-holding capacity; as available from Pennsylvania Perlite Corporation, Lehigh Valley, Pennsylvania 18001 or equal.

F. Mulch:
1. Mulch blanket: Knitted construction of bio-degradable yarn with uniform openings, Hold-Gro as manufactured by Gulf States Paper Corporation, Tuscaloosa, Alabama 35401 or equal.
a. 150-foot lengths or greater.
b. U-shaped staples: As supplied by mulch-blanket manufacturer.

2. Shredded hardwood or shredded pine bark: Sound, non-decomposed bark free from sticks, stones, clay and other foreign and toxic substances, with 50 percent over the minimum size indicated.
a. Regular size: 1/2-inch to two inches.
b. Extra-Coarse size: One inch to three inches.
c. Sources: Cove Dehydrated Products, Martinsburg, Pennsylvania 16662; Weyerhauser Garden Bark, Weyerhauser Company, Silva Products Department, Takoma, Washington 98401; or equal.

G. Crushed Stone: ASTM D448, Size 57.

H. Pea Gravel: Smooth, rounded pieces of gravel, clean and free from objectional materials, such as soft particles, coal and lignite particles, or friable particles, graded from 1/4 to 3/8 inch in size.

I. Sand: Sharp, common, coarse, wet sand as approved, for use under plants.

J. Peat Moss: Type 1 sphagnum peat moss (at least 75-percent), finely divided, with a pH of 3.1 to 5.0, moistened prior to and at time of use.

K. Perforated Plastic Pipe: ASTM D2729.

L. Landscape Fabric and Weed Barrier: Porous geotextile fabric for water and nutrient exchange; tear-resistant, minimum four ounces per square yard; Typar Landscape Fabric, DeWitt Earthmat, Pro 5, or equal.

M. Limestone: Agricultural or dolomitic, ASTM C51, capable of neutralizing soil acidity and containing not less than 85 percent of total carbonates. Containers or sacks labeled to show chemical and mechanical analysis.

N. Plant Hormone: Vitamin powder; Transplantone, American Chemical Paint Co., Ambler, Pennsylvania 19002; Super Thrive, Vitamins Institute, 5409 Satsuma Avenue, North Hollywood, California 91601; or equal.

O. Antidesiccant for Retarding Excessive Loss of Plant Moisture and Inhibiting Wilt: Sprayable, water-insoluble vinyl-vinyldine complex which will produce a moisture-retarding barrier not removable by rain or snow. Capable of forming a film at temperature commonly encountered out-of-doors during planting season and with the moisture-vapor transmission rate of the resultant film not more than 10 grams per 24 hours at 70-percent humidity; Wilt-Pruf, as manufactured by Wilt-Pruf Nursery Specialty Products, Inc., Greenwich, Connecticut 06830; Vapor Gard as manufactured by Miller Chemical Company, Hanover, Pennsylvania 17331; or equal.

P. Tree Stakes and Guys:
   1. Stakes: Sound No. 2 Douglas fir or rough sawn straight-grain oak of uniform size.
      a. Type 1: Two-inch square or 2-1/2 inches in diameter, eight feet long, with six-inch point at one end. Paint with two heavy brush coats of dark walnut oil stain before installation. After installation, cut off stakes square to a level two inches above the wires.
      b. Type 2: Two-inch square by 30 inches long and notched to bold wires.
   2. Metal stakes: Steel angle, zinc-coated, ASTM A153, 1/4-inch thickness, 1-3/4 inches by 1-3/4 inches by 30 inches long.
   3. Pipe: ASTM A53, hot-dip galvanized, 1-1/4 inch OD eight feet long.
   4. Wood flags: 1/2 inch by two inches by ten inches, painted white.
   5. Turnbuckles: Galvanized, ASTM A153, three-inch minimum adjustment and 5/16- inch minimum diameter threaded opening fitted with screw eyes.
   6. Wires: Zinc-coated steel, No. 12 wire.
   7. Wire guards: Sound, two-ply, 5/8-inch inside diameter, round hose of fabric and rubber, black or green color.
   8. Ring bolts: 1/4-inch by three-inch tie-wire anchor HILTI HKT 14, HILTI Fastening Systems, Langley Park, Maryland 20783; or equal.

Q. Wrapping Material:
   1. Tree wrap: Two thicknesses of crinkled paper cemented together with bitumen, waterproof, four inches wide; as manufactured by Bemis Bag Company, Chase Bag Company, Sisalkraft or equal. Use as directed by Authority Representative or required by jurisdiction, always applicable for. plants subject to sun scald.
   2. Twine: Lightly tarred medium or coarse sisal yarn.

R. Watering Pipe: As shown.

S. Marker Stakes: Sound No. 2 Douglas fir, or equivalent grades of rough sawn straight-grain oak, rough sawn cypress, hard pine, cedar, or locust; straight, of uniform size, 3/4-inch x 2-inch x 18 inches, pointed at one end.

T. Tree Grates, Tree Grate Frames and Tree Guards:

1. Round tree grates: As shown, or with five-foot diameter, radial pattern, and expandable, as approved.
2. Square tree grates: As shown.
3. Guards: As shown.
4. Cast iron: ASTM A48.
5. Steel angles, plates and collars: ASTM A36.
6. Steel tubing: ASTM A501.
7. Bolts and washers: ASTM A307, zinc-coated.
8. Screws: Stainless steel, ASTM F593, Alloy S30400.
9. Tubing and collars: Shop-painted in accordance with Section 05500; finished as shown.
10. Steel bars: ASTM A36.

U. Hedge Guards: PVC-coated chain link fencing and accessories as specified in Section 02820, and as shown; consisting posts, fabric, tension wire and ties.

V. Water: Potable.

W. Composted screened leaf mold:
1. Processed leaves aerobically composted, free from litter such as glass, paper, plastic and other foreigh substances, as approved.
2. Source: Leaf-Gro as available from Maryland Environmental Services, 2020 Industrial Drive, Annapolis, Maryland 21401 (301) 261-8596, or equal. Do not use composted sewage sludge.

X. Planting Mixtures:
1. Planting Mixture A:
   a. Use: For backfilling plant pits of deciduous and evergreen trees, shrubs, excluding azaleas:
   b. Mixture: Four parts topsoil and one part leaf mold or decomposed cow manure plus five pounds of 10-10-10 fertilizer per cubic yard, mixed on site to an approved consistency.
2. Planting Mixture B:
   a. For backfilling plant pits of deciduous and evergreen groundcover and vines and all azaleas:
   b. Mixture: Four parts topsoil, one part leaf mold and one part perlite plus five pounds of 10-10-10 slow-release fertilizer per cubic yard, all mixed on site to an approved consistency.

2.02 EQUIPMENT

A. Use only equipment that meets federal OSHA, state and local safety requirements and that is properly licensed. This includes but is not limited to equipment such as bucket trucks, aerial lifts, chipper trucks, wood trucks and stump grinders, which may be needed to correctly perform landscaping, maintenance, and tree pruning and removal in accordance with the

requirements.

B. Have the name or logo of the Contractor or subcontractor clearly displayed on trucks used on the job.

C. Use equipment of sizes that clear access routes, protective markers and barriers by 2 feet or more on each side.

D. Do not use material storage devices or equipment that could increase compaction of existing, undisturbed soils.

PART 3 - EXECUTION

3.01 PREPARATION FOR PLANTING

A. See Article above on Scheduling and Coordination.

B. Pre-Planting Conference: See Article above, under Quality Assurance.

C. Locate and mark location of each underground utility.

D. Mark outlines on the ground for locations of individual trenches and planting beds as approved. Have the Authority Representative approve marked locations before excavating.
   1. Drive marker stakes with at least eight inches projecting above surrounding ground cover.
   2. Paint top four inches of each stake according to the following color schedule and mark stakes with plant common name and sizes for each location:
      a. Evergreens: Blue.
      b. Deciduous trees: Red.
      c. Flowering trees: Yellow.

E. Do not permit personnel, vehicles, or equipment not directly associated with the work into the planting areas.

F. Inspect Plants: Do not plant if plants appear damaged, unhealthy, insect infested, or if the root ball is cracked or broken either before or during planting operation.

3.02 PRESERVATION OF EXISTING PLANTS

A. Preserve and protect existing plants in accordance with the existing Plant Schedule as shown and with the requirements of Section 02205.

3.03 EXCAVATION FOR PLANTING

A. Exercise care during entire time of excavation and planting work so as to prevent contact with, disturbance of or unearthing of utilities and devices. Hand excavate wherever necessary to ensure this level of care.

B. Exercise care in excavating tree pits at locations with existing drainage systems so as to prevent contact with, disturbance of or unearthing of drainage systems. Hand excavate wherever necessary to ensure this level of care. Place landscape fabric as shown. Staple per manufacturer's directions.

C. Plant Locations: Locate plants as shown on the Contract Drawings, from dimensions shown, and as approved by the Authority Representative after locations are marked per the Preparation for Planting requirements specified above.

D. Excavate pits, trenches, and beds with vertical sides and flat bottoms, to dimensions shown.

E. Excavate pits to a minimum depth of 24 inches, measured from finished grades, or as shown.

F. Make pits for bare-root plants to diameters at least 12 inches larger than the maximum spread of the roots and to minimum depth of at least 12 inches below the roots of the plant as placed.

G. Make pits for balled or potted plants, with ball or container less than 12 inches in diameter, to diameters at least 16 inches larger and depth to size of ball or container. Alleviate hardpan compaction by rototilling or discing sub-soil beneath plant.

H. Make pits for balled or potted plants, with ball or container 12 inches or greater in diameter, to diameters at least 24 inches larger and minimum depth to size of ball or container.

I. Install trench drain for trees on slopes greater than 3:1 in locations as shown. Excavate four to six inches wide. Start bottom of trench at elevation of bottom of plant ball and extend away on low side of plant location until daylighted. Fill bottom twelve inches of trench with pea gravel. Backfill to surface with excavated material from trench. Blend surplus over area next to trench. Cover surface with material to match the surrounding area.

J. Make beds for ground cover plants to the length and width shown with minimum depth of six inches. Install landscape fabric beneath mulch layer, stapling per manufacturer’s directions.

K. Backfill plant pits that are abandoned due to unsuitable conditions with same excavated material, grade and seed.

L. Before the close of each working day, barricade open pits. When pits are excavated more than fourteen days in advance of planting, backfill the excavations with the planting mixture specified.

M. Remove and dispose of rocks, debris and excess excavated material off site. Set aside excavated soil needed for backfill mix and to form saucers.

3.04 PLANTING:

A. Set plants plumb and straight with allowance for settlement. Set watering pipe as shown.

B. Place balled plants so that the top of the root ball bears the same relation to finish grade as it bore to previous finish grade in nursery, or 1/8 higher than depth of root ball= approximately two inches higher. Place fertilizer packets or tablets in accordance with manufacturer's recommendations alongside the base of root ball. Backfill with specified planting mixture in 12-inch layers and tamp each layer to fill voids until planting mixture is at grade. Cut and remove burlap and lacing six inches away from trunk, or as approved. Leave remainder of burlap and lacing intact. Soak plant with water containing plant hormone.

C. Open and remove containers from potted plants. If the growing medium is comprised of 75 percent or more of peat, perlite, sand or like material other than soil, pull visible roots away from container medium leaving the roots partially exposed. Place plants in plant pit or trench and carefully place backfill planting mixture among exposed roots. Continue backfilling and tamping in six-inch layers until finish grade is reached. Soak with water containing plant hormone.

D. Remove and store existing tree grates and replace when planting is complete.

E. Placement of bare-root plants: Place in pit or trench, cut off broken or frayed roots, spread root system, backfill with planting mixture in six-inch layers, settle to finish grade with water containing plant hormone.

F. Create saucer around isolated plants with soil to retain water unless otherwise shown. Bring beds to smooth, even surfaces which will conform to established grade after full settlement has occurred.Plant shrubs as a bed, using weed barrier fabric beneath mulch when shrubs are spaced less than six foot on center (6' O.C.), unless otherwise detailed.

G. Place specified planting mixture in groundcover bed at six-inch depth or as otherwise shown in contract drawing detail , place landscape weed barrier and then top with a layer of mulch to depth of three inches after compaction.

H. Remove groundcover plants from pots with root system intact and set in mulched planting beds, cut through weed barrier, in the spacing and arrangement shown. Work soil firmly around each plant and restore the mulching material. Settle to finish grade with water containing plant hormone. On slopes greater than 2:1, after preparing planting beds and mulching, but prior to planting, apply mulch blanket as directed and staple according to manufacturer's instructions.

I. When pits are dug in wet areas or where subsoil will not permit drainage as shown, set plant higher than normal using extra depth of crushed of crushed stone or sand, up to 12 inches total depth, to keep ball from settling. Set top of plant root ball up to six inches higher than grade, as directed. Blend the immediate area outside the saucer with suitable soil to meet existing grade.

J. Topsoil or approved fine, dry subsoil excavated or augered from plant pits may be used to form saucers. If plant pits are augered, break down side of the hole to permit root penetration.

K. Create soil berm around downhill portion of planting pits on slopes.

L. Cultivating: Cultivate trenches and shrub beds to the line shown. Cultivate area around isolated plants at least six inches beyond diameter of pit.

M. Mulching: After planting and cultivating are completed, spread a layer of mulch on finished grade around plants to a depth of three inches after compaction. Lay landscape fabric beneath shrubbery beds, groundcover areas, and in tree pits, stapling as necessary per manufacturer’s directions. Spread mulch around isolated plants over an area at least six inches greater than diameter of the pit and extend mulch over berm saucers as shown. Completely cover trenches and shrubbery beds with mulch. In planters and beds, spread a layer of mulch to depth of three inches after compaction.

N. Pruning: Prune plant material after installation as approved to thin branches and foliage and yet retain species shape and trim hedges as shown. Do not cut leaders.
   1. Remove limbs, branches, canes and runners which require trimming with a clean cut flush with trunk or adjacent stem.
   2. When pruning lateral branches, cut at the same angle as that at which the buds are growing from the branches. Cut at a distance of 1/8-inch to 1/4-inch beyond the buds to avoid injuring them.
   3. Sterilize cutting tools with alcohol before proceeding to next plant after pruning out infected twigs and branches.

O. Planting in Planters: Install crushed stone, landscape fabric and weed barrier, planting mixture and mulch as shown. Mound planting mix as shown for positive drainage. Do not work soil when frozen.

P. Flower Beds: Plant flowers as shown, at planting seasons recommended by regional jurisdictions and/or growers.

Q. Wrapping: Check with Authority Representative for necessity. For plants prone to sun scald use immediately after planting, spirally wrap trunk and main branches of trees with an overlay of two inches starting at the bottom. Tie wrap securely in place with twine.

R. Guying: Within three days after planting, guy each tree four-inch caliper or larger as shown. Protect trees at points of contact by use of wire guards. After installation, cut stakes square to a level two inches above the wires.

S. Staking: Support trees smaller than four-inch caliper within three days after planting by staking at perimeter line of ball as specified and to sufficient depth to hold tree rigid. Drive stakes vertically to achieve uniform height of five feet-six inches above finish grade or as directed. Do not twist or pull. Wire tree with wire guards interlocked to each stake at four inches above finish grade, or as directed.
1. Planting areas: Three stakes, 120-degrees apart.
2. Trees with grates: Four stakes, 90-degrees apart.

T. Installation of Hedge Guard: Space hedge guard posts at a maximum of eight feet on centers. On curves with radii less than 100 feet, space hedge guard posts at a maximum of four feet on centers. Drive posts plumb to a height of three feet-six inches; protect end of pipe. Install one-cubic foot of concrete around base of end post in each run to serve as
T. pull anchor. Secure fabric to posts with ties spaced 12 inches on centers. Install tension wire two inches below top of fabric. Install permanent caps on posts.

U. Removal of Seals and Tags: As approved.

3.05 EXISTING TREE PRUNING AND REMOVAL:

A. Safety:
1. Conduct operations in accordance with national and local fire and safety codes, laws, rules, regulations and ANSI Z133.1 Safety Requirements for Pruning, Trimming, Repairing, Maintaining and Removing Trees and Cutting Brush.
2. Have employees wear reflective, bright orange vests while conducting operations in or adjacent to roadways.
3. Do not permit any one except the operator within six feet of a power saw.
4. Block off the work area to pedestrians, other workers and vehicles.
5. Look for, note and report to the Authority Representative in writing the presence of the slightest structural weakness, disease conditions, decayed trunk or branches, split crotches or branches, or other hazardous condition that has potential for damage to property or personal injury.

B. Tree Pruning:
1. Prune and thin trees when in foliage according to the Pruning Standards for Shade Trees (revised 1988) by the National Arborist Association. The classes of pruning are as follows:
a. Class I Fine Pruning: Fine pruning consists of removing dead, dying, diseased,

interfering, objectionable, obstructing and weak branches, as well as selective thinning to lessen wind resistance. Removal of such branches includes those on the main trunks as well as those within the leaf area. An occasional branch as described above up to ½-inch in diameter may remain within the main leaf area where it is not practical to remove.

b. Class II Medium Pruning: Medium pruning consists of removing dead, dying, diseased, interfering, objectionable and weak branches on the main trunk as well as those within the leaf area. An occasional branch up to one inch in diameter may remain within the main leaf area where it is not practical to remove.

c. Class III Coarse Pruning: Coarse pruning consists of removing dead, diseased, or obviously weak branches, two inches in diameter or greater.

d. Class IV Cutting Back or Drop Crotch Pruning: Cutting back or drop crotch pruning consists of reducing tops, sides, underbranches or individual limbs.

1) Undertake this practice only in cases of utility line interference, or where certain portions of the roots or root systems have been severely damaged, or when there is unusual and rapid tree growth, where it is necessary to reduce the top, sides or underbranches, or for specific topiary training or dwarfing.

2) When cutting back, do not reduce more than 1/3 of the total area as a single operation. When cutting back trees, only drop crotch as much as necessary. Make every effort to cut back to a lateral, one- third of the diameter of the cut being made.

3) In reducing overall size, give attention to the symmetrical appearance. Keep top higher and sides reduced in order to maintain a tree-like form.

4) Contact the Authority Representative prior to pruning a tree specified as Class I or Class II pruning if said pruning will reduce the surface area of the tree by more than 25 percent. Report tree structural problems.

2. Cut back dead, diseased and dying wood into healthy wood.
3. On trees known to be diseased, disinfect tools after use on each tree with methyl alcohol at 70 percent (denatured wood alcohol diluted appropriately with water) or Chlorox bleach solution.
4. Remove weak crotches, defined as split or rotted wood between two trunks of limbs that may break and fall during high wind.
5. Where branches cross and rub together or are forming a V-crotch, remove one branch without ruining the appearance of the tree.
6. Selectively prune trees which are developing more than one dominant leader in order to promote a single dominant leader by sub-dominating the other competitive branches. Make selection of the dominant leader with consideration of the tree's natural form, health, and structure.
7. Inspect old injuries. Where appropriate, trace those not closing properly and where callus growth is not already completely established.
8. Remove girdling roots.
9. Trimming for clearance:
   a. Trim trees to provide three feet of clearance from adjacent buildings and structures.
   b. For street trees and trees over walks, trails, and picnic areas over six inches diameter at breast height (dbh), remove lateral limbs and water sprouts from the main trunk of the tree to a height of 12 feet above the ground. For trees over 10 inches dbh, remove lateral limbs and water sprouts from the main trunk of the tree to a height of fourteen feet above the ground.
   c. Prune trees in the vicinity of electrical or phone lines so as to provide six to eight feet of clearance between lines and the nearest limb.
10. Remove branches with a slanting cut starting just above a vigorous bud or shoot and running back across the limb at a 45 degree angle. Make cuts sufficiently close to the trunk or parent limb, without cutting into the branch collar or leaving a protruding stub, so

that closure can readily start under normal conditions. Make clean cuts.

11. Precut branches that are too heavy to handle to prevent splitting or peeling the bark. Where damage to other trees, foliage or property is possible, lower branches safely to the ground by ropes or equipment. Under no circumstances drop branches or main trunks freely onto a road, shoulder or paved surface.
12. Trim salvageable branches by removing smaller branches flush with the surface of the main branch.
13. Do not remove entire or large portions of healthy, sound limbs in order to facilitate the removal of dead or dying terminals.
14. Complete required pruning and removals at the site of each tree, including removal of logs and debris, before initiating work on the next tree.
15. Do not use chain saws or circular power blades to remove branches less than two inches in diameter.
16. Do not use wounding paint,
17. Do not use climbing hooks while pruning.

C. Tree and Stump Removal:
   1. Take every reasonable precaution, including but not limited to topping, sectioning and lifting of trees, diagnosing soundness of existing wood, and planning escape routes for workers to prevent damage to other vegetation, property, utility lines and persons and to prevent gouging and erosion of soils as a result of removal operations.
   2. Fell trees only when there is an adequate felling area at least equal in radius to the height of the tree. Top and remove in sections trees that cannot be felled due to proximity of buildings, conductors, adjacent trees, or lack of an adequate felling area.
   3. Properly rope, guy, or anchor trees to be felled that may cause damage to property or existing vegetation.
   4. Climbing hooks may be worn for tree removal work.
   5. Remove stumps to a depth of 12 inches below grade. Backfill and level the stump hole with clean wood-waste material.
   6. Completely remove each tree, including removal of logs and debris, before initiating work on the next tree.

D. Debris removal:
   1. Cut branches over six inches into 18 to 24 inch lengths.
   2. Chip material less than six inches in diameter.
   3. Collect, deliver, and unload wood and chips to a location specified by the Authority Representative. If approved, chips may be blown into adjacent natural areas.
   4. Remove wood, debris and chips on a daily basis. Sale of wood is not permitted on the project site.

3.06 INTERIM MAINTENANCE (UNTIL SCI):

A. While planting is in progress, perform interim maintenance and management practices on work completed. During the post-planting period and until the SCI, properly care for plants furnished; performing watering, cultivating, and other maintenance tasks necessary to keep the plants in a live, healthy condition.

B. Maintain plants and work incidental thereto by performing the following and other operations of care to promote root growth and plant health so that plants are in an approved condition throughout the interim maintenance period. Perform work in a manner which maintains the original intent of the reforestation and landscape design. Submit maintenance reports and schedules as specified.
   1. Watering and draining: Water plants as required twice each month, or more frequently if

weather conditions require such, as directed.

2. Weeding: Weed by hand the mulched area around each plant and within bedded areas, at least twice each month during the growing season. Remove weeds from the site immediately. As directed, approved chemical weed killers may be used with precautions to prevent undesired damage resulting from such use. Submit Herbicide spill plan and daily use log , when required by jurisdictional agency.
3. Pruning: Prune plants to ensure a desired growth habit and to remove dead wood, as directed and approved.
4. Mulching: Mulch to maintain the depth as indicated or as directed.
5. Securing stakes: Replace or adjust as necessary to maintain stability.

C. Periodically inspect plants during the interim maintenance period and notify the Authority Representative in writing of suspected problems. The Contractor is responsible for insect and disease control on Authority property. Take necessary measures to ensure effectiveness of the treatment and plant survival. Insect and disease control are the responsibility of the NPS and MNCPPC ,unless brought in by Contractor's plant source.

3.07 SOIL DENSITY ADJUSTMENT

A. After completion of work and before Substantial Completion Inspection (SCI), have the soil-proctor testing along work routes and storage areas performed as required above under Submittals, Documentation.
B. Adjust unacceptably compacted soil to a maximum of 75 percent maximum dry density in accordance with the Authority Representative's directions and at no additional cost to the Authority. In root protection zone, use of decompaction machinery is unacceptable.

3.08 SUBSTANTIAL COMPLETION INSPECTION (SCI)

A. A Substantial Completion Inspection will be held by the Authority Representative after completion of planting to verify that the work was performed as defined in the Contract Documents.

B. Do not remove tags, labels, etc. after SCI. These are needed during Concurrent Maintenance and Warranty period. Remove such identifications only at final acceptance.

C. SCI commences the Concurrent Maintenance and Warranty Period of the Contract for items accepted as of this inspection.

3.09 CONCURRENT MAINTENANCE AND WARRANTY PERIOD

A. See warranty requirements in General Provisions, General Requirements, and specified in Part 1 of this section.

B. After the Authority Representative has accepted the completed work in accordance with SCI, perform post- planting maintenance and plant management concurrent with the warranty period. During this period, properly care for plants; performing the following and other beneficial operations of care for promotion of root growth and plant life so that each plant is in an approved condition at the Substantial Completion Inspection and throughout the maintenance period:

1. Watering and draining: Water plants as required twice each month. Every two weeks during the growing season, examine or sound the watering pipe at each plant to determine if too much water is collecting in the plant pit. Remove surplus water by pump or syphon without staining the pavement. Bi-weekly check relative moisture content of

soil for typical tree and typical area of shrub or hedge planting; weekly during the months of July and August. Use Peerless Moisture Indicator, Tree-Type; or equal; following manufacturer's recommendations. Provide sufficient water to maintain relative moisture content of 25 to 30 percent. Provide water, fittings, hose, and water tanks as required to perform watering operation.

2. Weeding: As necessary, perform seasonal weeding in the mulched area around each plant and in bedded areas, at least twice each month. Pull roots by hand or use approved chemical weed killers . Submit Herbicide spill plan and daily use log, when required by jurisdictional agency. Correct any damage resulting from such use and no not spray when winds are over . Remove weeds from the site.
3. Controlling insects and diseases: Treat plants year-round with an approved chemical spray or systemic chemical as necessary to prevent insects, disease and fungus. Take necessary measures to ensure effectiveness of the treatment and plant survival. Submit Pesticide spill plan and daily use log, when required by jurisdictional agency. Protect vehicles and construction in the vicinity from damage or staining.
4. Pruning: Prune plants during each growing season to develop a desired growth habit and to remove dead wood.
5. Fertilizing: Fertilize trees, shrubs, hedge plants and groundcover once between May 15 and July 1 with 15-30-15 soluble fertilizer, or equal, at the manufacturer's recommended rate.
6. Edging: At least twice during the growing season, edge around the mulched area of each plant.
7. Mulching: Mulch to maintain the depth as shown.
8. Wrapping: Rewrap to maintain protection and a neat appearance. Remove wrapping at end of first winter period after planting as approved. Repair damaged areas previously covered by wrapping.
9. Securing guys and stakes: Replace or adjust to maintain stabilization. Before end of maintenance period, remove stakes and guys above grade.

C. Removing and Replacing Plants: After early Spring and early Fall seasonal inspections and written notification by the Authority Representative of the plant material to be removed and replaced, proceed as follows:
   1. Remove or cut off at ground line said plant materials that are dead or in an unhealthy, unsightly or badly impaired condition, within three weeks after notification.
   2. Replace the plant materials during the next specified planting season with healthy plants of the same kinds and sizes as originally specified. Make such replacements in the same manner as specified for the original planting. Notify the Authority Representative prior to performing the work.
   3. Attach color-coded tag indicating replacement, and mark with the date of replacement in weather-resistant ink, keyed to the Plant Schedule shown. Securely attach tag to each plant in a manner that will not restrict growth. Maintain tag on plants until removal is directed by the Authority Representative.
   4. Failure to notify Contractor of plant material to be removed or replaced does not relieve the Contractor from warranty obligations.

D. The Contractor will not be held responsible or liable for damage by animals, by malicious or careless human agencies over which the Contractor has no control, by fire or storm, or by vehicular accidents by others that occur after the Substantial Completion Inspection.

E. Clean-Up: Leave paved surfaces broom clean and stain free. Remove rubbish and debris caused by this work. Keep site clean during maintenance period.

3.10 FINAL ACCEPTANCE

A. Prior to final acceptance, perform final cleanup, including removal of stakes above grade, guys, signs and other items as directed by the Authority Representative, and for remulching plants and beds to a loose measurement as specified. Place no mulch against a trunk or stem.

B. Cut off watering pipe projecting above the mulch level.

C. Replace rejected plants as specified.

D. Submit maintenance reports and schedules as specified.

E. Request inspection for final acceptance at least 10 days before the end of the Concurrent Maintenance and Warranty Period.

PART 4 - MEASUREMENT AND PAYMENT

4.01 BASIS

A. Compensation for work specified in this section will be made in the following manner for work done satisfactorily based upon the lump sum price for the work of this section:
   1. Installation: 70-percent of lump sum price, pro-rated monthly during planting operations.
   2. Concurrent Maintenance and Warranty: 20-percent of lump sum price, pro-rated monthly or quarterly after planting operations.

B. 3. Final Acceptance: 10-percent of lump sum price, for satisfying Contract requirements pertaining to Final Acceptance.

THIS SPACE INTENTIONALLY LEFT BLANK

TABLE 32 90 00-1: MATERIALS SUBMITTAL CHART
This chart indicates the minimum length of time required for the approval process before intended use and by which submittals must be made, as well as the minimum quantity for each sample. Useable samples will be returned.

ITEM	TIME	QUANTITY	COMMENT
Fertilizer	14 days	50 pounds (25 kilograms)	Sample of each type to be used in unopened container.
Mulch	7 days	10 pounds (5 kilograms)	- -
Crushed Stone	7 days	10 pounds (5 kilograms)	- -
Sand	7 days	10 pounds (5 kilograms)	- -
Plastic Pipe	7 days	3 feet (1 meter)	- -
Mulch Blanket	7 days	1 square yard (1 square meter)	Include staples.
Pea Gravel	7 days	10 pounds (5 kilograms)	- -

ITEM	TIME	QUANTITY	COMMENT
Plant Hormone	14 days	10 pounds (5 kilograms)	- -
Antidessicant	7 days	1 pint (0.5 liter)	- -
Tree Stakes and Guys	14 days	1 each	Sample of complete guying system to be used.
Wrapping Material	14 days	1 foot (30 centimeters)	Sample of complete wrapping system to be used.
Landscape Fabric and Weed Barrier	7 days	1 square yard (1 square meter)	- -
Marker Stakes	7 days	1 each	- -
Tree Grates and Guards	14 days	1 each	Sample of complete system to be used.
Perlite	14 days	10 pounds (5 kilograms)	- -
Peat Moss	14 days	10 pounds (5 kilograms)	- -
Limestone	14 days	50 pounds (25 kilograms)	Sample in unopened container.
Hedge Guard	14 days	6 feet (2 meters)	Sample of complete system to be used.

ITEM	TIME	QUANTITY	COMMENT
Topsoil	28 days	25 pounds (15 kilograms)	- -
Screened Leaf Mold	14 days	50 pounds (25 kilograms)	Sample in unopened container
Herbicide	14 days		Supply MSDS and use directions
Other Material	- -	- -	As directed.

END OF SECTION

SECTION 32 91 00

PLANTING PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies providing and maintaining seeding and sodding, including grass, crownvetch and lespedeza.

B. Related Work Specified Elsewhere.
   1. Section 31 20 00 – Earth Moving.
   2. Section 02 42 13 – Deconstruction of Structures.
   3. Section 32 90 00 – Planting.

1.02 REFERENCES

A. Definitions:
   1. UMCP: University of Maryland, College Park
   2. Numerical fertilizer analysis: Three-digit number indicates nitrogen, phosphoric acid and potash percentages by weight. Thus, 3-25-25 means three-percent nitrogen, 25-percent phosphoric acid and 25-percent potash by weight.

B. Reference Standards: Keep always available at the work site a copy of each of the cited references.
   1. ASTM International:
      a. ASTM C51 – Standard Terminology Relating to Lime and Limestone
   2. UMCP:
      a. Current publication of Agronomy Mimeo #77 (Turfgrass Cultivar Recommendations for Maryland).
   3. U.S. Government:
      a. Federal Transit Administration:
         1) 49 CFR 661 Buy America Requirements.
      b. United States Department of Agriculture:
         1) USDA-SCS.

1.03 SUBMITTALS

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Samples:
      a. Submit in accordance with Table 32 91 00-1 and as follows:
         1) Seed: Each seed bag bearing the following upon delivery:
            a) Analysis tag.
            b) Certification tag.
            c) Maryland or Virginia State tags where applicable.
         2) Inoculant: Sample packet of inoculant, viable bacteria, true to legume strain required and listing source.
         3) Sod: Maryland or Virginia State-Certified, each delivery bearing a Maryland or Virginia certification tag and label as required by law.
         4) Topsoil: Submit supplier's name and address and source of topsoil. Submit

certified report of soil laboratory test results listing textures, pH, P and K nutrients, soluble salt, organic matter and mechanical analysis as to percentage of sand, silt and clay. Do not deliver topsoil to site until approved. Approval does not constitute final acceptance.

5) Fertilizer: Labeled with manufacturer's name and address, guaranteed analysis, including nutrient and its derived source and listing of potential acidity.
6) 6Limestone and acidifying agent: Labeled with manufacturer's name and address, chemical analysis, oxide content and size gradation of each used.
7) Mulch and mulch binder: Labeled with manufacturer's name and address, material components, trademark, chemical analysis, species, size, age and source.
8) Herbicide: Labeled with manufacturer's name and address and chemical analysis. Include in submittal the Material Safety Data Sheet, with copies to the Authority Representative and Contractor's Safety Officer.

b. Usable samples will be returned.

2. Certificates:
   a. Buy America Act Certification.
3. Qualification Statements:
   a. Personnel qualifications: A list of the qualifications and experience of the workers, and qualifications and experience of the Superintendent, as attested by knowledge and experience in supervising contracts of similar size and scope in the past.
   b. Soil tests for crownvetch and lespedeza areas: Submit certified report of soil tests made by a local state agricultural experiment station or agricultural laboratory recommended by U.S. Department of Agriculture. Test for pH, P and K nutrients, soluble salt, organic matter and mechanical analysis as to percentage of sand, silt and clay; and include recommended quantities of soil amendments to be added to produce the target pH value and to produce optimal growing conditions for the target crop.
   c. Furnish one test for each 500 square feet of each crownvetch and lespedeza planting area, and not less than one test for each area.
   d. Equipment list: A list of the equipment anticipated for use, including the make and model, year manufactured.

1.04 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals:
   1. Jurisdictions Having Authority:
      a. Codes and regulations of the jurisdictional authorities.
   2. 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. Personnel Qualifications:
   1. Superintendent: Use a Superintendent with previous knowledge and verifiable experience in supervising seeding and sodding work of similar size and scope. Have the Superintendent present whenever work is being performed and have the Superintendent responsible for controlling the quality of work and inspecting completed work to ensure that Contract requirements are met. The Superintendent is the primary contact person with the Authority Representative regarding seeding and sodding work.
   2. Workers: Have the work performed only by experienced workers, who through related training and verifiable previous on-the-job experience, are familiar with the technical aspects of seeding and sodding, and with the materials and equipment used for each operation. Have each worker abide by the code of ethics or professional conduct

established by the Landscape Contractors Association MD-DC- VA.

C. Certifications:
   1. Buy America Act Certification:
      a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.
      b. Submit the Buy America Act Certification to the Authority Representative for approval.

1.05 DELIVERY, STORAGE AND HANDLING

A. General: Materials and supplies are subject to inspection and sampling for testing. Allow no seed, sod, fertilizer, straw or other agronomic materials or supplies on site other than those for the project

B. Seed: Deliver with labels and tags.

C. Inoculants: Store inoculant containers below 70F until used. Keep containers sealed until contents are used in their entirety. Use inoculants before expiration date shown on packet. Using inoculants exposed to temperatures of 70F or greater is prohibited.

D. Sod: Deliver sod with labels and tags.
   1. Deliver sod to job within 24 hours after being cut; place sod within 36 hours after being cut.
   2. Prior to and after delivery during wet weather, allow sod to dry to the extent that will prevent tearing during handling and laying. During dry weather, water sod to ensure its vitality and prevent dropping of the soil in handling.

E. Topsoil: During hauling operations, keep walkway and roadway surfaces clean. Promptly remove fallen material.

1.06 JOB CONDITIONS

A. Conduct seeding and sodding only under favorable seasonal conditions throughout the period of the Contract as determined by the Authority Representative. Install no work during adverse weather or during periods when soil conditions are unfavorable as determined by the Authority Representative. Do not plant or lay sod during freezing weather, when planting area is muddy or frozen, nor when sod is frozen.

B. Protection: During progress of operations, protect walls, walks, curbs, benches, established lawn areas, plant material, and other site improvements by adequate means acceptable to the Authority Representative.
   1. Weight Restrictions: Do not overload entrance paving, sidewalks and curbs.
   2. Pollution: Take necessary and adequate measures to prevent soil erosion, air pollution and water pollution by the materials and equipment used during construction.
   3. Repairs: If damage by the Contractor should occur, it is the Contractor's responsibility to repair or replace per the Authority Representative's direction, as acceptable to concerned parties, and at no additional cost to the Authority. Perform work so that damaged areas make smooth, satisfactory, and imperceptible transitions to existing adjacent work. Use materials and methods conforming to current standards for the area damaged, matching adjacent materials in appearance, and meeting approval of jurisdictional authorities and the Authority Representative.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Seed: Free of quack grass, timothy, bentgrass, clover, dock, annual bluegrass, cheat, chess, chickweed, crabgrass, plantain, black medic and, except where specified in Table 32 91 00-2, Canada Bluegrass. Kentucky Bluegrass and red fescue free of tall fescue.
   1. Grass Seed: Dated material from last available crop, with date of test not more than nine months before date of sowing; listed as Proven Cultivars in the latest Agronomy Mimeo #77 (Turfgrass Cultivar Recommendations for Maryland), published by UMPC; and as specified in Table 32 91 00-2 below.
   2. Crownvetch Seed: Dated material from last available crop, with date of test not more than nine months before date of sowing. Germination portion consisting of minimum 35-percent normal sprouts, maximum 35-percent hard seed and as specified in Table 32 91 00-4.
   3. Appalow Sericea Lespedeza Seed: Germination portion consisting of minimum 35-percent normal sprouts, maximum 35-percent hard seed and as specified in Table 32 91 00-5.

B. Inoculant: Adaptable culture of live nitrogen-fixing bacteria true to legume strain used.

C. Sod:
   1. Well-rooted Maryland or Virginia State-Certified sod, at least 18 months old.
   2. Varieties, identical to one of the following, or as approved:
      a. Seed mixture specified in Table 32 91 00-3.
      b. Proven Cultivars in the latest Agronomy Mimeo #77, published by UMPC, certified 90-percent Turf-type Tall Fescue and 10-percent Kentucky Bluegrass.
   3. Sod and attached soil free from noxious weeds such as Bermuda grass, quack grass, garlic, Johnson grass, Canada thistle and other turf weeds.
   4. Mowed in production field to height of not more than 2-1/2 inches within five days prior to lifting.
   5. Machine cut in sections not less than 2-1/2 feet in length nor less than 12 inches in width and to a depth equal to growth of fibrous roots, uniform soil thickness of 3/4 inch, plus-or-minus 1/4 inch. Measurement for thickness to exclude top growth and thatch.
   6. Cut in sections or strips strong enough to support its own weight and retain size and shape when suspended vertically from firm grasp on upper 10 percent of section. Small, irregular or broken pieces of sod are prohibited. Sod on Beck Roll is permitted.

D. Topsoil: Weathered surface soils or natural friable loam obtained from approved sources, free of subsoil, hard fragments and stones larger than one-inch across greatest dimension, objectionable salts, noxious weeds and plants, debris and other materials inferior to surface soils or that would be toxic or harmful to growth; containing not less than 1.5-percent organic matter as determined by Walkley-Black Method; capable of sustaining normal, healthy growth and development of seed and sod scheduled and specified. Seed shall not be placed in topsoil which has been treated with soil sterilants until sufficient time has elapsed to allow for the dissipation of toxic materials.
   1. Grading analysis:

Sieve	Minimum Percent Passing
2 inches	100
1/2 inch	90
1/4 inch	80
No. 10	70

2. Test and analysis of proposed topsoil material: Performed by local state agricultural experiment station or agricultural laboratory recommended by the U.S. Department of Agriculture, including recommendations for fertilizer and pH adjustment for target crop, and meeting the following requirements.
   a. Acidity range: pH 5.5 to pH 7.5, inclusive. When topsoil pH is not within pH 5.5 - pH 7.5, modifications to correct topsoil pH shall be made according to the recommendations of the soil test lab, or the applicable State Cooperative Agricultural Extension Service.
   b. Salinity by electrical-conductivity measurement: 500-ppm soluble salt maximum.
   c. Fertility: Rated high in natural nutrients in pounds per acre based on the standard soil test in laboratory.
   d. Texture: Classification consisting of 5-percent to 25-percent clay, 20- percent to 60-percent sand and 15-percent to 45-percent silt as determined by hydrometer or pipette method. Sand, silt and clay as defined by USDA- SCS.

E. Fertilizer:
   1. For grass seeded and sodded areas: Commercial fertilizer of standard quality, recommended by approved soil test report; 10-22-22.
   2. For crownvetch seeded areas: Use both of the following:
      a. Commercial fertilizer of standard quality; 0-20-20 or 3-25-25.
      b. Blue Chip Nitroform, slow-release nitrogen, granular form, of standard quality; 38-0-0.
   3. For appalow-sericea-lespedeza seeded areas: Commercial fertilizer of standard quality, recommended by approved soil test report; 10-22-22.

F. Limestone: ASTM C51, Dolomitic, Agricultural Grade.
   1. Capable of neutralizing soil acidity and containing not less than 85 percent calcium and magnesium carbonates
   2. Sieve analysis: 95-percent passing No. Eight sieve and 40-percent passing a No.100 sieve. For hydroseeding, use pulverized limestone.
   3. Containers labeled to show chemicals.

G. Acidifying Agent: As approved per soil analysis recommendations and seeding method.

H. Mulch:
   1. Wood-cellulose fiber: Containing no growth or germination-inhibiting factors and dyed green.
      a. Properties:
         1) Fiber length: Approximately 3/8 inch.
         2) Diameter: Approximately 1/32 inch.
         3) Acidity range: pH 4.0 to 8.5, inclusive.
         4) Ash content: 1.6-percent maximum.
         5) Water-holding capacity: 90-percent minimum.

b. Packaging: Furnish fibers air-dry in packages not exceeding 50 pounds gross, with net weight shown on package.
c. Source: Conwed Hydro Mulch by Conwed Corp., St. Paul, MN 55101 or equal.

2. Straw: Wheat, barley, oat or rye straw, threshed, air-dried and free from Canada thistle, dock, Johnson grass and other foreign matter.
3. Mulch blanket: Knitted construction of biodegradable yarn with uniform openings, Gulf States Paper Corporation, Tuscaloosa, AL 35401 or equal.
   a. 150-foot lengths or greater.
   b. U-shaped staples: As standard with mulch-blanket manufacturer.

I. Mulch Binders: Non-asphaltic only.
1. Synthetic binder for use with the following:
   a. Wood-cellulose fiber: Terra Tack 1 by Grass Growers, Plainfield, NJ 07061; Soil-Gard by Alco Chemical Company, Philadelphia, PA 1913, or equal.
   b. Straw: Terra Tack 1 by Grass Growers, Plainfield, NJ 07061 or equal.
2. Biodegradable netting for use with straw: Conwed Erosion Control Netting by Conwed Corporation, St. Paul, MN 55101 or equal.

J. Herbicides:
1. Broadleaf weed control: Trimec by P.B.I. Gordon Corporation, Kansas City, KS 66118 or equal.
2. Pre-emergent crabgrass control: Balan by Elanco Products Company, Division of Eli Lilly Corporation, Indianapolis, IN 46206 or equal.
3. Post-emergent crabgrass control: A.M.A., D.S.M.A., M.A.M.A. or Calcium Methyl Arsenate by W.A. Cleary Company, Somerset, NJ 08873 or equal.
4. Perennial bunch-grass control: Round-up by Monsanto Agricultural Products Company, Wilmington, DE 19810 or equal.

K. Stakes (for pegging sod): Wood or other biodegradable stakes suitable for the purpose, measuring 1/2-inch by one-inch by 12 inches.

L. Water: Potable.

M. Seed Mixtures:
1. Grass Seed: Tables 32 91 00-2 and 32 91 00-3.
2. Crownvetch Seed: Table 32 91 00-4.
3. Lespedeza Seed: Table 32 91 00-5.
4. Hydroseeding Crownvetch and Lespedeza Seed: Tables 32 91 00-6 and 32 91 00-7.

PART 1
PART 2
2.01

2.02 EQUIPMENT:

A. Dry-Type Seeder: Brillion seeder, drill seeder or other approved mechanical seeder.

B. Spraying Equipment for Hydroseeding: Use water tank equipped with liquid-level gauge calibrated in increments not larger than 50 gallons over entire range of tank capacity with gauge visible to nozzle operator. Use tank equipped with agitation system capable of maintaining solids in complete suspension until used.

PART 3 - EXECUTION

3.01 PLACING TOPSOIL

A. After completion of construction work in the area, prepare surface of subsoil. Finish to lines shown and parallel to proposed finished grade, as approved. Remove rocks and other foreign materials 1-1/2 inches or greater in any dimension. Immediately prior to covering with topsoil, loosen prepared subsoil surface to a minimum depth of four inches. Leave no depressions.

B. Place and spread topsoil over areas to be seeded and sodded except areas to receive crownvetch or lespedeza (unless Contract Drawings require 2:1 or greater slopes to be sodded or seeded), to depth which will produce four-inch depth after natural settlement and will conform to finish lines, grades and elevations.

C. When placing topsoil on slopes, work topsoil into subsoil to minimum depth of four inches to eliminate slip-plane between the two materials. Leave topsoil at surface to ensure germination of seed.

D. After spreading topsoil, rake up and remove large stiff clods, hard lumps, large rocks, roots, stumps, litter and other foreign matter.

E. Maintain specified depth of topsoil from time placed until specified seed or sod is established.

F. If soil or weather conditions are unsuitable, cease topsoil operations. Resume topsoil operations when proper conditions prevail.

3.02 SEEDING GRASS

A. Dry Seeding: After placing topsoil, proceed as follows:
   1. Seed bed preparation:
      a. pH adjustment: Adjust topsoil pH to raise it by applying limestone or approved acidifying agent or elemental sulfur to lower the topsoil pH at per- acre rate recommended by approved soil test report so as to obtain a 6.5 pH. Apply separately prior to fertilizing and seeding operations. Work into the top three inches of soil.
      b. Fertilizing: After acidity adjustment and within 24 hours before seeding, apply fertilizer at per-acre rate recommended by approved soil test report. Use machine spreader and lightly drag or rake fertilizer into top 1/4 inch of soil.
   2. Seeding: Clean seeders as approved prior to applying seed. Apply seed mixture directly after fertilizing.
      a. Sow specified grass seed mixture from March 1 to April 30 and from August 15 to October 15. Extend or reduce specified periods as approved and as required by weather and soil conditions.
      b. Sow at minimum rate as specified in Table 32 91 00-3.
      c. Work seed in to depth of 1/4-inch maximum.
      d. Finish as follows:
         1) Lawn areas with slopes up to 3:1: Raked surface.
         2) Roadside areas with slopes up to 3:1: Scarified surface.
         3) Slopes over 3:1: Leave surface in irregular condition with ridges running parallel to contour of slope to prevent erosion.
   3. Rolling: Directly after seeding, roll lawn areas with slopes up to 3:1 using approved lawn roller, weighing 40 to 60 pounds per foot of width, unless intervening precipitation would cause such rolling to be detrimental.

B. Hydroseeding: After placing topsoil, proceed as follows:

1. Seed bed preparation:
   a. Clean hydroseeders as approved prior to coming on site.
   b. pH adjustment: Adjust soil pH by either applying limestone or approved acidifying agent or elemental sulfur at per-acre rate recommended by approved soil test report so as to obtain a 6.5 pH. Apply separately prior to fertilizing and seeding operations.
      1) Use only pulverized limestone to raise soil pH.
      2) Apply not more than 300 pounds of limestone for each 100 gallons of water.
      3) After applied limestone mixture has dried, work into the top three inches of soil.
   c. Apply elemental sulfur as recommended, and incorporate into top three inches of soil.
   d. After pH adjustment, again grade and dress seed beds for lawn areas to raked surface.
2. Fertilizing and seeding: After seed bed preparation, apply fertilizer-seed mixture.
   a. Apply fertilizer at per-acre rate recommended by approved soil test report.
   b. Apply seed at same rates and times specified for dry seeding. Mix seed and fertilizer together in proportions to meet required application rates.
   c. If mulching with wood-cellulose fiber on areas with slopes up to 3:1, add mulch to seed and fertilizer mixture.
3. Application method:
   a. Apply mixtures by means of high-pressure spray directed upward into air so that mixtures fall to ground in uniform spray. Do not direct nozzle of hand- held hose toward ground in manner that would produce erosion or runoff.
   b. Make uniform applications at required rate, with two passes at 90 degrees to each other, to ensure uniformity and prevent misses.
   c. Agitate mixtures constantly from time mixed until application to seed bed.
   d. Use mixtures within eight hours after mixing.

3.03 SEEDING CROWNVETCH

A. Seed Bed Preparation: After construction work in the area has been completed, proceed as follows:
   1. Grading: Rough grade to remove large stones and roots. Remove or break up clods greater than one-foot diameter. Chisel surface to depth of four to six inches. When preparing slopes, chisel parallel to contour of slope.
   2. pH adjustment: Adjust soil pH by applying limestone or approved acidifying agent or elemental sulfur at per-acre rate in Table 32 91 00-6, except as recommended by approved soil test report so as to obtain a 6.5 pH. Apply separately prior to fertilizing and seeding operations.
      a. Apply 2/3 of limestone when seed bed is prepared. Work this into the top six inches of soil.
      b. Apply remaining 1/3 of limestone with seed mixture.
   3. Fertilizing: After acidity adjustment, apply fertilizer at per-acre rate in Table 32 91 00-6, except as recommended by approved soil test report.
   4. Hydraulic overseeding: For overseeding existing vegetation, cut existing vegetation to height of three inches and remove resultant refuse prior to overseeding.

B. Seed Preparation:
   1. Inoculate crownvetch seed on day it is used.
   2. Reinoculate seeds not sown within 24 hours following inoculation.

C. Hydroseeding: Clean hydroseeders as approved prior to coming on site.
   1. From March 1 to October 15, sow specified crownvetch seed mixture (Table 32 91 00-4) at a rate of 100 pounds per acre.

2. From June 1 to August 15 sow specified crownvetch seed mixture (Table 32 91 00-4) at a rate of 100 pounds per acre, except add an additional three-percent by weight of Loehmans Weeping Lovegrass.
3. Extend or reduce specified periods as approved and as required by weather and soil conditions.
4. Bare areas: Perform application-sequence Stages I and II, specified below.
5. Existing vegetation areas (hydraulic overseeding): Perform only application- sequence Stage I, specified below. Obtain the Authority Representative's on-site approval on whether to use nozzle or hose for hydraulic overseeding.
6. Application method:
   a. Apply mixtures by means of high-pressure spray directed upward into air so that mixtures fall to ground in uniform spray. Do not direct nozzle of hand- held hose toward ground in manner that would produce erosion or runoff.
   b. Make uniform applications at required rate, with two passes at 90 degrees to each other, to ensure uniformity and prevent misses.
   c. Agitate mixtures constantly from time mixed until application to seed bed. Use mixtures within eight hours after mixing.
   d. Use inoculated crownvetch in slurry with fertilizers within one hour after mixing. Use fresh crownvetch seed and reinoculate seed whenever this requirement cannot be met.
7. Application sequence:
   a. Stage I, Table 32 91 00-5: Load materials into water-filled tanks in proportion to tank size; agitate until smooth slurry is formed. Spray on seed bed at rates specified. Follow within two hours with Stage II.
   b. Stage II, Table 32 91 00-6: Mulch area within two hours after completing Stage I. Use straw mulch for slopes up to 2:1. Use mulch blanket for slopes greater than 2:1. Do not use wood-cellulose fiber.

3.04 SEEDING LESPEDEZA

A. Seed Bed Preparation: After construction work in the area has been completed, proceed as follows:
   1. Grading: Rough grade to remove large stones and roots. Remove or break up clods greater than one-foot diameter. Chisel surface to depth of four to six inches. When preparing slopes, chisel parallel to contour of slope.
   2. ph adjustment: Adjust soil pH by applying limestone or approved acidifying agent, or elemental sulfur at per-acre rate in Table 32 91 00-6, except as recommended by approved soil test report so as to obtain a 6.5 pH. Apply separately prior to fertilizing and seeding operations.
      a. Apply 2/3 of limestone when seed bed is prepared. Work this into the top six inches of soil.
      b. Apply remaining 1/3 of limestone with seed mixture.
   3. Fertilizing: After acidity adjustment, apply fertilizer at per-acre rate in Table 32 91 00-6, except as recommended by approved soil test report.
   4. Hydraulic overseeding: For overseeding existing vegetation, cut existing vegetation to height of three inches and remove resultant refuse prior to overseeding.

B. Seed Preparation:
   1. Have lespedeza seed hulled, scarified and inoculated for spring sowing.
   2. Inoculate lespedeza seed on day it is used.
   3. Reinoculate seeds not sown within 24 hours following inoculation.

C. Hydroseeding: Clean hydroseeders as approved prior to coming on site.

1. Sow specified lespedeza seed (Table 32 91 00-5) from March 1 to April 30 and August 15 to October 31 at the rate of 90 pounds per acre.
2. Extend or reduce specified period as approved and as required by weather and soil conditions.
3. Bare areas: Perform application-sequence Stages I and II, specified below.
4. Existing vegetation areas (hydraulic overseeding): Perform only application- sequence Stage I, specified below. Obtain the Authority Representative's on-site approval on whether to use nozzle or hose for hydraulic overseeding.
5. Application method:
   a. Apply mixtures by means of high-pressure spray directed upward into air so that mixtures fall to ground in uniform spray. Do not direct nozzle of hand- held hose toward ground in manner that would produce erosion or runoff.
   b. Make uniform applications at required rate, with two passes at 90 degrees to each other, to ensure uniformity and prevent misses.
   c. Agitate mixtures constantly from time mixed until application to seed bed. Use mixtures within eight hours after mixing.
   d. Use inoculated lespedeza in slurry with fertilizers within one hour after mixing. Use fresh crownvetch seed and reinoculate seed whenever this requirement cannot be met.
6. Application sequence:
   a. Stage I, Table 32 91 00-5: Load materials into water-filled tanks in proportion to tank size; agitate until smooth slurry is formed. Spray on seed bed at rates specified. Follow within two hours with Stage II.
   b. Stage II, Table 32 91 00-6: Mulch area within two hours after completing Stage I. Use straw mulch for slopes up to 2:1. Use mulch blanket for slopes greater than 2:1. Do not use wood-cellulose fiber.

3.05 MULCHING

A. General:
   1. Mulch according to the following slope limitations, except as limited for crownvetch and lespedeza.
   2. Mulch within two hours after seeding as follows:
   3. Immediately replace displaced mulching.

B. Slopes up to 3:1:
   1. Wood-cellulose fiber:
      a. Apply at a net dry weight 1,500 pounds per acre.
      b. Apply hydraulically with seed and fertilizer at rate of 50 pounds per 100 gallons of water.
   2. Straw:
      a. Methods of application:
         1) Hand spreading: 4,000 pounds per acre (100 pounds per 1,000 square feet). Cover areas uniformly to depth of not less than two inches of loose material.
         2) Blowing: Use of cutters is permitted in blowing equipment if at least 95-percent of mulch is six inches or more in length. For cut mulches applied by blowing method, achieve uniform distribution and loose in-place depth of not less than two inches.
         3) Mulch-binder application:
      b. a) Synthetic binder: Apply according to manufacturer's instructions.
      c. b) Biodegradable netting: Apply according to manufacturer's instructions.

C. Slopes 2:1 to 3:1: Straw as specified above.

D. Slopes over 2:1: Mulch blanket, applied and stapled according to manufacturer's instructions.

3.06 SODDING

A. Sod Bed Preparation: After placing topsoil, proceed as follows:
   1. pH adjustment: Adjust soil pH by applying limestone or approved acidifying agent, or elemental sulfur at per-acre rate recommended by approved soil test report so as to obtain a 6.5 pH. Mix into soil to a depth of four inches minimum.
   2. Fertilizing: After pH adjustment, apply fertilizer at per-acre rate recommended by approved soil test report. Mix into soil to a depth of four inches minimum.
   3. Compact topsoil with lawn roller or tractor roller to three inches of final compacted thickness as approved.

B. Laying Sod:
   1. Lay sod between September 15 and June 1, grown from seed varieties identical to grass seed mixture in Table 32 91 00-3, or sod which is Blue-Tag certified.
   2. Extend or reduce specified period as approved and as required by weather and soil conditions.
   3. When soil surface is hot or dry, wet soil to a depth of two inches, six to eight hours before sodding. Do not accept or lay dried sod.
   4. Place sod by hand with butted joints and no overlapping. When Beck Roll of sod is used, lay also in accordance with the supplier's instructions.
   5. Lay first row of sod in straight line. Place subsequent rows parallel to and tightly against each other. Stagger perpendicular joints to promote more uniform growth and strength. Do not stretch sod. On slopes, lay sod parallel to contour of slope.
   6. Peg sod placed on slopes 2:1 or greater. Peg each strip or section of sod with at least two stakes not more than two feet apart. Drive stakes flush with top of sod so that roots are in contact with topsoil.
   7. Water sod immediately to prevent excessive drying during progress of work. Sod which dries out will be rejected.
   8. Roll entire area as sodding is completed in each section so that sod is without surface irregularities, such as depressions and high spots.
   9. Irrigate immediately after rolling, enough to wet underside of sod and one inch of soil immediately below.

3.07 SITE QUALITY CONTROL

A. Non-Conforming Work:
   1. If, at any time, the Authority Representative determines that work is unsatisfactory or being conducted in an unsafe manner, immediately cease such work activities upon notification.

3.08 MAINTENANCE AND REPLACEMENT

A. Maintenance: Maintain seeding, sodding and incidental work during seeding and sodding and thereafter for a period of 120 days for work performed in the spring and for 90 days of subsequent growing weather for work performed in the fall. Perform the following and other operations of care appropriate for promotion of healthy growth, so that work is in an approved condition throughout maintenance period; uniform in color, quality and coverage; and free of weeds, insects, diseases, surface damage and other imperfections:
   1. Watering:

a. First week: Perform watering daily to keep soil and sod pads continuously moist, maintaining moist topsoil to a depth of at least four inches. Water prior to heat of the day as necessary to prevent wilting or as approved.
b. Subsequent weeks: Water seeded and sodded areas to maintain moisture in upper four inches of soil for promotion of deep root growth.

2. Mowing: Mow only when seed or sod has firmly rooted, is securely in place and has grown to height of six inches. Mow to height of three inches at first cutting. Thereafter, do not remove more than 1/3 of grass leaf at any cutting. Maintain Kentucky Bluegrass between height of two and 2-1/2 inches and tall fescue at height of three inches, unless otherwise directed.
3. Edging: Edge walks during alternate mowings.
4. Rolling: Roll to maintain uniform surface.
5. Applying herbicides: Apply in spray form. Do not apply when temperature exceeds 80F or during periods of drought. Have workers wear personal protective equipment appropriate for the submitted MSDS.
6. Clean-up: Remove rubbish and debris caused by this work. Keep site clean during maintenance period.

B. Replacing Seeding and Sodding: During maintenance period and until Final Acceptance, replace seeded and sodded areas that are dead, unhealthy, unsightly or badly impaired. Replace as soon as possible during the specified planting seasons. Make such replacements in the same manner as required for original seeding and sodding.

3.09 SUBSTANTIAL COMPLETION INSPECTION (SCI)

A. Substantial Completion Inspection will be held by the Authority Representative after completion of seeding and sodding to verify that the work was performed as defined in the Contract Documents.

B. The Contractor will not be held responsible or liable for damage by animals, by malicious or careless human agencies over which the Contractor has no control, by fire or storm, or by vehicular accidents by others that occur after the Substantial Completion Inspection.

3.10 FINAL ACCEPTANCE

A. Request inspection for final acceptance at least 10 days before end of maintenance period.
B. Replace rejected seeded and sodded areas as specified so that repair or replacement plantings are rooted and established prior to final acceptance.

C. Final acceptance of crownvetch or lespedeza areas requires a minimum of nine vigorous, healthy seedlings evenly distributed per each square yard after 12 weeks of growing weather following germination.

TABLE 32 91 00-1: MATERIALS SUBMITTAL CHART
This chart indicates minimum length of time required for the approval process before intended use and by which submittals must be made, as well as the minimum quantity for each sample. Useable samples will be returned.

ITEM	TIME	QUANTITY	COMMENT
SEED	40 days	10 pounds or 5 kilograms 5 pounds or 3 kilograms	If seed is purchased as a mixture. er component prior to blending if Contractor blends mixture.
INOCULANT	7 days	1 packet	temperature of inoculant below 70F (21C).
SOD	7 days	- -	Notification of source.
FERTILIZER	14 days	50 pounds (25 kilograms)	Provide sample of each type of fertilizer used. Unopened container.
LIMESTONE	14 days	50 pounds (25 kilograms)	As specified. Unopened container.
MULCH	7 days	10 pounds (5 kilograms) 1 unbroken bale 1 square yard (1 square meter)	Wood-cellulose fiber mulch. Straw mulch. Mulch blanket including staples.
MULCH BINDER	14 days	1 quart (1 liter) 1 square yard (1 square meter)	Synthetic binder. Biodegradable netting including staples.
TOPSOIL	28 days	25 pounds (15 kilograms)	- -
HERBICIDE	7 days	1 quart (1 liter)	Unopened container. Include MSDS
OTHER MATERIAL	7 days	As directed and as approved	- -

TABLE 32 91 00-2: GRASS SEED FOR SEED MIXTURES			
SPECIES	MINIMUM GUARANTEED PURITY	MAXIMUM WEED SEED AND OTHER CROP	MINIMUM GUARANTEED GERMINATION
Certified Turf-Type Tall Fescue Festuca elatior arundinacea (Cultivars from current Agronomy Mimeo #77)	98 percent	0.2 percent	85 percent
Certified Kentucky Bluegrass Poa pratensis	95 percent	0.2 percent	85 percent

TABLE 32 91 00-3: GRASS SEED MIXTURES
For areas with slopes up to 2:1, unless otherwise shown.
Seed Mixture: 90-percent Tall Fescue (Maryland Green-label certified cultivars from current Agronomy Mimeo #77) 10-percent Kentucky Bluegrass (Maryland Yellow-label certified cultivars from current Agronomy Mimeo #77)

TABLE 32 91 00-4: CROWNVETCH SEED MIXTURE.				
For areas with slopes 2:1 or greater, unless otherwise shown.				
SPECIES	PROPORTION BY WEIGHT	MINIMUM GUARANTEED PURITY	MAXIMUM WEED SEED & OTHER CROP	MINIMUM GUARANTEED GERMINATION
Certified Penngift Crownvetch Coronilla varia	40 percent	99 percent	0.25 percent	70 percent
Certified Pennfine or Manhattan or Citation Perennial Ryegrass Lolium perenne	60 percent	98 percent	0.25 percent	90 percent
Loehmans Weeping				

TABLE 32 91 00-5: LESPEDEZA SEED MIXTURE				
For areas with slopes 2:1 or greater, unless otherwise shown.				
SPECIES	PROPORTION BY WEIGHT	MINIMUM GUARANTEED PURITY	MAXIMUM WEED SEED & OTHER CROP	MINIMUM GUARANTEED GERMINATION
Certified Lespedeza Certified Appalow	44 percent	99 percent	0.25 percent	70 percent
Nurse Grass: *Certified Tall Fescue per Maryland Green-label certified cultivars from current Agronomy Mimeo #77	56 percent	98 percent	0.20 percent	85 percent

THIS SPACE INTENTIONALLY LEFT BLANK

TABLE 32 91 00-6MATERIALS FOR HYDROSEEDING CROWNVETCH AND LESPEDEZA STAGE I		
MATERIAL	PER ACRE	PER 1,000 SQUARE FEET
Limestone	**2 ton minimum	**100 pounds
3-25-25 fertilizer or 0-20-20 fertilizer or *10-22-22 fertilizer	600 pounds 800 pounds *1,075 pounds	15 pounds 20 pounds *25 pounds
Blue Chip Nitroform, granular, 38-0-0	200 pounds	4.5 pounds
Nurse Grass: Certified Pennfine, Citation, or Manhattan Perennial Ryegrass Seed or *Certified Tall Fescue per Table 32 91 00-5	60 pounds *50 pounds	1.5 pounds *1.25 pounds
Target Crop: Blue Tag Certified Penngift Crownvetch Seed or *Certified Appalow Sericea Lespedeza	40 pounds *40 pounds	1 pound *1 pound
Bacterial crownvetch or lespedeza inoculant in 5-pound-size packets	Five times manufacturer's recommended rate	Five times manufacturer's recommended rate
Wood-Cellulose Fiber	435 pounds (dry weight)	10 pounds
Mulch Binder (synthetic type)	20 pounds	0.5 pounds

* Lespedeza requirements only.
**Superseded recommendation of approved soil test report

TABLE 32 91 00-7: MATERIALS FOR HYDROSEEDING CROWNVETCH AND LESPEDEZA STAGE II		
MATERIAL	PER ACRE	PER 1,000 SQUARE FEET
Straw	4,000 pounds	100 pounds
Mulch Blanket and Staples	Use according to manufacturer's instructions	Use according to manufacturer's instructions

END OF SECTION

SECTION 33 00 00

UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies protecting, supporting, maintaining and reconstructing existing utility facilities affected by construction, including but not limited to the following:
   1. Storm, sanitary and combined sewer facilities.
   2. Water distribution and service
   3. Gas distribution and services.
   4. Electric light and power facilities and services.
   5. Telephone, telegraph and GSA communication facilities and services.
   6. Police and fire alarm systems.
   7. Traffic signals and street lighting, temporary and permanent.
   8. Steam distribution facilities.
   9. Parking meter installations.

B. Related Work Specified Elsewhere:
   1. Section 02 41 00 – Selective Demolition: .
   2. Section 31 20 00 – Earth Moving.
   3. Section 31 23 19 – Dewatering.
   4. Section 31 50 00 – Excavation Support and Protection.
   5. Section 33 40 00 – Storm Drainage Utilities.
   6. Section 22 11 00 – Facility Water Distribution.
   7. Section 33 05 13 – Manholes and Structures.
   8. Section 02 42 13 – Deconstruction of Structures.
   9. Section 03 20 00 – Concrete Reinforcement.
   10. Section 03 00 00 – Concrete.
   11. Section 03 30 00 – Cast-in-Place Concrete.
   12. Section 01 53 00 – Temporary Construction.

C. Work by Others:
   1. Gas distribution and services: Gas company will do its own work.

1.02 REFERENCES

A. Definitions:
   1. Facility: Utility structures and system components belonging to utility company including service lines which are used to provide service to utility's customers and product which these facilities convey.
   2. Utility: Company, agency, owner or operator of facility concerned.
   3. Abandoned: Use of facilities shown as existing has been discontinued by the owners and operators. Demolish or remove such facilities to extent they conflict with proposed work.
   4. To be abandoned: Particular facility will be removed from operation and/ or replaced by other facilities after written notice has been received that service is no longer required. Maintain service for as long as required, including temporary support, rerouting, substitution of temporary facility or other measures, as directed by the Authority Representative. Demolish or remove such facilities to extent they conflict with proposed work.

5. Maintenance: Ensuring continuous and satisfactory service during construction.
6. Proposed facility:
   a. New facility constructed and, if necessary, temporarily supported in place, by the Contractor.
   b. Temporary facility constructed, supported in place and ultimately removed and new facility constructed, by the Contractor.
   c. New facility constructed as part of rapid transit construction.
7. Temporary facility: Facility provided by the Contractor in lieu of existing or proposed facility, to ensure continuity of service.
8. Maintain complete-in-place: Support and maintenance in serviceable condition, of existing facilities during construction, which may include constructing permanent support, temporary support or other measures necessary to maintain continuous service of existing facility.
9. Expose and maintain existing cables and replace ducts and manholes: Remove existing duct and manhole structures, construct temporary manholes, place existing cables in split conduits and replace spare ducts with whole conduit. Maintain this system during construction. Reconstruct permanent concrete manholes and encase conduits in concrete as specified. Cables for electric power and telephone facilities shall be exposed, separated and supported under supervision of electric power and telephone companies.
10. Maintain service and replace:
    a. Construct new facility in same location and support it in place.
    b. Provide temporary facility and ultimately remove it, and construct permanent replacement facility in its original location.
    c. Temporarily support original facility and ultimately replace it with new facility.
11. Remove and replace: Remove existing facility without providing temporary replacement and reconstruct new facility in same location during execution of contract.
12. Local Jurisdictional Authority: Agency responsible for acceptance and approval of work on storm, sanitary and water distribution facilities.
13. Salvage: Remove and store material and equipment for reuse in this or other Authority contracts.

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

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Establish through the Authority Representative direct and continuous contact with respective utilities and cooperate with them in all phases of the work.
   2. Contact utility early enough to allow them sufficient time to accomplish the work. Give special consideration to lead times required for cable work. Provide schedule of utility relocation to the utility to permit coordination with Authority's construction sequence.
   3. To locate buried telephone cables, call the local telephone company's Buried Cable Location Service at least 48 hours prior to starting excavation.
   4. Comply with printed standards and practices of utilities available from the Authority Representative.
   5. Aerial facilities shown to be relocated by others will be relocated by facility owner. The Contractor is responsible for coordinating relocation work with utility owner as far as possible in advance of required time of relocation. A minimum three-month lead time is required by utility owner when facility serves only one utility. When facility to be relocated

is shared by more than one utility agency or when a street light is included in the relocation, a minimum four-month lead time is required

B. Scheduling:
   1. Schedule of Work on Utility Facilities:
      a. Submit to the Utilities and the Authority Representative a detailed sequence of work, with starting and ending dates for each interruption of utility services, and method of coordination for shutoff, capping and continuation of utility services.
      b. Give notice at least two weeks prior to date of intended commencement of operations to parties having surface, subsurface or overhead structures in the construction area. .Provide copies of notices to the Authority Representative.
      c. Do not commence work until written approval has been received from the Utility and the Authority Representative.

1.04 SUBMITTALS

A. Submit the following to the Authority Representative (AR) for approval in accordance with the requirements of Special Provision 2.5 Contractor's Submittals and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Show actual location of existing facilities, interference which these facilities present to new work, proposed method of proceeding with actual construction and details of proposed support systems.
      b. Show actual location of settlement measurement points for facilities as indicated on the drawings.
   2. Samples:
      a. Cassettes or other type recording media to be used for television sewer inspection.
   3. Certificates:
      a. Buy America Act Certification.

   4. Test and Evaluation Reports:
      a. Submit copies of settlement readings and measurements within 24 hours after such readings are taken.
      b. Prior to construction, submit two copies of records of inspection of sewers, one copy to local jurisdictional authority and one copy to the Authority Representative. On completion of tunneling and cut-and-cover and prior to paving or other construction over sewers, submit to local jurisdictional authority and the Authority Representative one copy each of the inspection records of sewers, including video-tape records of television inspections and coordinated logs, photographs and other records as specified by local jurisdictional authority for visual walk-through inspections. Obtain and submit a written approval and acceptance from local jurisdictional authority of the inspection records of preconstruction and post-construction conditions of affected storm and sanitary sewers.

1.05 QUALITY ASSURANCE:

A. Regulatory Agency Sustainability Approvals: Comply with codes and regulations of the jurisdictional authorities, published standards of owning utility agency, and ASTM: C136.

B. Certificates:
   1. Buy America Act Certification:
      a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the

products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.

b. Submit the Buy America Act Certification to the Authority Representative for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Coordinate with utilities who are furnishing materials for the work to determine availability, locations and required methods of storage and care of materials prior to incorporation into the work.

B. Transport store and handle materials in accordance with the requirements of the utilities.

1.07 SITE CONDITIONS:

A. Existing Facilities:
1. Locations of existing facilities shown are plotted from available records; however, these locations are not guaranteed.
2. Verify by field investigation and “Miss Utility” utility locating service, locations of facilities within and adjacent to limits of project which may be affected by construction operations. Avoid damage or disruption of facilities during operation.
3. Upon encountering existing facility which is not shown or upon ascertaining that facility differs from that shown, determine ownership, use and disposition of such facility and proceed as follows:
   a. If facility is abandoned or is to be abandoned, perform necessary work for either condition as specified.
   b. If facility is to remain in service, perform support and restoration work in accordance with these Specifications and the CHANGES article of the General Provisions.

B. Temporary Service:
1. Do not interrupt facility service to building connections unless permitted in writing by Authority Representative, and then only after arranging to provide temporary service as required..
2. Notify the Authority Representative and the Utility of damage to facilities caused by construction operations. Repair such damage, except that damaged cables will be repaired or replaced only by the Utility.
3. Provide access for inspection of facilities and for emergencies involving utility services as specified in Section 01 53 00.
4. Permit free and clear access to utility personnel for purposes of inspection, maintenance, providing additional service and construction of new facilities.
5. When approved working or shop drawings show temporary facility provided for the Contractor's benefit, supply necessary materials and perform necessary work.
6. Pay utility directly if, as an aid to the Contractor's construction, the utility performs work not shown.
7. Items supplied by the utility companies are as listed and as shown.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Refer to individual Sections for Storm, Combined And Sanitary Sewer, Water Distribution and Services, Ducts and Manholes Sections for pipe, tubing, fittings and appurtenances, and for joining and installation methods.

B. Refer to individual Sections for 3 Concrete and Reinforcement Sections for materials and installation methods.

C. Sand Backfill Around High Voltage Conduits And Pipes:
1. Thermal Resistivity Value (RHO) of not more than 70 and the following sieve analysis when tested in accordance with ASTM C136:

Sieve Size	Percent Passing
4	94 - 100
8	80 - 90
16	60 - 80
30	35 - 60
50	31 - 35
100	3 - 13
200	1 - 5

2. The power company, through the Authority Representative, will inform the Contractor of approved sources for this material.

PART 3 – EXECUTION

3.01 PREPARATION

A. Demolition/Removal
1. Remove pavements, sidewalks, lawns, landscaping , curbs and gutters where necessitated by utility trenches in accordance with Section 02 41 00.

3.02 SALVAGE

A. Salvage and clean material shown to be salvaged.

B. Maintain adequate records and storage facilities for salvaged items as specified in the General Requirements. Make available for inspection a detailed record including signed vouchers and receipts.

C. Reuse salvaged items after inspection and approval for reuse has been given by the Utility

D. Return salvaged materials which are not reused to the Utility.

3.03 SETTLEMENT OR MOVEMENT

A. Where settlement or movement monitoring system is shown, comply with the following:
1. Provide series of settlement measurement points along each facility and make regular readings to detect movements.

2. Use approved painted marks, metal marker plugs or pins as settlement measurement points.
3. Prior to subsurface work, make initial survey to establish elevations of installed settlement measurement points utilizing permanent, established bench marks outside 100-foot line.
4. Take readings weekly on settlement points until completion of this Contract. Take readings daily during work which may affect facilities.
5. Make readings to an accuracy of 0.01 foot.
6. Take immediate remedial measures to correct conditions causing settlement or other movement and to repair damages thus caused.

3.04 EXCAVATION AND BACKFILLING OF UTILITY TRENCHES

A. Excavate and backfill utility facility trenches in accordance with Sections 31 22 00, 31 23 19, 31 23 19 and 31 50 00, 31 50 00.

B. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to facility owner.

3.05 SURFACE RESTORATION:

A. Replace pavements, sidewalks, curbs and gutters in accordance with Section 02 05 00.

B. Place temporary pavements where necessitated by sequence of operations.

C. Replace lawns and landscaping in accordance with Sections 32 91 00 and 32 90 00.

D. Provide erosion control measures to prevent erosion or displacement of soils and discharge of sediment bearing water or airborne dust from the site.

3.06 UNSAFE AND UNSUITABLE UTILITY STRUCTURES:

A. General Requirements:
1. If upon exposure, condition or location of facility to be supported in place is found to be unsafe for maintenance or support, replace or reconstruct facility as required after receiving prior approval of the Authority Representative and Utility Owner.
2. Maintain continuity of existing utility facilities. Protect, support, relocate and reconstruct such facilities, regardless of jurisdictional control.

B. Electric, Communication and Similar Type Facilities:
1. If structures containing electrical, communication and similar types of cables shown to be maintained complete in place are found upon exposure to be incapable of being maintained in place because of condition, location or both, replace such structures with timber enclosures or split ducts after prior approval of the Authority Representative and the utility owner.
2. When service box, manhole or conduit structure containing electrical or communication cables is broken away, replace it immediately with temporary structure having facilities for racking and supporting cables equivalent to existing facilities.
3. Exercise care when working in vicinity of telephone structures containing coaxial cable which cannot withstand movement.
4. Give timber enclosures one interior and one exterior coat of fire-retardant paint of type specified by owners and operators.
5. Replace temporary timber enclosures with permanent structures in accordance with

details shown and restore facilities to the satisfaction of the Authority Representative and utilities prior to completion of work. Remove materials of temporary nature after completion of permanent installation.

C. Procedures for payment of costs of work on unsafe and unsuitable utility structures are governed by the CHANGES article of the General Provisions.

3.07 SITE QUALITY CONTROL

A. Inspection of Sewers:
   1. Employ a sewer inspection company which has been regularly engaged in television sewer inspections and which is acceptable to local jurisdictional authority to perform preconstruction and post-construction inspections of sewers 36 inches and smaller in diameter. Submit to Local Jurisdictional Authority and the Authority Representative for prior approval one sample of the cassettes or other recording media to be used for television sewer inspection.
   2. Conduct preconstruction and post-construction inspections under conditions as nearly identical as practical and using the same company.

END OF SECTION

THIS PAGE

INTENTIONALLY

LEFT BLANK

SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies installing storm sewers, roadway drains, roadway underdrains, ditch lining and slope protection.

B. Related Work Specified Elsewhere:
   1. Section 31 20 00 – Earth Moving.
   2. Section 33 00 00 – Utilities.
   3. Cathodic Protection – Section 26 42 00.

C. Material Furnished By Others:
   1. Except for those items which bear the METRO logo, WSSC furnishes the following:
      a. Manhole frames and covers: 22-inch diameter.
      b. Manhole steps, except where precast manholes are used.

1.02 REFERENCES

A. Definitions:
   1. Granular bedding required by WSSC is equivalent to aggregate for pipe cradle as specified.
   2. WSSC: Washington Suburban Sanitary Commission.
   3. WASA: Water and Sewer Authority.

B. Reference Standards:
   1. U.S. Government:
      a. Federal Transit Administration:
         1) 49 CFR 661 Buy America Requirements.
   2. Building Stone Institute:
      a. Stone Catalogue.
   3. Cast Iron Soil Pipe Institute:
      a. CISPI HSN 85 – Specification for Neoprene rubber gaskets for hub and spigot cast iron soil pipe and fittings.
   4. American Association of State Highway and Transportation Officials (AASHTO):
      a. M33 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
      b. M36 – Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
      c. M153 – Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
      d. M175
      e. M176
      f. M190 – Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
      g. M197 – Standard Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe
      h. M199 –
      i. M246 – Standard Specification for Steel Sheet, Metallic-Coated and Polymer-Precoated, for Corrugated Steel Pipe
      j. M252 – Standard Specification for Corrugated Polyethylene Drainage Pipe
      k. M274 – Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for

Corrugated Steel Pipe
   l. M288 – Standard Specification for Corrugated Polyethylene Drainage Pipe
   m. T85 – Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate
   n. T96 – Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   o. T104 – Standard Method of Test for Soundess of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
5. American National Standards Institute (ANSI)
   a. ANSI/ASME B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
6. ASTM International (ASTM):
   a. ASTM A36/A36M – Standard Specification for Carbon Structural Steel
   b. ASTM A48 – Standard Specification for Gray Iron Castings
   c. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   d. ASTM A74 – Standard Specification for Cast Iron Soil Pipe and Fittings
   e. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
   f. ASTM A742/A742M – Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
   g. ASTM A744/A744M – Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
   h. ASTM 745/A745M – Standard Practice for Ultrasonic Examination of Austenitic Steel Forgings
   i. ASTM A760/A760M – Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
   j. ASTM A929/A929M – Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
   k. ASTM A998/A988M – Standard Practice for Structural Design of Reinforcements for Fittings in Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
   l. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
   m. ASTM C14 – Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
   n. ASTM C32 – Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)
   o. ASTM C33/C33M – Standard Specification for Concrete Aggregates
   p. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
   q. ASTM C109/C109M – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
   r. ASTM C144 – Guide for the Investigation of Pressure-Regulating Valves
   s. ASTM C150 – Standard Specification for Portland Cement
   t. ASTM C207 – Standard Specification for Hydrated Lime for Masonry Purposes
   u. ASTM C361 – Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
   v. ASTM C425 – Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
   w. ASTM C443 – Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
   x. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections
   y. ASTM C507 – Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
   z. ASTM C700 – Standard Specification for Vitrified Clay Pipe, Extra Strength,

Standard Strength, and Perforated

aa. ASTM D698 – Standard Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Mixed Oxides
bb. ASTM D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
cc. ASTM D2466 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
dd. ASTM D2564 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ee. ASTM D3034 – Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ff. ASTM D4101 – Standard Specification for Polypropylene Injection and Extrusion Materials
gg. ASTM D5034 – Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
hh. ASTM D5035 – Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
ii. ASTM F628 – Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core

7. Structural Steel Painting Council (SSPC):
   a. SSPC SP-6 – Commercial Blast Cleaning
8. U.S. Government:
   a. Federal Transit Administration:
      1) 49 CFR 661 Buy America Requirements.
   b. Federal Standards:
      1) TT S001543A
      2) TT S00230C
   c. Military Standards:
      1) MIL-P-23236.
   d. U.S. Army Corps of Engineers:
      1) CRD-C588
9. Washington Suburban Sanitary Commission (WSSC):
   a. WSSC General Conditions and Standard Specifications.

1.03 PERFORMANCE CRITERIA

A. The Contech Engineered Solutions LLC StormFilter® Manhole Cartridge Operation:
   1. Each stormwater filtration system shall contain one or more siphon actuated media filter cartridges that maintain a uniform pressure profile across the face of the filter during operation. At the design flow rate the maximum filter hydraulic loading rate is not to exceed 2.1 gallons per minute per square foot of filter surface area. Stormwater shall enter the filter cartridges through sides and shall flow through the filter media radially from the outer perimeter to the inner cartridge lumen and shall have an average contact time no less than 38 seconds.
   2. Documentation of Sediment Removal:
      a. The Filtration system should have the Washington GULD certification and approval from New Jersey DEP.
   3. Cartridge Sediment Loading:
      a. Filter cartridges shall be of a design that has demonstrated a minimum sediment retention capacity of 22 pounds of silty loam per cartridge in laboratory tests without a reduction in hydraulic capacity. Laboratory data shall be corroborated with field observations showing similar longevity without impact to normal hydraulic performance of the stormwater filtration system. All laboratory and field tests submitted in support of this specification must have undergone peer review.
   4. Overflow:

a. The filter system will have a baffled, non-siphoning internal overflow with a minimum of 1.0 cfs capacity.

B. The Contractor shall furnish and install the StormFilter stormwater treatment system, complete and operable as shown and as specified herein, in accordance with the requirements of the plans and contract documents.

C. StormFilter stormwater treatment system shall consist of an underground precast structure that houses passive siphon-actuated, radial-flow media-filled filter cartridges. The radial-flow filter cartridges shall be rechargeable, and shall incorporate a self actuated surface cleaning mechanism to increase the effective life of the filter media. Each radial-flow filter cartridge shall operate at a predetermined flow rate through the use of an integrated flow control orifice.

1.04 SUBMITTALS

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Drawings for each size and configuration of precast manhole with details of accessories and joints.
      b. Diagrams showing dimensioned locations for openings in precast concrete manhole walls.
      c. CONTECH Stormwater Solutions, Inc or authorized precast supplier to submit shop drawing to contractor for engineer's approval.
      d. Contech Engineered Solutions LLC, ., or authorized supplier, to submit shop drawings for StormFilter stormwater treatment system with the vault, filter cartridges and accessory equipment. Drawings shall include principal dimensions, filter placement, location of piping and unit foundation.
      e. Contech Engineered Solutions LLC , or authorized supplier, shall submit an Operation and Maintenance Manual.
   2. Samples:
      a. Sewer brick: Ten.
      b. Manhole brick: Ten.
      c. Slope protection materials:
         1) Concrete blocks: Ten each.
         2) Paving bricks: Ten each.
         3) Riprap: 1.5 cubic yards.
         4) Gabions: Two each, complete.
      d. Geotextile filter fabric: Two, 12 inches long by 12 inches wide, minimum.
   3. Certificates:
      a. Buy America Act Certification.
      b. Washington GULD certification for the stormwater filtration system.
   4. Delegated Design Submittals:
      a. Submit calculations for modified or special designs to demonstrate compliance with required load-bearing capacity, certified by a professional Authority Representative registered in the jurisdiction where the work is to be installed.
   5. Test and Evaluation Records:
      a. Submit two copies of records of inspection of new and relocated sewers, one copy to W\SSC and one copy to the Authority Representative. Include video-tape cassette or other recording media of television inspections and logs, photographs and other records specified by WASA for visual walk-through inspections.
      b. Obtain and submit a written approval and acceptance from WASA.
   6. Operations and Maintenance Data:
      a. CONTECH Stormwater Solutions, Inc to submit Operation and Maintenance Manual

to contractor.

1.05 QUALITY ASSURANCE:

A. Regulatory Agency Sustainability Approvals:
   1. Jurisdictions Having Authority:
      a. Comply with codes and regulations of the jurisdictional authorities.
   2. 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. Qualifications:
   1. Manufacturers
      a. The StormFilter stormwater treatment system shall be of a type that has been installed and in use successfully for a minimum of five (5) or more years. The StormFilter stormwater treatment system shall be supplied by Contech Engineered Solutions LLC, 11835 NE Glenn Widing Dr, Portland OR, 97220 (800 548-4667), without exception.

C. Certifications:
   1. Buy America Act Certification:
      a. In accordance with Solicitation Instruction 17 and Certification RC-114 in the Contract Specifications for this Contract, provide written certification that the products provided under this Section meet the requirements of 49 CFR 661 Buy America Act.
      b. Submit the Buy America Act Certification to the Authority Representative for approval.

D. Allowable Tolerances:
   1. Subgrade: Plus-or-minus 1/2 inch of elevation shown.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Formwork: Section 03 00 00.

B. Reinforcing Steel: Section 03 20 00.

C. Portland Cement Concrete: Section 03 30 00, Class 3500, unless otherwise shown.

D. Aggregate for Subgrade Foundation: ASTM C33, coarse aggregate, No. 4. Where shown use layers of No. 4 and No. 67 in combinations and proportions determined by field conditions and as approved.

E. Aggregate for Pipe Cradle: ASTM C33, coarse aggregate No. 67.

F. Concrete Pipe:
   1. 10-inch diameter and smaller:
      a. ASTM C14, Class 2, nonreinforced concrete pipe.
      b. Bell-and-spigot type.
      c. Joints fabricated in accordance with ASTM C361. Physical characteristics for rubber gaskets in accordance with ASTM C443.
   2. 12-inch diameter and larger:
      a. ASTM C76, bell-and-spigot or tongue-and-groove, Class IV, unless otherwise

shown.

b. Radius (bevel) pipe, with drop between two pipe sections not exceeding the common wall thickness.
c. Rubber gasket joints, when required, fabricated in accordance with ASTM C361. Physical characteristics for rubber gaskets in accordance with ASTM C443.
d. Acceptance tests as specified in ASTM C76 form basis of acceptance for concrete pipe in accordance with the following:
   1) 72-inch diameter and smaller: Acceptance on the Basis of Plant Load Bearing Test, Material Tests and Inspection of Manufactured Pipe for Visual Defects and Imperfections.
   2) Larger than 72 inches in diameter: Acceptance on the Basis of Material Tests and Inspection of Manufactured Pipe for Defects and Imperfections.
e. Minimum laying lengths: Four feet.
f. Rubber gaskets: ASTM C361.
g. Jointing mastic: Elastic, water-resistant, formulation of plastic bituminous materials, nonflammable solvent and inert fillers so combined that:
   1) When applied to a vertical metal surface and heated to 120F, jointing mastic will neither slump nor lose plasticity.
   2) When applied directly from container without further fixing, jointing mastic can be applied in even, adherent coat within temperature range of 20F to 100F.
h. Reinforced concrete elliptical pipe: ASTM C507

3. Perforated nonreinforced concrete pipe: AASHTO M175, Type 1 or 2, bell-and- spigot or tongue-and-groove type.
4. Porous concrete pipe: AASHTO M176, tongue-and-groove.

G. Plastic Pipe:
   1. Polyvinyl chloride (PVC) pipe: ASTM D3034, SDR-35.
   2. Polyethylene corrugated pipe: AASHTO M252.

H. Bituminous-Coated Corrugated Metal Pipe: AASHTO M190, Type A or C, with connecting bands, AASHTO M36.

I. Vitrified Clay Pipe: ASTM C700; Joints, ASTM C425, using plastic materials.

J. Cast-Iron Soil Pipe and Fittings: ASTM A74, extra-heavy (XH), with hub and spigot ends so constructed that joints may be made with gaskets conforming to CISPI Designation HSN 85 and the requirements of the relevant plumbing codes.

K. Lubricant for Rubber Gasket Pipe Joints: Vegetable oil soap.

L. Mortar Materials:
   1. Portland cement: ASTM C150, Type I.
   2. Sand: ASTM C144, natural sand.
   3. Lime: Pressure-hydrated, ASTM C207, Type S.
   4. Water: Potable.
   5. Pigment: As approved.

M. Brick: ASTM C32; solid brick; Grade MS for manhole brick, Grade SS for sewer brick; 2-1/4 inches by 3-3/4 inches by eight inches.

N. Precast Concrete Manhole Sections:
   1. ASTM C478.
   2. Joint entry seal gasket: A-LOK as manufactured by Atlantic Precast Concrete, Inc.; A-LOCK gaskets, manufactured by A-LOK Products Corporation, Trenton, N.J.; DURAC-SEAL gaskets, manufactured by DURA-CRETE, Inc., Dayton, Ohio; or equal.

O. Manhole Steps:
   1. Cast iron: ASTM A48 Class 30 A.

2. Rebar: No. 4 reinforcing bar with molded polypropelene or rubber encasement.

P. Manhole Frame and Cover; Inlet Frame and Grate; and Ballast Screen;
   1. Authority manhole: Cast-iron, ASTM A48, Class 30, with METRO logo.
   2. Rust-resistant cast iron or rust-resistant malleable cast iron.
   3. True to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes and defects affecting strength.
   4. Fillets at angles in casting with arises sharp and perfect.
   5. Sandblasted to effectively remove scale and sand, presenting smooth, clean and uniform surfaces. Coated with bituminous coating.
   6. Covers that receive paver tile:
      a. Omit bituminous coating.
      b. Provide positioning lug and lug receptor as a permanent part of the cover and frame rim so that the cover can only be installed (flush) in one position.

Q. Metal Water Seals for Basin Connections: Neenah Foundry Model No. R-3707 or equal.

R. Structural Steel Members: ASTM A36.

S. Steel Pipe: ASTM A53, black finish, extra strong wall class. U. Stainless Steel Angle: ASTM A167, Type 304.

T. Jute for Caulking: Good quality jute, free from tar, oil, or grease and dry when installed.

U. Preformed Expansion Joint Fillers: AASHTO M153, Type I, Type II or Type III.

V. Bituminous Expansion Joint Filler: AASHTO M33.

W. Galvanizing: Section 05120.

X. Ditch Lining and Slope Protection:
   1. Riprap: Material meeting the following requirements:
      a. Hard, durable and free of fractures; angular in shape; weather-resistant; and free from overburden, spoil, shale and organic material.
      b. Size: Weight distribution of pieces provided in accordance with the following:
         1) Class I: From 50 to 150 pounds with 60-percent minimum weighing 100 pounds or more; approximately 10 percent may weigh 50 pounds or less.
         2) Class II: From 150 to 500 pounds with 50-percent minimum weighing more than 300 pounds; approximately 10 percent may weigh 150 pounds or less.
      c. Quality:
         1) Water absorption: 3.0-percent maximum when tested in accordance with AASHTO T85.
         2) Specific gravity: 2.5 minimum when tested in accordance with AASHTO T85.
         3) Resistance to abrasion: Grade B maximum when tested in accordance with AASHTO T96.
         4) Soundness: Loss 20-percent maximum when tested in accordance with AASHTO T104.
   2. Aggregate filter:
      a. Coarse aggregate, ASTM C33, Size 357.
      b. Use only tough, durable materials free of thin, flat, elongated or soft friable particles and free of organic matter.
   3. Granite block facing: Type 4, quarry split finish on face and edges.
   4. Sand cushion for concrete block: Section 03 30 00, fine aggregate.

Y. Geotextile Filter Fabric: AASHTO M288 and the following additional requirements:
   1. Woven or non-woven pervious filter fabric weighing approximately 0.03 to 0.05 pounds

per square foot; free of defects.

2. Fabric: Long chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, amide or vinyl-chloride and with stabilizers or inhibitors to make fabric resistant to deterioration due to ultraviolet and heat exposure.
3. Fabric formed or treated so that filaments retain their positions relative to each other.
4. Edges selvaged.
5. Physical strength:
   a. Tensile strength: 200-pound minimum in each direction, ASTM D5034.
   b. Elongation at failure: 10 to 30 percent, ASTM D5034 amd D5035.
   c. Puncture strength: 70-pound minimum, ASTM D5034 and D5035.
6. Percent of open area: Not less than five percent nor more than six percent.
7. Equivalent opening size (E.O.S.): 70-100 US Standard Sieve, CW-02215-77.
8. Securing Pins: As recommended by manufacturer of filter fabric.

Z. Gabions:
1. Wire mesh: Galvanized steel wire 0.105 minimum diameter, 60,000 pounds per square inch tensile strength, galvanized at rate of 0.80 ounces per square foot. Wires twisted to form nonraveling hexagonal openings of uniform size, not to exceed 4-1/2 inches in length nor eight square inches in area of mesh opening. Horizontal dimension uniform, not to exceed 36 inches. Gabion dimensions not to vary more than three percent from manufacturer's stated size.
2. Tie devices: Malleable iron or steel, producing frictional force of 160 pounds per foot of spacing. Sized to conform to requirements of jurisdictional agency.
3. Stone: Durable, free from cracks and seams, unweathered, weighing between four pounds (four-inch average diameter) and 30 pounds (eight-inch average diameter) except five percent may vary more or less and 50 percent to exceed 10 pounds.
   a. Stone size:

AA. Coal-Tar Epoxy Coating:
1. Two-component.
2. Chemically cured.
3. Conforming to MS MIL-P-23236 (Ships), Type I, Class 2.
4. Thinner: As recommended by manufacturer of coating and as approved.

BB. Pipe Supports:
1. Pipe: Three-inch diameter, ASTM A53, Weight B, Class 1.
2. Flanges: ANSI/ASME B16.1, 125-pound Class, galvanized after fabrication.

CC. Underdrain Filter Material: ASTM C33, Size 57.

DD. Mortar and Grout Mixes

1. General Requirements:
   a. Mix dry in specified proportions by volume. Control and maintain accurate measurement throughout progress of work.
   b. Add sufficient water as specified to produce approved consistency.
   c. Do not mix in amount exceeding that which can be used within one hour after introduction of water.
   d. Do not retemper mix that has begun to set nor use such mix in the work.
   e. Where shown, specified or directed, mix pigment into dry mix to attain color selected by the Authority Representative. Pigment not to exceed 10 percent of dry batch weight of cement.
2. Proportions:
   a. Mortar: One part portland cement, 2-1/2 parts sand and water sufficient to produce stiff workable mix.
   b. Grout: One part portland cement, 2-1/2 parts sand and water sufficient to produce

plastic flowable mix.

c. Mortar for setting and pointing granite: One part portland cement, four to five parts sand, one part lime and water sufficient to produce approved consistency.

d. Mortar for setting granite paving and grouted granite blocks: One part portland cement, four parts sand, with water sufficient to produce approved consistency.

EE. Pipe for Underground Stormwater Detention Systems:

1. Allowable Materials:
   a. Pipe for underground storm water detention system shall be aluminized type 2 steel, polymer coated steel, or corrugated aluminum. Pipe must provide a minimum of 75 years of service life. Sizes may range from 36" through 144" diameter. Pipe material thickness may range from 16 gage to 10 gage.
   b. Aluminized steel type 2 shall conform to the applicable requirements of AASHTO M274 or ASTM A929. Polymer coated steel shall conform to the applicable requirements of AASHTO M246 or ASTM A742. Aluminum shall conform to the applicable requirements of AASHTO M197 or ASTM A744.
2. Pipe:
   a. Aluminized steel type 2 and polymer coated CSP shall be manufactured in accordance with AASHTO M36 or ASTM A760. Aluminum CMP shall be manufactured in accordance with AASHTO M196 or ASTM A745.
3. Fittings:
   a. All fittings shall be subject to a structural evaluation by manufacturer. All necessary reinforcing shall be designed and supplied by the manufacturer in accordance with ASTM A998. Manufacturer must submit CAD details of all fittings to project engineer for approval prior to fabrication of fittings.

FF. Diversion Structure: Precast *StormGate*™

1. Internal Components:
   a. All internal components are provided by CONTECH Stormwater Solutions, Inc.™; 12021-B NE Airport Way, Portland, OR 97220
   b. The *StormGate*™ weir: Shall be constructed of ASTM B209 6061 Aluminum sheet.
2. Precast Concrete Components:
   a. Precast Concrete: Shall be provided according to ASTM C478.
   b. Joint Sealant: Shall be Conseal CS-101 or Engineer approved.
   c. Steps: Shall be steel reinforced polypropylene steps, if required.
3. Contractor Provided Components:
   a. Sub-base: Shall be six (6) inch minimum of ¾ inch minus rock, 95% compaction. Compact undisturbed sub-grade materials to 95% of maximum density at +/- 2% of optimum moisture. Unsuitable material below sub-grade shall be replaced to site engineer' approval.
   b. Concrete (for concrete not covered by pre-cast specification above): Shall be 3000 psi, 28 day strength, 3/4 inch round rock, 4 inch slump maximum, placed within 90 minutes of initial mixing.
   c. Grout: Shall be non-shrink grout meeting the requirements of Corps of Engineers CRD-C588. Specimens molded, cured and tested in accordance with ASTM C-109 shall have minimum compressive strength of 6,200 psi. Grout shall not exhibit visible bleeding.
   d. Backfill: Shall be 3/4 inch minus rock (95% compaction), or as otherwise specified in the projects general technical specifications.
   e. Silicone Sealant: Shall be pure RTV silicone conforming to Federal Specification Number TT S001543A or TT S00230C or Engineer approved.

GG. Contech Engineered Solutions Llc Stormfilter®:

1. Internal Components: All internal components including ABS and PVC manifold piping, filter cartridge(s), filter media (as specified on the plans in the StormFilter data block or by the Engineer), and outlet riser with scum baffle shall be provided by Contech Engineered Solutions LLC.

a. ABS manifold pipe shall meet ASTM specification F628. PVC manifold pipe shall meet ASTM specification D1785 and PVC fittings shall meet ASTM specification D2466.

b. Filter cartridge bottom pan, inner ring, and hood shall be constructed from linear low-density polyethylene (LLDPE) or ABS. Filter cartridge screen shall consist of 1" x ½" welded wire fabric (16 gauge minimum) with a bonded PVC coating. Internal parts shall consist of ABS or PVC material. Siphon-priming float shall be constructed from high-density polyethylene (HDPE). All miscellaneous nuts, bolts, screws, and other fasteners shall be stainless steel or aluminum. An orifice plate shall be supplied with each cartridge to restrict flow rate to a maximum of 22.5 gpm at system design head or as specified on drawings.

c. If a sump cover/overflow baffle/inlet sump/outlet sump/inlet tower/outlet overflow is provided, they shall be constructed of ABS and sealed to the interior vault walls and floor with a polyurethane construction sealant rated for use below the waterline, SikaFlex 1a or equal. Contractor to provide sealant material and installation unless completed prior to shipment.

d. Underdrain Design: the size of the underdrain will provide a minimum of 0.067 in2 of underdrain cross sectional area per 1 gpm of design flow rate. (example: 105 gpm maximum design flow rate will require an underdrain with 7.035 in2 of cross sectional area, which is equal to one 3" diameter pipe)

e. Filter media shall be provided by Contech Engineered Solutions LLC, or approved alternate source. Filter media shall consist of one or more of the following, as specified in the StormFilter data block, or by the Engineer:

1) Perlite Media: Perlite media shall be made of natural siliceous volcanic rock free of any debris or foreign matter. The perlite media shall have a bulk density ranging from 6.5 to 8.5 lb/ft3 and particle sizes ranging from that passing through a 0.50 inch screen and retained on a U.S. Standard #8 sieve.

2) CSF Media: CSF media shall be made exclusively of composted fallen deciduous leaves. Filter media shall be granular. Media shall be dry at the time of installation. The CSF leaf media shall have a bulk density ranging from 40 to 50 lb/ft^3 and particle sizes ranging from that passing through a 0.50 inch screen to that retained on a U.S. Standard #8 sieve.

3) Metal Rx Media: Metal Rx media shall be made exclusively of composted fallen deciduous leaves. Filter media shall be granular. Media shall be dry at the time of installation. The Metal Rx media shall have a bulk density ranging from 40 to 50 lb/ft^3 and particle sizes ranging from that passing through a U.S. Standard #8 sieve to that retained on a U.S. Standard #14 sieve.

4) Zeolite Media: Zeolite media shall be made of naturally occurring clinoptilolite, which has a geological structure of potassium-calcium-sodium aluminosilicate. The zeolite media shall have a bulk density ranging from 44 to 48 lb/ft3, particle sizes ranging from that passing through a U.S. Standard #4 sieve to that retained on a U.S. Standard #6 sieve, and a cation exchange capacity ranging from 1.0 to 2.2 meq/g.

5) Granular Activated Carbon: Granular activated carbon (GAC) shall be made of lignite coal that has been steam activated. The GAC media shall have a bulk density ranging from 28 to 31 lb/ft3 and particle sizes ranging from that passing through a U.S. Standard #4 sieve to that retained on a U.S. Standard #8 sieve.

6) Zeolite-Perlite-Granular Activated Carbon (ZPG): ZPG is a mixed media that shall be composed of a 1.3 ft3 outer layer of 100% Perlite (see above) and a 1.3 ft3 inner layer consisting of a mixture of 90% Zeolite (see above) and 10% Granular Activated Carbon (see above).

7) Zeolite-Perlite (Zeo/Perl): Zeo/Perl is a mixed media that shall be composed of a 1.3 ft3 outer layer of 100% Perlite (see above) and a 1.3 ft3 inner layer consisting of 100% Zeolite.

8) CSF – Granular Activated Carbon (CSF/GAC): CSF/GAC is a mixed media that shall be composed of a 1.3 ft3 outer layer of 100% CSF media (see above) and a 1.3 ft3 inner layer consisting of 100% Granular Activated Carbon (see above).
9) Perlite – Metal Rx : Perlite/Metal Rx is a mixed media that shall be composed of a 1.3 ft3 outer layer of 100% Perlite (see above) and a 1.3 ft3 inner layer consisting of 100% Metal Rx (see above).
10) PhosphoSorb: PhosphoSorb media shall be made from Perlite pellets with activated alumina bound to the surface. The PhosphoSorb media pellets shall be granular and have a bulk density from 18 to 25 lb/ft3. The pellet size should range from that passing through a U.S. Standard ¼ inch sieve and retained on a #8 sieve.

f. Outlet riser with scum baffle shall be constructed of HDPE. Outlet riser shall have an outlet stub outside dimension (O.D.) of 12-inch diameter PVC, SDR 26 and a secondary outlet stub O.D. of 8-inch diameter PVC, SDR 26.

2. Precast Concrete Manhole Components:
   a. Precast Concrete Manhole shall be provided according to ASTM C478.
   b. Vault Joint Sealant shall be Conseal CS-101 or Engineer approved.
   c. Frames and covers shall be gray cast iron and shall meet AASHTO H-20 loading requirements, and shall be provided according to ASTM A48.
   d. Steps shall be constructed of copolymer polypropylene conforming to ASTM D-4101. Steps shall be driven into preformed or drilled holes once concrete is cured. Steps shall meet the requirements of ASTM C-478 and AASHTO M-199.
3. Contractor Provided Components: All contractor-provided components shall meet the requirements of this section, the plans specifications and contract documents. In the case of conflict, the more stringent specification shall apply.
   a. Crushed rock base material shall be six-inch minimum layer of ¾-inch minus rock. Compact undisturbed sub-grade materials to 95% of maximum density at +/-2% of optimum moisture content. Unsuitable material below sub-grade shall be replaced to engineer's approval.
   b. Concrete shall have an unconfined compressive strength at 28 days of at least 3000 psi, with ¾-inch round rock, a 4-inch slump maximum, and be placed within 90 minutes of initial mixing.
   c. Silicone Sealant shall be pure RTV silicone conforming to Federal Specification Number TT S001543A or TT S00230C or Engineer approved.
   d. Contractor shall connect to 12-inch or 8-inch diameter outlet riser with Fernco flexible coupling, or approved equal.
   e. Grout shall be non-shrink grout meeting the requirements of Corps of Engineers CRD-C588. Specimens molded, cured and tested in accordance with ASTM C-109 shall have minimum compressive strength of 6,200 psi. Grout shall not exhibit visible bleeding.
   f. Backfill material shall be ¾-inch minus crushed rock, or approved equal.

2.02 SOURCE QUALITY CONTROL:

A. Ditch lining and slope protection materials:
   1. After approval, do not change source.
   2. Replace defective material.

PART 3 - EXECUTION

3.01 EXCAVATION FOR SEWER AND DRAINAGE STRUCTURES

A. Perform excavation for sewers and drainage structures to line and grade shown in accordance with Section 31 20 00 and the following additional requirements:
   1. Excavate test pits sufficiently in advance of construction of sewers and drainage structures so that reasonable changes in line and grade can be made where location of

existing structures varies from that shown.

2. Excavate below horizontal plane extending two feet above top of sewer or drainage structures to maximum width of trench pay width shown. Where dimensions are not shown, make maximum horizontal width of excavation 18 inches from outside of sewer or drainage structure and minimum six inches. Where approved, excavation above such plane may exceed specified dimensions.
3. If excavation exceeds permissible dimensions, encase pipe or install pipe of higher strength.
4. Where necessary to place backfill or embankment so that trench can be excavated, extend backfill or embankment full depth laterally at least 2-1/2 times diameter of pipe on each side measured from centerline of pipe.

3.02 GEOTEXTILE FILTER FABRIC

A. Prepare surface to receive fabric to relatively smooth condition free of obstructions, depressions, debris and soft or low density pockets of material.
   1. Place fabric with long dimension parallel to centerline of trench and lay smooth and free of tension, stress, folds, wrinkles or creases with sufficient excess to allow for minimum overlap of 12 inches.
   2. Place strips in trench to provide minimum width of 12 inches of overlap for each joint.
   3. Insert securing pins with washers through both strips of overlapped fabric at not greater than 3-foot intervals along a line through the midpoint of overlap at joints.
   4. Where this method of placement conflicts with manufacturer's instructions, the manufacturer's instructions prevail.

B. At time of installation fabric to be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation, storage or handling.

C. Place fabric in manner and at location shown.

3.03 PIPE CRADLE

A. Place pipes on cradle of aggregate or concrete where shown.

B. Place aggregate so as to avoid segregation; compact to maximum practicable density so that pipe can be laid to required tolerances.

3.04 LAYING PIPE

A. General Requirements:
   1. Excavate to lines and grades shown in accordance with Sections 31 20 00 and herein. Excavate depressions for bells.
   2. Protect pipe and fittings during handling to prevent damage.
   3. Place, shape and compact bedding material to receive barrel of pipe. Type and thickness of bedding material as shown.
   4. Start laying pipe at lowest point; lay true to line and grade shown.
   5. Install pipe to bear on bedding material along entire length. Shape bedding material to fit bells and flanges.
   6. Install perforated pipe with perforations downward.
   7. Install pipe so that bells and grooves are on upstream end.
   8. Align each section of pipe with adjoining section with uniform annular space between bell and spigot and so as to prevent sudden offsets in flow line.
   9. As each section of pipe is laid, place sufficient backfill to hold it firmly in place.
   10. Keep interior of sewer clean as work progresses. Where small pipe size makes cleaning difficult, keep suitable swab or drag in pipe and pull through each joint immediately after jointing is completed.

11. Keep trenches and excavations free of water during construction and until backfilled. Each day, excavate only as much trench as needed to lay pipe.

12. When work is not in progress, securely plug ends of pipe and fittings to prevent trench water or other substances from entering pipes and fittings.
13. Where length of stub is not shown, install four-foot length and seal free end with brick masonry bulkhead or approved stopper.
14. Have work approved prior to covering pipe.
15. Where shown, place additional aggregate filter around and over pipe in lifts not exceeding six inches loose. Compact each lift before placement of next lift.
16. Backfill in accordance with Section 31 20 00.
17. Accomplish compaction by method that will avoid damage to pipe and will not disturb its alignment and grade. The use of vibratory rollers is prohibited until compacted cover over pipe has reached three feet or half the pipe diameter, whichever is greater.
18. Where cathodic protection is shown, apply coal-tar epoxy coating.

B. Vitrified Clay Pipe:
   1. Nonperforated pipe:
      a. Use pipe hoist, crane or other approved device when laying pipe greater than 18 inches diameter.
      b. Prevent damage to premolded joint rings or attached couplings.
      c. Clean joint contact surfaces immediately prior to jointing. To complete joint, use lubricants, primers or adhesives as recommended by pipe or joint manufacturer
   2. Perforated pipe:
      a. Firmly position spigot in bell of preceding pipe. Saturate jute gasket in cement grout and caulk into annular space. Ensure that jute is long enough to reach entirely around pipe and is of such thickness to bring pipe sections to same grade.
      b. After pipe sections have been caulked and centered, fill annual space with cement mortar.
      c. After mortar joints have set, place additional aggregate filter material as specified.

C. Concrete Pipe:
   1. Bell-and-spigot joints:
      a. Lay bell-and-spigot joint pipe as specified for vitrified clay pipe.
   2. Tongue-and-groove joints:
      a. Clean groove end of preceding pipe with wet brush and apply soft mortar to lower 1/4 of groove. Clean tongue end of succeeding pipe with wet brush and position it. Remove mortar from interior surface if squeezed out of joint.
      b. Complete mortaring interior and exterior portions of joint for entire circumference, extending from previously placed mortar. Perform final exterior mortaring of joints three lengths of pipe behind laying.

D. Plastic Pipe:
   1. Perforated pipe:
      a. Use sleeve couplings designed to hold pipe in alignment without use of sealing compound or gaskets.
      b. Place additional aggregate filter material as specified.
      c. Cap open ends of underdrains.
   2. Nonperforated pipe:
      a. Join sections of pipe with couplings recommended by pipe manufacturer.

E. Corrugated Metal Pipe:
   1. Perforated pipe:
      a. Place additional aggregate filter material as specified
   2. Nonperforated pipe:
      a. When pipe is shown to be bituminous paved, place paved area on bottom.

3. Connections for corrugated metal pipe:
    a. Join sections of pipe with coupling bands arranged to fit corrugations accurately.
    b. Do not damage protective coating when tightening bolts.
    c. After final tightening of connection bolts, apply brush coat of bituminous paint to bands and bolts.

F. Porous Concrete Pipe:
1. Fill joints with mortar as specified for tongue-and-groove joints of concrete pipe.
2. After pipe joints have been made, place additional filter material as specified.

G. Inspections Of Sewers:
1. Perform all work in accordance with current requirements of WASA.
2. Perform inspections on new or relocated storm sewers within or adjacent to the zone of influence, as defined by the limits of a theoretical slope of 1:1 from the bottom edges of tunneling and cut-and-cover excavations, as follows:
    a. Make inspections upon completion of tunneling and cut-and-cover operations, but prior to paving.
    b. Obtain video-tape television inspection records of sewers 36 inches and smaller in diameter.
    c. By means of visual walk-through inspection, obtain coordinated logs, photographs and other records specified by WASA of sewers larger than 36 inches in diameter and of associated structures.
3. Coordinate all television and walk-through inspection field operations with WASA. All such work to be performed in the presence of a WASA representative.

3.05 BACKFILL

A. Perform backfilling only after inspection and approval of pipe laying.

B. On completion of construction, backfill excavation in accordance with Section 31 20 00.

3.06 JOINTS FOR CONCRETE STORM SEWER 12 INCHES TO 33 INCHES

A. Use cold applied jointing mastic for joints of storm sewer 12 inches to 33 inches in diameter.

B. Bell-and-Spigot Joints:
1. Clean interior surface of bell and fill lower portion with mastic of sufficient thickness to make inner surfaces of abutting sections flush.
2. Install spigot end of adjoining pipe into bell so that sections are closely fitted and aligned.
3. Apply sufficient jointing mastic to fill remaining void in joint.
4. Remove excess mastic from interior of pipe.

C. Tongue-and-Groove Joints:
1. Clean groove. Apply mastic to lower half of groove.
2. Clean tongue of next pipe and apply layer of mastic to upper half.
3. Fit tongue into groove until pipes are closely fitted and aligned and mastic covers inner and outer surfaces.
4. Remove excess mastic from interior of pipe.

3.07 JOINTS FOR CONCRETE STORM SEWER 36 INCHES AND LARGER.

A. Where not prohibited by jurisdictional agencies, Use mortar for joints of storm sewers 36 inches diameter and larger.

B. Bell-and-Spigot Joints:
1. Where pipe cradle is aggregate, place shallow bed of mortar under joint.

2. Thoroughly wet bell and fill lower half with mortar.
3. Thoroughly wet spigot and uniformly fit into bell so that sections are closely fitted and aligned.
4. Fill remaining annular space in bell with mortar sufficient to form bead around outside of spigot end of pipe.
5. Remove excess mortar from interior of pipe and finish exterior and interior to smooth surfaces.

C. Tongue-and-Groove Joints:
1. Thoroughly wet groove; apply mortar to lower half of groove.
2. Thoroughly wet tongue of next pipe and apply a layer of mortar to top half.
3. Fit tongue into groove until pipes are closely fitted and aligned and mortar covers inner and outer surfaces of the joint.
4. Clean inner surface of pipes at joint and point up outside with bead of mortar.

3.08 JOINTS FOR VITRIFIED CLAY PIPE

A. Immediately before joining vitrified pipe, liberally coat bell with lubricant and fit spigot with gasket.

B. Join pipes using equipment designed for purpose.

3.09 JOINTS FOR CAST-IRON SOIL PIPE AND FITTINGS

A. Immediately before joining cast-iron soil pipe and fittings, liberally coat hub with lubricant and fit spigot with pipes using equipment designed for purpose.

3.10 CONNECTIONS WITH EXISTING SEWERS

A. Make connections with existing public sewers in accordance with requirements of the jurisdictional authority.

B. Do not connect existing sewer to sewer under construction unless approved.

3.11 TUNNELING AND JACKING

A. Perform tunneling and jacking by approved methods.

B. Where open cut is specified and the Authority Representative permits the work to be done by tunneling or jacking, perform such work as specified and as approved.

C. Cost of material substitutions required by change of methods will be borne by the Contractor.

D. Make horizontal borings necessary to lay pipe lines true to line and grade.

E. When sewers are laid in borings, completely fill void between outside barrel of pipe and boring with cement grout pumped into place.

F. When drainage pipes are laid in borings, completely fill void between pipe and boring with sand, using water pressure to ensure that voids are filled.

G. Methods of boring and filling of voids between pipe and boring are subject to approval.

3.12 CAST-IN-PLACE CONCRETE CONSTRUCTION

A. Conform to applicable requirements of Sections 03 10 00, 03 20 00 and 03 30 00. Section

designer to specify the type of cement to be used. The type of cement will vary depending upon the jurisdiction where the work is performed.

1. Cement.

B. Construct concrete support systems where shown. Section designer to specify the type of mortar to be used. Mortar type will vary depending upon jurisdiction in which the work is performed.

1. Mortar and cement.

3.13 BRICK CONSTRUCTION

A. Perform brick construction as specified in Section 04215, with the following additional requirements:

1. Use sewer brick wherever brick construction is exposed to flow; otherwise, use manhole brick.
2. Lay sewer brick on edge so that 2-1/4 by 8-inch side is exposed to flow.
3. Lay manhole brick so that every sixth course is a header course.
4. Where practicable, lay each course with a line. For curved courses or those in nonparallel planes, use bonded-and-keyed construction.
5. Do not exceed joint thickness of 3/8 inch in straight courses in parallel planes; for courses curved or in nonparallel planes, make thickest part of joint as thin as practicable.
6. Rack or tooth uncompleted brick construction and parge unexposed surfaces with 1/2 inch of mortar.

3.14 MANHOLES

A. Construct manholes of precast sections, cast-in-place concrete or brick as shown.

B. Provide base of precast or cast-in-place construction. Make watertight connection between base and risers.

C. Unless otherwise shown, place axes of manholes directly over centerlines of pipes.

D. Construct appropriate flow channels in bottom of manholes.

E. Where necessary, build connections for public and residential sewers into manholes. Cut pipe flush with inside wall of structure. Do not build pipe into wall; provide mortar joint between pipe and structure.

F. Install manhole steps and cast iron frame and cover for each manhole; adjust frame and cover to proper grade by brick construction.

G. Install joint entry seal gaskets in openings in the walls of 48-inch precast manholes with O-ring joint.

3.15 CATCH BASINS AND INLETS

A. When grading has been substantially completed as approved, construct catch basins of cast-in-place concrete using Class 3500 concrete and steel reinforcement as shown, precast sections or brick as shown.

B. Cut pipe flush with inside wall of structure. Provide mortar joint between pipe and structure or install water seal as shown.

C. Install cast iron frame and grate or cover and adjust to proper grade.

D. Install pipe supports as shown. Fill with concrete after installation.

3.16 DITCH LINING AND SLOPE PROTECTION

A. Slope Preparation:
   1. Excavate or fill slopes to the required cross section, lines and grades.
   2. Compact earth slopes to not less than 95 percent of the maximum dry density for a depth of not less than 12 inches, as specified in Section 32 11 23.
   3. Where lining or protection is to be applied to rock surfaces, clean off mud, debris and loose fragments.
   4. Construct toe or cut off walls where shown.
   5. Remove loose material and buried debris protruding from subgrade.
   6. Placement of aggregate filter:
      a. Place filter aggregate where shown to depth shown.
      b. Compact each layer of aggregate filter in accordance with ASTM D698, Method D, to 100 percent at plus-or-minus one percent of optimum moisture content.

B. Ungrouted Riprap:
   1. Place aggregate filter as specified.
   2. Place riprap by machine to full course thickness in one operation upward from bottom of slope. Prevent displacement of underlying materials. Dumping of riprap is prohibited.
   3. Fill spaces between larger stones to produce nearly even surface with minimum of voids. Manually supplement machine placement of stone to choke in voids.
   4. Rearrange individual stones as necessary to ensure that finished configuration conforms to lines, grades and thickness shown.

C. Bituminous Concrete Paving:
   1. Place bituminous concrete where shown to the lines, grades, thickness and shapes shown.
   2. Give base course prime coat of medium-curing, cutback asphalt and allow to cure before hot bituminous concrete is placed.
   3. Place hot-mix bituminous concrete by hand or by machine.
   4. When hand methods are used, place mixture by means of hot shovels or forks and spread with hot rakes to thickness required to obtain specified compacted thickness. Thoroughly rake loose material throughout its depth, to eliminate honeycombing. Use screed boards of width equal to required thickness of lining.
   5. After spreading, compact until specified compacted thickness is obtained.
   6. Place mixture as continuously as practicable to eliminate joints. Where joints are required at end of a day's work or when the placing is discontinued for such period of time that material becomes chilled, form joints as specified.

D. Cast-in-Place Concrete:
   1. Use Class 3500 concrete unless otherwise shown.
   2. Use wood or steel forms.
   3. Place reinforcing steel or wire mesh as shown.
   4. Provide and install dowel bars where shown in accordance with Section 32 13 13.
   5. Locate expansion and contraction joints where shown in accordance with Section 32 13 13, 03 30 00.
   6. Unless otherwise shown, give surface wood float finish.
   7. Protect and cure concrete in accordance with Section 03 30 00.

E. Concrete Masonry Units:
   1. Place two-inch layer of sand cushion on previously prepared slope.
   2. Set units firmly by hand in sand cushion with long dimension parallel to base of slope so as to produce even surface.
   3. Lay blocks with open 3/8-inch joints and with joints staggered as shown.
   4. Completely fill joints with mortar.

5. Protect and cure newly laid blocks for seven days using wet cotton mats or wet burlap.
6. Lay blocks when the temperature is 40F or above.

F. Paving Brick:
1. On the previously prepared slope, place concrete base of thickness shown.
2. Give concrete smooth screed finish.
3. Clean base, dampen and lay one-inch thick mortar bed.
4. Lay bricks with long dimension parallel to base of slope, with open 3/8-inch joints and with joints staggered.
5. Bed bricks firmly in mortar bed so as to produce even surface free from depressions or high spots.
6. Fill joints completely with mortar.
7. Protect and cure newly laid brick for a period of seven days using wet cotton mats or wet burlap.

G. Sodding: Section 32 91 00.

H. Concrete Pavement:
1. Lay plastic pipe as shown.
2. Place aggregate filter as specified.
3. Place concrete base in accordance with specified requirements for cast-in-place concrete.

I. Concrete with Granite Block Facing:
1. Lay plastic pipe as shown.
2. Place aggregate filter as specified.

3. Place concrete base in accordance with specified requirements for cast-in-place portland cement concrete.
4. Installation of granite block facing:
   a. et granite blocks in bedding course, one-inch minimum depth with 3/4-inch joint width.
   b. Slope bedding to true surface parallel to finished surface of blocks; strike off bedding until true alignment is attained.
   c. After final sloping, do not disturb bedding prior to laying blocks.
   d. Lay blocks on bedding course in successive courses with quarry split finish up.
   e. Align each course, lay true and even and bring to true grade by use of wood mallets or similar tools.
   f. Lay blocks in continuous sequence.
   g. Lay no more mortar than can be covered with blocks before end of work day.
   h. Point voids in joints with preshrunk mortar. Do not point when ambient temperature is 50F and falling.After pointing, scrub surfaces with soap solution and remove stains. Rinse immediately with clean water. Leave work in first class condition, free from mortar stain and other defacement as approved.

J. Gabions:
1. Prepare ground surface smooth and even where gabions will be installed.
2. Assemble gabions and tie together in accordance with manufacturer's instructions.
3. Fill gabions in lifts of 12 inches maximum. Install tie devices in all units with exposed faces, spaced in accordance with requirements of jurisdictional agency.
4. Ensure stone fill is placed without voids larger than approximately smaller stones. Hand-place stones in exposed faces.

3.17 CONCRETE HEADWALLS AND WINGWALLS

A. Excavation:
1. Excavate for foundations and walls to lines and grades shown in accordance with

Section 31 20 00.

B. Formwork and Reinforcement:
   1. Erect formwork and install reinforcement as shown and in accordance with Sections 03 00 00 and 03 20 00.

C. Concrete Work:
   1. Place concrete of class shown and protect and cure in accordance with Section 03 30 00.

D. Backfilling:
   1. Backfill and compact in accordance with Section 31 20 00.

3.18 UNDERGROUND STORMWATER DETENTION SYSTEM:

A. The underground storm water detention system shall be designed for H-20 loading conditions. Pipe spacing shall be ½ diameter of round pipe and 1/3 span of pipe-arch with a maximum required spacing of 3' between pipe runs.

B. The system shall have access manholes with steps to allow for inspection and maintenance; manholes shall provide access to the entire system. All pipe and fitting connections, although not required for perforated CMP systems, shall be gasketed; joints are required to be soil tight.

3.19 DIVERSION STRUCTURE

A. Precast Concrete Vault:
   1. Contractor to grout all inlet and outlet pipes flush with interior wall. Contractor to grout interior walls.
   2. Sanded PVC fittings shall be used on all PVC inlet and outlet pipes.

B. Weirs:
   1. At project completion, weirs shall be set to specified elevation, leave and sealed at all joints with silicone sealant. Sealant shall be worked into joints from both sides.

C. PVC Piping:
   1. Shall be joined in accordance with ASTM D2564.

D. Cleanup:
   1. Remove all excess materials, rocks, roots, or foreign material, leaving the site in a clean, complete condition approved by the Engineer. All PVC and fiberglass filter components shall be free of any foreign materials including concrete and excess sealant.

3.20 THE CONTECH ENGINEERED SOLUTIONS LLC STORMFILTER®

A. Precast Concrete Manhole:
   1. Place precast manhole on crushed rock base material that has been placed in maximum 12-inch lifts, loose thickness, and compact to at least 95-percent of the maximum dry density as determined by the standard Proctor compaction test, ASTM D698, at moisture content from 0- to 2-percent above optimum water content.
   2. Manhole floor shall slope 1/4 inch maximum across the "width" and slope downstream 1 inch per 12 foot of "length" ("Length" is defined by a line running from the invert of the outlet through the center of the manhole and "width" is the perpendicular to the "length"). Manhole top finish grade shall be even with surrounding finish grade surface unless otherwise noted on plans.
   3. Contractor to grout inlet pipe(s) flush with manhole interior wall.
   4. Inlet pipe(s) shall be stubbed in and connected to precast concrete manhole according to Engineer's requirements and specifications.

B. When required, ballast shall be to the dimensions specified by the engineer and noted on the data block. Ballast shall not encase the inlet and/or outlet piping. Provide 12" clearance from outside diameter of pipe.

C. Contractor to install filter cartridges:
   1. Filter Cartridges With CSF Media and Slip Connector Fittings: Tape shall be cleanly and completely removed from manifold fitting openings. Spool pieces (slip fittings) shall be inserted without glue into all manifold fittings to be equipped with a filter cartridge. Filter cartridges shall be placed over the spool pieces to contact the vault floor. Plugs shall be inserted without glue in all manifold fittings not equipped with a filter cartridge.
   2. Filter Cartridges with Threaded Connector Fittings: Tape shall be cleanly and completely removed from manifold fitting openings. Threaded connectors shall be glued and inserted into all manifold fittings to be equipped with a filter cartridge. Filter cartridges shall be threaded onto the connectors until they contact the vault floor. Plugs shall be inserted without glue in all manifold fittings not equipped with a filter cartridge.
   3. Filter Cartridges with ¼-Turn Connector Fittings: Tape shall be cleanly and completely removed from manifold fitting openings. ¼-turn connects shall be glued and inserted into all manifold fittings to be equipped with a filter cartridge. Filter cartridges shall be turned onto the connector until they reach the hard stop on the connector – approximately ¼ revolution. Plugs shall be inserted without glue in all manifold fittings not equipped with a filter cartridge.

D. Clean Up:
   1. Remove all excess materials, rocks, roots, or foreign material, leaving the site in a clean, complete condition approved by the engineer. All filter components shall be free of any foreign materials including concrete and excess sealant.

3.21 COATING APPLICATION AND REPAIR

A. Preparation of surface: Perform the following in order given:
   1. Clean surfaces contaminated with oil or grease using naphtha or xylol.
   2. Remove rust and mill scale from surfaces by dry abrasive blasting to commercial finish in accordance with SSPC SP-6.
   3. Coat surfaces within 24 hours and before dew point is reached.
   4. Apply coating only to surfaces which are dry and free of contaminants. Whip blast surfaces not coated within specified time limit.
   5. Application of coating:
      a. Mix coating in quantity which can be applied within its pot life if in accordance with manufacturer's recommendation. Thin only with approval.
      b. Apply coating to exterior surfaces of pipes and fittings in accordance with recommendations of coating manufacturer and as follows:
         1) Two coats of equal thickness.
         2) Total dry film thickness: 20 mils.
         3) Pretreat first coat as required prior to application of second coat.
         4) Apply second coat before first coat has dried tack-free but not later than 24 hours after application of first coat, unless otherwise recommended by coating manufacturer.
         5) Inspect coating prior to burial. Repair damages in accordance with recommendations for field corrections by coating manufacturer.
   6. Test cathodic protection as specified in Section 26 42 00

3.22 SITE QUALITY CONTROL

A. Maximum Surface Variation Tolerances:
   1. Grouted riprap: 1-1/4 inches in four feet from true plane.
   2. Bituminous concrete: Plus-or-minus 1/4 inch from specified grade in 25 feet.

3. Cast-in-place concrete: Plus-or-minus 1/4 inch from specified grade in 15 feet.
4. Precast concrete block: Plus-or-minus 1/2 inch from specified grade in 25 feet.
5. Paving brick: Plus-or-minus 1/2 inch from specified grade in 25 feet.

B. Site Tests and Inspections:
1. Obstruction Tests:
   a. Perform field tests to verify that installed storm systems are free from obstructions.
   b. Remove obstructions by excavating at the apparent obstruction and repairing or replacing the defective pipe as directed by the Authority Representative.
2. Inspection:
   a. Prior to paving or other construction over new or relocated sewers, conduct visual walk-through inspection of sewers larger than 36 inches in diameter and of associated structures and internal television inspection of sewers 36 inches and smaller in diameter.
   b. Employ the services of a sewer inspection company which has been regularly engaged in television sewer inspections and which is acceptable to WASA to perform preconstruction and post-construction inspections of sewers 36 inches and smaller in diameter.
      1) Submit to WASA for prior approval one sample of the cassettes to be used.

3.23 TRANSPORTATION AND INSTALLATION OF MATERIALS FURNISHED BY OTHERS

A. Transport and install materials furnished at the WSSC's storeyard at Bladensburg or other delivery points designated by the WSSC.

B. Use only suitable equipment, tools, and appliances for the safe and convenient handling and hauling of materials.

C. Check that all materials furnished by the WSSC are in satisfactory condition.

D. Materials damaged, lost or wasted after acceptance will be replaced by the WSSC at the expense of the Contractor.

E. Material showing inherent defects will be replaced by the WSSC without charge.

END OF SECTION

SECTION 33 71 19

ELECTRICAL UNDERGROUND DUCTS AND MANHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for underground electrical work, materials and products and raceway systems.

B. Related Sections:
1. Division 2 Sections as included
2. Section 03 33 00 – Precast Concrete
3. Sections 26 05 00 – Common Work Results for Electrical
4. Section 26 05 26 – Grounding and Bonding for Electrical Systems
5. Section 26 05 63 – Acceptance Testing of Electrical Systems
6. Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables
7. Section 26 05 33.13 – Conduits for Electrical Systems
8. Section 26 05 33.23 – Boxes for Electrical Systems

1.02 REFERENCE STANDARDS

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

B. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

C. American Society for Testing and Materials (ASTM):
1. ASTM A 36, Specification for Structural Steel.

D. Federal Specifications (Fed. Spec.):
1. Fed. Spec. FF-S-107C(2), Screws, Tapping and Drive.
2. Fed. Spec. FF-S-325, Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry) Group II (Shield, Expansion Bolt Anchor) Type 4 (Wedge expansion anchors) Class 1 (one piece steel expander with cone taper integral with stud).

1.03 QUALITY CONTROL

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. Equipment Manufacturer:
   1. In cases where the Contractor contemplates using equipment not made by the first named manufacturer of these specifications, refer to Section 26 05 00 of these specifications for special requirements and/or substitution requirements.

1.04 GENERAL REQUIREMENTS

A. Refer to Procurement Documents

B. Section 26 05 00, Common Work Results for Electrical, with the following additions and modifications.

C. Factory Tests:
   1. Determine applicable soil-density relationships for underground electrical installation bedding per applicable soil tests as defined in Division 2 of the Specifications.
   2. Determine soil-density relationships for compaction of backfill material as defined in Division 2 of the Specifications.

1.05 SUBMITTALS

A. Submit the following information for approval:
   1. Catalog Information:
      a. Conduit. (All Types)
      b. Precast Concrete Manhole and Handhole.
      c. Precast Polymer Concrete Handhole
      d. Manhole Frame and Cover.
      e. Handhole Frame and Cover.
      f. Sump Pumps.

1.06 CERTIFICATES

A. Material and Equipment: Provide manufacturer's statement certifying that the product supplied meets or exceeds contract requirements.
   1. Precast Concrete Manhole and Handhole and accessories.
   2. Manhole frame and cover.
   3. Precast Polymer Concrete Handhole

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Basic Electrical Materials: Those products such as building wire, connectors, fittings and similar devices as required for work of this Section are as specified in other Sections of these Specifications.

B. Provide materials and equipment listed by UL, when such equipment is listed or approved.

C. Conduit and Conduit Spacers: Conform to Section 26 05 33 13.

D. Wire and Cable: Conform to Section 26 05 19.

E. Grounding Material: Conform to Section 26 05 26.

2.02 WATERPROOFING OF CONDUIT JOINTS

A. General: Ensure that equipment and materials for waterproofing conduit joints complies with the following manufacturers for quality, installation procedures and guaranteed end results.
   1. Rigid Metal Conduit:
      a. Thread sealant: As recommended and approved by the conduit manufacturer.
      b. Cleaning solvent: As recommended and approved by the conduit manufacturer.
   2. Non-Metallic Conduit:
      a. All weather, quick-set joint cement: Approved by the conduit manufacturer.
      b. Cleaning solvent: As recommended and approved by the conduit manufacturer.

2.03 CAST JUNCTION BOXES

A. Provide weatherproof and watertight junction boxes for flush in-ground installation where indicated on the Contract Drawings.
   1. Construction: Cast iron type with necessary boxes, checkered cover and neoprene gasket for flush mounting.
   2. Install junction box in concrete pad as detailed on the Contract Drawings.
   3. Provide box of minimum size of 8-inches x 8-inches; larger as required by the
   4. National Electrical Code, or as indicated on the Contract Drawings and/or required by the field conditions.
   5. Acceptable Manufacturers:
      a. Appleton.
      b. Crouse Hinds.
      c. Killark.

2.04 PRECAST CONCRETE MANHOLES & HANDHOLES

A. Provide precast concrete, watertight manholes/handholes as indicated on the Contract Drawings. Provide manholes/handholes complete with necessary, required and specified appurtenances such as watertight locking type covers, cable racks, pulling-in irons, ground rods and ladder and water drainage provisions.

B. Acceptable manholes/handholes manufactures as indicated on Contract Drawings or as approved equal.

2.05 PRECAST POLYMER CONCRETE HANDHOLES

A. Provide precast polymer concrete, handholes as indicated on the Contract Drawings. Provide handholes complete with necessary, required and specified appurtenances such as watertight locking type covers, cable racks, ground rods and water drainage provisions.

B. Provide precast polymer concrete handholes constructed of sand-gravel aggregate bonded together with a matted fiberglass-reinforced polymer concrete. In no assembly can the cover design load exceed the design load of the box. All covers are required to have a minimum coefficient of friction of .50 in accordance with ASTM C 1028 and the corresponding Tier Level embossed on the top surface.

C. Provide handhole a heavy duty cover suitable for driveway and parking lot application with occasional non-deliberate heavy vehicular traffic and a service load of 6800 kg over a (15,000 pounds over a 10-inch) square.

D. [Provide enclosures, boxes and covers to conform to all test provisions of the latest version of the ANSI/SCTE 77 “Specification For Underground Enclosure Integrity” for Tier 22].

E. Provide handhole with the following identification cast into the cover as appropriate for the service: "Electric", "Lighting","Telephone", "Communications", "Fiber Optics".

F. Acceptable Manufactures
   1. Quazite
   2. CDR Systems
   3. Strongwell
   4. Hubbell Enclosures

2.06 WATERPROOFING PRECAST CONCRETE MANHOLES

A. Provide asphalt compound coating of either the solvent type or the emulsion type. However, mixtures of the two types in the Project is not permitted.
   1. Solvent Type: Brush or spray-on asphalt compound, cold-applied.
   2. Emulsion-Type: Brush or spray-on asphalt-base, clay emulsion with fibers, cold-applied.
   3. Acceptable Manufacturers:
      a. W. R. Meadows, Inc.; SEALMASTIC.
      b. Coopers Creek; Coopers Black.
      c. Tnemec; 46-465.
      d. Or Approved Equal.

2.07 SUPPORTS AND FASTENERS

A. Supporting Devices: Carbon steel angles, channels, and bars meeting material requirements of ASTM A36. Pre-engineered UL Listed supporting systems of electrogalvanized steel or electrogalvanized steel PVC coated products may be used in lieu of field fabricated support systems.

B. Fasteners: Provide anchoring devices to anchor conduit or raceway, and supporting devices or pre-engineered supporting systems, to the structure, of the type designed for the specific purpose of anchoring into structure materials at intended point of installation. RAWL PLUGS NOT PERMITTED.
   1. Toggle and Expansion Bolts: Fed. Spec. FF-B-588C.
   2. Self-Tapping Screws: Fed. Spec. FF-S-107C(2).

3. Conform anchoring devices for fastening into solid masonry or concrete to Fed Spec. FF-S-325 Group II, Type 4, Class 1 for expansion type anchors.

2.08 UNDERGROUND WARNING TAPE

A. Metal detectable polyester material, with minimum one-inch high lettering. Overcoated graphics to read, "CAUTION-BURIED ELECTRIC LINE" for electric lines and/or “CAUTION - BURIED TELEPHONE” for telephone lines. APWA color to be red for electric lines and orange for telecommunication or fiber-optic lines.

B. Acceptable Manufacturers:
   1. Brady #91600 Series
   2. Presco
   3. Seton
   4. Or Approved Equal

2.09 GROUNDING

A. Ground rods are to be copper clad steel with diameter adequate to permit driving full length of the rod minus 6 inches, which extends above the finished concrete slab. Conform to Section 26 05 26 of these Specifications.

B. Ground Wires: 600Volt, size as indicated or required by code minimum #6.

2.10 TEXTILE INNERDUCT

A. Install one 3-cell innerduct set in each 4-inch conduit (existing and new) identified as communications on the Drawings with integral color coded pull tapes.

B. Install innerduct in conduit as specified in Section 26 05 33.13.

C. Install fiber optic cable and copper telephone cable in innerducts in separate conduits.

D. Utilize manufacturer recommended terminations accessories in conduits upon entry to Communications Room.

E. Acceptable Manufacturers:
   1. Maxcell Innerduct, 4” 3-Cell product
   2. Or Approved Equal

PART 3 EXECUTION

3.01 INSTALLATION

A. Incoming Service Requirements:
   1. Coordinate work and work requirements with Servicing Utility Company and the Authority prior to installation.
   2. Contact the following representative of the Serving Utility Company for electrical service installation requirements and to verify exactly the work required by the utility company to perform under this Contract.
      a. Ed Stonework with BGE.

Phone: 410-470-8450

B. General Requirements (Refer to Procurement Documents):
   1. For Underground Work
      a. Install underground conduit systems in accordance with Article 300-5 of the NEC, in accordance with previous requirements of this Section, and the following requirements exceeding NEC:
         1) Perform earthwork for buried conduit as specified previously for electrical work under Division 2.
         2) Install Concrete Encasement as indicated and detailed. Concrete as previously specified in Section 03 30 00.
         3) Where detailed on the Contract Drawings, underground conduits, both single and banked, concrete encase and reinforce using 5/8-inch steel reinforcing rods as indicated on the Contract Drawings.
         4) Bank conduits to the extent indicated and secure same in place with install separators at 5-foot intervals. Provide separators with sufficient strength to prevent displacement of conduits when placing backfill or pouring concrete encasement.
         5) Lay conduit lines to grade a minimum of three inches per 100 feet. Grade conduit lines away from buildings, except conduit lines running between buildings, without intervening handholes or manholes shall be level.
         6) Where conduit lines run to manholes, handholes or similar underground structures, grade conduits to drain to such.
         7) Construct underground conduit lines to be watertight. Stagger conduit couplings in banks of conduits.
         8) Unless otherwise indicated on drawing or details, where conduits change direction or turn up at equipment, transformers, buildings, terminal poles, etc., use long sweep PVC coated rigid galvanized steel conduit elbows.
         9) Provide two and one half feet minimum cover over conduits and over concrete encasement of conduit, unless indicated otherwise or specified.
         10) Where conduits are to be turned up into equipment or transformer pads, extend the concrete encasement for the conduits up to the top of the concrete pad and provide a 3/4" chamfer around exposed top edges. Isolate the concrete encasement for the conduits from the concrete pad for the equipment or transformer pad. Provide 2" high crushable fiber materials around duct bank encasement.
         11) Extend conduits 6 inches above concrete slab surface. Install insulating grounding bushing on all conduits. Perform concrete work as specified in Division 3 "Cast-In-Place Concrete".
         12) Where conduits are to be turned up at terminal poles, extend the concrete encasement for the conduits up pole to a height of 24 inches above finished grade and be provided with a 3/4" chamfer around all exposed top edges. Perform concrete work as specified in Division 3 "Cast-In-Place-Concrete".

C. Underground Duct Bank with Concrete Encasement: Construct underground duct bank lines of individual conduits encased in concrete as indicated. Except where rigid galvanized steel conduit is indicated or specified, use only one kind of conduit in any

one duct bank. Use ducts no smaller than 4 inches in diameter unless otherwise indicated. Provide concrete encasement rectangular in cross-section surrounding the bank and provide at least 3 inches of concrete cover for ducts. Separate conduit by a minimum concrete thickness of 2-inches, and maintain a separation, between conduit centerlines, of seven and one-half inches. Separate power conduits from telephone, communication and/or data highway conduits a minimum of 24 inches of earth or concrete thickness of 8 inches, unless otherwise indicated.

D. Place duct bank lines with a continuous slope downward toward manholes, handholes and away from buildings with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, change direction of bends in runs exceeding a total of 10 degrees, either vertical or horizontal, by long sweep bends having a minimum radius of curvature of 25 feet. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Use only manufactured bends with a minimum radius of 18 inches for use with conduits of less than 3 inches in diameter and a minimum radius of 36 inches for conduits of 3 inches in diameter and larger. Terminate conduits in end-bells where duct bank lines enter manholes and handholes as indicated on the Contract Drawings.

E. Provide separators compatible with the conduit utilized and conforming to those specified in other Sections of these Specifications. Stagger the joints of the conduits by rows and layers so as to provide a duct bank line having the maximum strength. During construction, protect partially completed duct bank lines from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of a duct bank line is completed from manhole to manhole, from manhole to building or structure and/or from handhole to handhole, draw a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the size of the conduit, through each conduit, after which draw a brush having the diameter of the duct bank and stiff bristles through until the conduit is clear of particles of earth, sand, and/or gravel; immediately install conduit plugs. Provide a plastic pull rope, having a minimum of 3 additional feet at each end, in telephone and spare duct banks.

F. Underground Conduit for Service Feeders: Indicate underground conduit for service feeders into buildings on the Contract Drawings. Where rigid steel conduit bank is utilized, protect the ends of the conduit by threaded metal caps or brushings; coat the threads with graphite grease or other suitable coating. Clean and plug conduit before conductors are installed.

G. Conform concrete to that specified in Division 3 of this Specification.

H. Backfilling: Provide a continuous plastic warning tape about 12 inches below the top of the trench directly over each underground duct bank. Conform concrete to that specified in Division 3 of this Contract. Progress backfilling as rapidly as the construction, testing and acceptance of the work permits. Ensure backfill is free from roots, wood, scrap material, and other vegetable matter and refuse. Install and compact backfill as specified in Division 2.

3.02 CONDUIT WATERPROOFING

A. Non-Metallic Conduit:

1. Plastic PVC Conduit (Schedule 40): Liberally coat the end of the conduit with an approved all weather, quick-set clear cement before joining. Insert joint into the coupling, pushing firmly and rotating conduit until it reaches the pre-formed stopping ridge within the coupling.

3.03 PRECAST CONCRETE MANHOLES & HANDHOLES

A. Provide steel bar pulling-in irons bent in the configuration of a deformed "Z" and cast in the walls and floors. Pocket pulling-in irons in the floor and center directly under the manhole cover. Locate pulling-in irons in the wall not less than 6 inches above or below, and opposite the conduits entering the manhole. Locate the pulling-in-irons such as not to interfere with the cable distribution racks. Project pulling-in-irons into the manhole approximately 4 inches. Zinc-coat irons after fabrication.

B. Ensure cable racks, including hooks and insulators, are sufficient to accommodate the cables and spaced not more than 24 inches horizontally. Provide wall bracket of glass reinforced nylon channel. Provide support brackets of glass reinforced nylon and of the removable type. Provide insulators of dry-process glazed porcelain.

C. Provide aluminum step: aluminum alloy AA designation 6061-T6. Coat that portion of aluminum step being embedded in concrete with heavy bodied bituminous paint.

3.04 MANHOLE/HANDHOLE INSTALLATIONS

A. Where openings into manholes are below final finished grade, extend openings to the required elevation with either concrete or brick suitably arranged to support or anchor the frames and covers. Obtain engineer approval of the construction method and procedure before any work is done.

B. Where required for pulling cables, furnish and install in the walls of the manholes and handholes, a sufficient number of inserts for the proper attachment of cable supports.

C. In general, properly dress and rack cable/or wire on the support arms and insulators around the walls of the manholes and handholes, providing slack where required for future rearrangements. Install cable support brackets, along with the support arms and porcelain insulators, on each wall of the manhole and handhole. Secure cables within manholes and handholes to the insulators by marlin rope. Use proper regard for neat and orderly appearance and location, and provide accessibility for future connections. Take care not to damage the walls of the manholes and handholes during cable pulling.

D. Provide each manhole with a 1 inch diameter hole in the floor for a ground rod. Provide a 3/4 inch diameter by 10 foot long copper clad ground rod installed in one corner with 6 inches of the ground rod left extended above finished floor. Ground metal work to the ground rod.

E. Conform manhole frames and covers to requirements as outlined above in these Specifications; and ensure Engineer approval.

F. Provide a manhole drainage system as indicated on the Contract Drawings.

3.05 PRECAST CONCRETE MANHOLE & HANDHOLE FRAME AND COVER INSTALLATION

A. Where required, make final adjustment of frame to elevation using materials grade rings.
   1. Set precast grade rings in Waterproof Mortar. Do not exceed 3/4-inch maximum and 3/8-inch minimum mortar thickness. Wet, but do not saturate precast grade rings immediately before laying.
   2. Precast grade ring: Pre-set to proper plane and elevation using wedges or blocks of cementation material not exceeding one spare inch wide on each side. Permit no more than four wedges or blocks per grade ring. Incorporate wedges or blocks in fresh mortar in a manner to completely encase each. Crown fresh mortar to produce squeeze-out between grade rings. Tool exposed joints with appropriately shaped tool and compact mortar edge into joints. Clean off excess mortar prior to initial mortar set.
   3. Bolt manhole frames in place on manhole top section, or on leveling units if required, after installing 2 inch thick preformed plastic sealing compound on bearing surface of manhole frame. Remove excess sealing compound squeeze-out after manhole frame is bolted in place.
   4. Use bolts of sufficient length to properly pass through leveling units, if used, engage full depth of manhole top section inserts and allow enough threaded end to pass through manhole frame to properly tighten nut and washer. Tighten manhole frame bolts after mortar has cured.

3.06 PRECAST CONCRETE HANDHOLES & MANHOLES FIELD COATING

A. Clean cast-iron or steel frames, covers and gratings not buried in masonry of mortar, rust, grease, dirt and other deleterious materials by an approved blasting process, and give a coat of bituminous coating material. Clean surfaces that cannot be cleaned satisfactorily by blasting to bare metal, by wire brushing, or other mechanical means. Wash surfaces contaminated with rust, dirt, oil, grease or other contaminants with solvents until thoroughly cleaned. Immediately after cleaning, coat surface with a pretreatment coating or give a crystalline phosphate coating. As soon as practicable after the pretreatment coating has dried, prime treated surfaces with a coat of zinc chromate primer and coat with synthetic exterior gloss enamel.

3.07 WATERPROOFING PRECAST CONCRETE HANDHOLES & MANHOLES

A. Apply a specified protective coal-tar-based coating of two applied coats, minimum, to surfaces in direct contact with in ground cover to obtain a minimum 12.0 dry mil total applied surface thickness. Apply coating in strict conformance with manufacturer's requirements.

B. Application: The coating may be either shop or field applied. Apply coating to the exterior of manhole components.

3.08 CONNECTIONS TO MANHOLES/HANDHOLES

A. Construct concrete encased duct bank lines connecting to manholes or handholes to have a tapered section adjacent to the manhole or handhole to provide shear

strength. Construct manholes and handholes to provide for keying the concrete envelope of the duct bank line into the wall of the manhole or handhole. Use vibrators when this portion of the envelope is poured to assure a seal between the envelope and the wall of the manhole or handhole.

3.09 CABLE DUCT BANK SHIELDS

A. Provide shields of a suitable type manufactured for the purpose where cables enter and leave manholes and handholes and other duct bank entrances.

3.10 EARTHWORK

A. Excavate to depths as required for manholes and handholes. Excavation for manholes and conform handholes to the requirements stipulated in Division 2 - Site Work.

B. Remove waste excavated materials not required or suitable for backfill on the project from the site as directed. Provide sheeting and shoring as necessary for projection of work and safety of personnel. Remove water from excavation by pumping or other approved method.

3.11 GROUNDING

A. Provide non-current carrying metallic parts associated with electrical equipment with a maximum resistance to solid "earth" ground not exceeding the values indicated in Section 26 05 63 of these Specifications.

3.12 DISSIMILAR SURFACES ISOLATION

A. Paint aluminum surfaces at point of contact with wood, concrete or masonry construction with one coat (minimum dry mil thickness - 5.0 mils) of bituminous paint.

B. Clean away excess or misplaced paint materials from aluminum surfaces and adjoining construction materials.

3.13 TEST

A. Field Tests: Field test of electrical equipment and conform systems to those specified in Section 26 05 53 of these Specifications.

END OF SECTION

SECTION 33 71 73

ELECTRICAL UTILITY SERVICE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: This section includes the specification of requirements for coordination, furnishing a service entrance from the local Utility Company.
   1. Work included in this Section:
      a. Utility Service Entrance design requirements.
      b. Utility Service Entrance coordination requirements, with Authority and local Utility Company Service Representative.
      c. Identification of responsible individuals for Authority and local Utility Company.
      d. Sequencing and scheduling, including outage scheduling.

B. Related Work:
   1. Refer to Procurement Documents
   2. Section 26 05 26 Grounding and Bonding for Electrical Systems
   3. Section 26 05 28 Hangers and Supports for Electrical Systems

1.02 REFERENCES

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

B. Institute of Electrical And Electronic Engineers (IEEE):
   1. IEEE C2 - National Electrical Safety Code (NESC).

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

D. Pennsylvania Power & Light Company, PP&L, Incorporated (PP&L)
   1. Rules for Electric Meter & Service Installations.

1.03 SYSTEM DESCRIPTION

A. Main Service Entrance System Voltage Design Requirements:
   1. Existing Main Utility Service:
      a. Building A: 800 Amp, 208/120 volts, three-phase, four-wire, 60 Hertz, grounded, wye.
      b. Building B: 2000 Amp, 208/120 volts, three-phase, four-wire, 60 Hertz, grounded, wye.
      c. Building C: (2) 100 Amp, 208/120 volts, three-phase, four-wire, 60 Hertz, grounded, wye.

2. Replacement Main Utility Services as indicated on the drawings.

B. Performance Requirements:
   1. Contractor Work:
      a. The complete installation, connection and energization of the new Utility Service Entrance will be the responsibility of the work of this Section.
      b. Obtain approval of the system installation requirements, as depicted on the Drawings and included within the Specifications with the local Utility Company. Assure that the proposed installation is thoroughly reviewed, coordinated, and approved to the satisfaction of the Authority and local Utility Company, prior to the installation of the service.
      c. Supply all items and perform all work indicated in the Utility Company rules and requirements as "by Customer".
   2. Local Utility Company Work:
      a. The local utility will be responsible for any final review, inspection, and approval of the new service, as constructed by the Contractor.
      b. The local Utility Company will provide and install items as outlined in their applicable rules for electric service.
      c. The local Utility Company will be responsible for reviewing all necessary metering changes. The local Utility company will review and make any necessary adjustments to existing overcurrent protective settings of Authority's incoming service entrance disconnecting means in accordance with the requirements of the new design.

1.04 SUBMITTALS

A. Make all project submittals in accordance with the Procurement Document requirements. Submit proposed utility layouts and details, as provided by the local Utility Company Service Representative.

B. Utility Approved Required for Installation: Submit a copy of the proposed service entrance design requirements as detailed and included within the Drawings and Specifications for local Utility Company approval. Clearly indicate the following items:
   1. Methods, locations, and types of attachments made to the service pole.
   2. Types and manufacturers of identified pole hardware.

C. Product Data and Catalog Cuts: Provide product data for all products provided; indicate clearly the usage of each product. Provide representative data for materials and construction of hardware, where required.

D. Shop Drawings: Submit shop drawings as required for all items included within this Section. Provide submittals required for the products contained within this Section, including:
   1. List of materials to be used.
   2. Catalog cuts of materials and/or equipment.

E. Project Record Documents:
   1. Record actual locations of poles, guys, anchors, and required horizontal and vertical clearances, as installed by the Contractor and local Utility for Authority's records.

2. Provide certificates of final electrical inspection from authority having jurisdiction to Authority with copies to Engineer.

1.05 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. Requirements of Regulatory Agencies: Conform with building and electrical code requirements of State, County, Township Utilities, and other political entities which exceed the requirement of national codes, standards, and approving bodies. Modify the electrical work in conformance with such all requirements without additional expense to the Authority.

C. Product Quality Control:
   1. Provide manufacturers' products fabricated in such a manner that criteria for appearance, fit and tolerances are complied with.
   2. Use manufacturers who carefully control operations to ensure that the engineering, quality, safety and reliability of product are achieved.

D. Code Compliance Inspection: Have the work of this Section inspected by an authorized inspection agency for compliance with the National Electric Code and local approving bodies. Obtain and submit certificates of approval, acceptance and compliance. Work shall not be deemed complete until such certificates are delivered to the Authority, with copy forwarded to the Engineer for review.

1.06 SCHEDULING

A. Schedule all work with the Authority, through Authority’s designated representative.

B. Schedule no work within an area until it has been review, submitted and approved by the Authority.

C. Outage Coordination:
   1. Provide necessary coordination, notification, and written approval of the Authority, Engineer, and local Utility Company to obtain authorization, concurrence and coordination needed to support the outage for the completion of work of this Section.
   2. The Authority will identify a proposed window of availabilities for a scheduled outage, which may include off working hours, weekends or regularly scheduled periods of non-use of his facility.

1.07 SYSTEM STARTUP/ENERGIZATION

A. Coordinate, notify, and obtain written approval of the Authority, to assure authorization, concurrence and coordination needed to support the startup and energization of the new service delivery line onto the property.

PART 2 PRODUCTS

2.01 GENERAL

A. Comply with the requirements of the various Division 26 Sections as applicable.

B. Comply with applicable Utility Company requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Carefully investigate the structural and finish condition, as well as other construction work, which may affect the work of this Section. Arrange electrical work accordingly as show on the Drawings and furnish such fittings and apparatus as required to accommodate such conditions.

B. Prior to performance of work described above, make detailed drawings of proposed departures from original design due to field conditions or other cause, and submit for Engineer's approval.

C. Inspect installed conduit and remove obstructions, dirt and debris if present. Provide and maintain protective covers on conduit, to avoid collection of dirt and moisture within conduit.

3.02 PREPARATION

A. Field Measurement: The Drawings are generally indicative of the work, but due to their small scale, it is not possible to indicate some offsets, fittings, and apparatus required nor the minor structural obstructions that may be encountered.

B. Obtain roughing-in dimensions of electrically operated equipment being installed in other construction work. Set conduit only verifying acceptable dimensions and the checking of actual equipment locations.

C. Layout electrical work to suit actual field measurements and according to accepted Trade standard practice. Provide electrical installations conforming to NFPA 70, Article 230 Services and Article 300 for general requirements (refer to Procurement Documents) and wiring methods, as well as other applicable articles of NFPA 70 governing methods of wiring.

3.03 CONDUIT INSTALLATION

A. See Section 26 05 33.13 for specific requirements.

3.04 GROUNDING AND BONDING

A. See Section 26 06 26 for specific requirements.

3.05 SUPPORTING SYSTEM INSTALLATION

A. See Section 26 05 28 for specific requirements.

END OF SECTION

SECTION 33 82 13

COPPER COMMUNICATIONS DISTRIBUTION CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of materials for furnishing, installing connecting, energizing, testing, cleaning and protecting a structured wiring system for voice and data.

B. Related Section:
1. Section 26 05 00 - Common Work Results for Electrical
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems
3. Section 26 05 53 - Identification for Electrical Systems
4. Section 26 05 28.33 - Conduits and Backboxes for Electrical Systems
5. Section 27 00 00 – Appendix B Approved Materials
6. Section 27 00 00 Appendix C WMATA Infrastructure Design and Wiring Standards

1.02 REFERENCES

A. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronics Industry Alliance (EIA):
1. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements
2. ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components.
3. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces
4. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
5. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
6. Institute of Electrical and Electronic Engineers (IEEE):
7. IEEE 802.3ab Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T

B. Insulated Cable Engineers Association (ICEA):

1. ANSI/ICEA S-80-576 Communication Wire and Cable for Wiring of Premises

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA WC 63.1 Telecommunications Cables

D. Underwriters Laboratories (UL):
   1. UL 444 Communications Cables
   2. UL 467 Grounding and Bonding Equipment
   3. UL 1863 UL Standard for Safety for Communications-Circuit Accessories

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

F. BICSI:
   1. Telecommunications Distribution Methods Manual

1.03 GENERAL REQUIREMENTS

A. Communications system cabling, raceways, pathways, and spaces shall at minimum comply with ANSI/TIA/EIA-568-B.1, -568-B.2, -568-B.3, -569-A and -607.

B. Provide grounding and bonding per, at minimum, ANSI/TIA/EIA-607, NFPA 70 and UL 467.

1.04 SUBMITTALS

A. General: Submit documentation to the Engineer in accordance with the applicable provisions of these Specifications, Section 26 05 00.

B. Product Data and Catalog Cuts: Submit product data for all products provided. Indicate clearly the usage of each product.

1.05 QUALITY ASSURANCE

A. 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 unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.

B. Provide products that have been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Test results shall be provided upon request of the Engineer.

C. Manufacturer Qualifications: Firm specializing in installing work of this Section with minimum five years documented experience in construction of similar equipment.

D. Conform all work to NFPA 70, National Electrical Code.

E. Installer Qualifications: Firm specializing in installing work of this Section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 CATEGORY 3 OUTSIDE PLANT BACKBONE CABLE (VOICE):

A. Copper backbone cable shall be solid conductor, 24 AWG, 100 ohm, 100-pair UTP (Unshielded twisted pair). Pair twist lengths and frequency per unit length shall be determined by the manufacturer. A minimum of two conductor twists per foot is required. Jacket sequentially marked at two-foot intervals. Metallic shield tape. Fully filled construction to prevent intrusion of moisture. Shall conform to Category 3 requirements, ANSI/ICEA S-84-608, ANSI/TIA/EIA-568-B, and RUS 7 CFR 1755.390 (PE-39).

1. Physical Description:
   a. Conductors: Solid annealed copper in 24 AWG.
   b. Insulation: Conductors are insulated with solid polyolefin, color coded in accordance with industry standards.
   c. Twisted Pairs: Individual conductors are twisted into pairs with varying lay lengths to minimize crosstalk and specific color combinations to provide pair identification.
   d. Core Assembly: Cables of 25 pairs or less are assembled into a cylindrical core.
   e. Filling Compound: The core assembly is filled with an 80° C ETPR or PIB Base Jelly compound, completely filling the interstices between the pairs and under the core wrap.
   f. Core Wrap: A non-hygroscopic, dielectric tape is applied over the core assembly to provide protection for the core.
   g. Shielding: A corrugated, copolymer coated, 8-mil aluminum tape is applied longitudinally with an overlap. The shield interfaces are flooded with an adhesive compound to provide a moisture barrier and inhibit corrosion.
   h. Jacket: A black, linear low-density polyethylene jacket is applied overall. The jacket provides a tough protective covering designed to withstand exposure to direct sunlight, atmospheric temperature changes and stresses expected in standard installations.
   i. Jacket markings: Information, such as manufacturer's identification, pair count, AWG, product identification and a telephone handset is printed at 2 ft. intervals on the cable jacket. Sequential footage markings are printed at alternate 2 ft. intervals.

2. Acceptable Manufacturers:
   a. Belden.
   b. CommScope.
   c. General Cable.
   d. Hubbell Premise Wiring.
   e. HCM (Hitachi Cable Manchester, NH).
   f. Or Approved Equal

2.02 CATEGORY 6 INSIDE PLANT CABLE:

A. Category 6 Backbone Cable (Voice):
   1. Copper backbone cable shall be solid conductor, 24 AWG, 100 ohm, 25-pair UTP (Unshielded twisted pair), NFPA 70 CMR rated, covered with a gray thermoplastic jacket. NFPA 70 type CMP may be substituted for type CMR. Pair twist lengths and frequency per unit length shall be determined by the manufacturer. A minimum of two conductor twists per foot is required. Color coding shall comply with industry standards for 25 pair cables. Jacket sequentially marked at two-foot intervals. Shall conform to Category 6 requirements, ANSI/ICEA S-80-576, ANSI/TIA/EIA-568-B, UL 444 and be 1000BASE-T compliant.
   2. Acceptable Manufacturers:
      a. Belden.
      b. CommScope.
      c. General Cable.
      d. Hubbell Premise Wiring.
      e. HCM (Hitachi Cable Manchester, NH).
      f. Or Approved Equal.

B. Category 6 Horizontal Cable (Voice, Data):
   1. Comply with NFPA 70, NEMA WC 63.1, ANSI/ICEA S-80-576 and performance characteristics in ANSI/TIA/EIA-568-B.
   2. UTP (unshielded twisted pair), 100 ohm. Provide four each individually twisted pair, 24 AWG conductors, NFPA 70 CMG rated, with a blue PVC jacket. NFPA 70 type CMP or CMR may be substituted for type CMG. Individual pairs shall be constructed to contain a minimum two twists per foot per each pair. Overall diameter of four pair cable shall not exceed 0.25 inches (6.32 mm). Ultimate breaking strength shall be minimum 90 pounds (40.82 kg). Four pair cable shall withstand a bend radius of one inch (25.4 mm) minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking. Conductors shall be color coded and polarized in accordance with ANSI/TIA/EIA-568-B. Jacket sequentially marked at two-foot intervals. Shall conform to Category 6 requirements and be 1000BASE-T compliant.
   3. Acceptable Manufacturers:
      a. Belden.
      b. CommScope.
      c. General Cable.
      d. Hubbell Premise Wiring.
      e. HCM (Hitachi Cable Manchester, NH)
      f. Or Approved Equal.

C. Category 6 Cross-Connect Wire (Voice):
   1. Jacketed or webbed cross-connect wire which binds conductors of a twisted-pair together to maintain consistent conductor spacing and pair twists that will not loosen during cross-connect installation.
   2. Solid conductor, 24 AWG UTP(unshielded twisted pair), NFPA 70 CM rated, number of pairs (1, 2, 3 or 4) as required.
   3. Shall conform to ANSI/TIA/EIA-568-B Category 6 requirements and shall be 1000BASE-T compliant.

4. Acceptable Manufacturers:
   a. General Cable.
   b. The Siemon Company.
   c. HCM (Hitachi Cable Manchester, NH)
   d. Or Approved Equal.

2.03 **CONNECTORS**

A. UTP Copper Cable (Voice, Data):

Connectors shall comply with FCC Part 68.5, and ANSI/EIA/TIA-568-B. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 4-pair, constructed of high impact rated thermoplastic housing and shall comply with Category 6 requirements and be 1000BASE-T compliant. Connectors shall be terminated using a 110-style PC board connector, color-coded for both T568A and T568B wiring. Each jack shall be wired T568B. UTP connectors shall comply with EIA-455-21A for 500 mating cycles.

2.04 STATION PROTECTORS:

A. See Drawings

2.05 CROSS PATCH BLOCKS

A. See Drawings

PART 3 EXECUTION

3.01 INSTALLATION

A. All telephone wires and cables shall be installed in raceways or cable trays as specified in Section 26 05 28.33.

B. Provide pull rope in all empty conduit runs with not less than 12 inches (30 cm) of slack both ends.

C. Conduits shall be restricted to no more than two 90-degree bends or equivalent without a pull box.

D. Maintain minimum bending radius of changes in direction as follows:
   1. 10 times diameter of 4” (100 mm) and larger conduits.
   2. 6 times diameter of smaller conduits.

E. Except as noted hereinafter for telecommunications cabling and pathways with copper media, keep conduit and cable tray minimum 6 inches (150 mm) away from parallel runs of electrical power equipment, flues, steam, and hot water pipes.

F. Telecommunications cabling and pathways with copper media shall be installed in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment.
   1. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling.

2. Pathways shall be installed in accordance with the following minimum clearance distances of 4 feet (1.2 meters) from motors, generators, frequency converters, transformers, x-ray equipment or uninterruptible power system, 12 inches (300 mm) from power conduits and cable systems, 5 inches (125 mm) from fluorescent or high frequency lighting system fixtures.

G. Telecommunications Grounding: Provide per ANSI/TIA/EIA-607. Run grounding conductors in conduits, raceways cable trays, etc. in accordance with ANSI/TIA/EIA standards, NFPA 70 and Section 16060. Grounding conductors shall be compatible with raceways. Protect all grounding and bonding conductors from physical damage.

H. Provide identification and labeling of communications cables, outlets and equipment per ANSI/TIA/EIA-606.

3.02 CLEANING

A. After wiring, vacuum out interior and wipe clean of all foreign material.

3.03 FIELD QUALITY CONTROL

A. Perform telecommunications cabling inspection, verification, and performance tests in accordance with ANSI/TIA/EIA-568-B.

B. Inspection: Visually inspect cabling jacket materials for UL or third party certification markings. Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for tip and ring pin assignments, and inspect cabling connections to confirm compliance with ANSI/TIA/EIA-568-B. Visually confirm Category 5e marking of outlets, cover plates, and connectors.

END OF SECTION

SECTION 33 82 23

OPTICAL FIBER COMMUNICATIONS DISTRIBUTION CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Fiber Optic Cable
2. Fiber Optic Patch Cords
3. Fiber Optic Connectors
4. Fiber Optic Patch Panels
5. Fiber Optic Splices
6. Innerduct

B. Related Section:
1. Section 02582 - Underground Ducts and ManholesSection 26 05 00 - Common Work Results for Electrical
2. Section 26 05 26 - Grounding and Bonding for Electrical Systems
3. Section 26 05 53 - Identification for Electrical Systems
4. Section 26 05 28.33 - Conduits and Backboxes for Electrical Systems
5. Section 26 05 33.23 - Boxes for Electrical Systems
6. Section 27 00 00 – Appendix B Approved Materials
7. Section 27 00 00 Appendix C WMATA Infrastructure Design and Wiring Standards

1.02 REFERENCES

A. Refer to latest version of all listed references.

B. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronics Industry Alliance (EIA):

1.	EIA-455-21A	FOTP-21 Mating Durability of Fiber Optic Interconnecting Devices
2.	ANSI/TIA/EIA-526-7	OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
3.	ANSI/TIA/EIA-526-14A	OFSTP-14A Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
4.	ANSI/TIA/EIA-568-C.0	Generic Telecommunications Cabling for Customer Premises
5.	ANSI/TIA/EIA-568-C.1	Commercial Building Telecommunications Cabling Standard – Part 1: General Requirements
6.	ANSI/TIA/EIA-568-C.3	Optical Fiber Cabling Components Standard.

7. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces
8. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
9. ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications

C. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 383 Vertical Wire Flame Test

D. Insulated Cable Engineers Association (ICEA):
   1. ICEA S-104-696 Standard for Indoor-Outdoor Optical Fiber Cable

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

F. Underwriters Laboratories (UL):
   1. UL 13 Power Limited Circuit Cables
   2. UL 444 Communications Cables
   3. UL 467 Grounding and Bonding Equipment
   4. UL 1277 Electrical Power and Control Tray Cables with Optional Optical Fiber Members
   5. UL 1666 Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts
   6. UL 1685 Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cable
   7. UL 1863 UL Standard for Safety for Communications-Circuit Accessories

1.03 GENERAL REQUIREMENTS

A. Provide a completely cabled and terminated fiber optic cable system.

B. Installation shall comply with NFPA 70 Article 770.

C. Provide communications system cabling, raceways, pathways, and spaces in conformance with ANSI/TIA/EIA-568-C.1, -568-C.3, -569-A and -607.

D. Provide all multi-mode and single-mode fiber optic cables as industry rated components and of the best-performing design for the intended application as judged by the Engineer.

E. Provide grounding and bonding systems in conformance with ANSI/TIA/EIA-607, NFPA 70 and UL 467.

F. It is the intent of this Section to provide a complete fiber optic cabling system which is Ethernet compliant across all network segments.
   1. For the purposes of this Section, the term "network segment" shall be defined as the sum total of all cables and related passive hardware (patch panels, etc.) between two communicating transceivers.

1.04 QUALITY ASSURANCE

A. 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 unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.
   1. Provide products that are listed and labeled or approved as stated above for the location they are to be installed in.
   2. Provide products listed and labeled or approved as indicated and specified for the applications the items are intended for.

B. Provide products that have been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Provide test results upon request of the Engineer.

C. Manufacturer Qualifications: Firm specializing in manufacturing products for work of this Section with minimum five years documented experience in production of similar products and equipment.

D. Installer Qualifications: Firm specializing in installing work of this Section with minimum three years documented experience constructing systems of similar size and type.

E. Install work under supervision of skilled and experienced installers.
   1. Submit current qualifications of all installation employees who will work on the job.
   2. Submit current qualifications of all supervisory personnel who will work on the job. Qualifications will consist of:
      a. Summary history of employee showing projects recently completed.
      b. Copy of current employee certifications.

1.05 SUBMITTALS

A. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. If no quality assurance verification is available for a product, provide from product manufacturer a written statement indicating why an item does not have a quality assurance verification. Acceptance of such manufacturer's statements are subject to the approval of the Engineer.

B. Third Party Performance Testing: Provide with all product data, evidence of third party performance testing by a Nationally Recognized Independent Testing Laboratory.

C. Product Data and Catalog Cuts: Submit manufacturer's data for all products provided. Indicate clearly by markup the usage of each product. Submit product data and catalog cuts for all material and equipment covered by this Section all together as either a single submittal package or as multiple submittal packages but all at the same time.

D. Installer Qualifications:
   1. Prior to installation, submit data of installer's experience and qualifications.
   2. Installers shall be a Building Industry Consulting Service International (BICSI) Registered Cabling Installation Technician or have experience that shall include 3 years on projects of similar complexity as this project.
   3. Submit copies of all current employee certifications installing or managing installation.
   4. Include names and locations of two projects successfully completed using optical fiber cabling systems. Include written certification from users that systems have performed satisfactorily for not less than 18 months. Include specific experience in installing and testing structured telecommunications distribution systems using optical fiber.

E. Test Plan: Provide a complete and detailed written test plan for the optical fiber cabling system including a complete list of test equipment.
   1. Include procedures for certification, validation, and testing.
   2. Include current test instrumentation calibration certificates.
   3. Include copy of all current certifications for testing personnel and supervisors.
   4. Include blank test documentation form.

F. Test Reports:
   1. Furnish factory reel tests for optical fiber cables.
   2. Furnish all field test reports.

PART 2 PRODUCTS

2.01 GENERAL:

A. Consistency of Fiber Optic Cable Application: It is the Owner’s intent for the manufacturer of fiber optic cable to be consistent across the project; multiple fiber optic cable manufacturers will not be permitted for different applications.

B. Except where indicated otherwise, provide multi-fiber cables with optical fiber counts as follows:
   1. Cross Patch Cables: Provide single or duplex fiber cables as required.
   2. Less than 50 feet: minimum 6 fibers
   3. Greater than 50 feet: minimum 12 fibers

2.02 OPTICAL FIBERS

A. Provide all fibers for use on this job as part of a manufacturer’s standard cable assembly. Do not provide bare fibers unless specifically shown on the drawings.

B. All fibers in the cable must be usable and meet required specifications.

C. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

D. Each optical fiber shall consist of a Germania-doped silica core surrounded by a concentric glass cladding.

E. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi.

F. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

G. The attenuation specification shall not exceed the manufacturer's rated maximum value for the cable product at the design passband center frequency. Test each strand on each cable at 23°C ± 5°C on the original shipping reel and label reel with test results.

H. Multimode 62.5/125 OM1 Fibers
   1. Standards: EIA/TIA-492AAAA-A-1997, IEC 60793-2-10 (Type A1b 62,5/125 µm graded index fibre)
   2. ISO/IEC 11801 Nomenclature: OM1
   3. Characteristics:

Core Diameter (µm)	62.5 ± 2.5	
Core Non-Circularity	5.0% max	
Cladding Diameter (µm)	125.0 ± 2.0	
Cladding Non-Circularity	1.0% max	
Core-to-Cladding Concentricity (µm)	1.5 max	
Coating Diameter (µm)	242 ± 5	
Wavelength (nm)	850	1300
Maximum Attenuation (dB/km)	3.4	1.0
Minimum Over Filled Launch Bandwidth (MHz*km)	200	500
Minimum Effective Modal Bandwidth (MHz*km)	220	---
Serial 1 Gigabit Ethernet Distance (m)	300	500
Serial 10 Gigabit Ethernet Distance (m)	33	---

I. Multimode 50/125 OM2 Fibers
   1. Standards: EIA/TIA-492AAAB, IEC 60793-2-10 (Type A1a.1 50/125 µm graded index fibre)
   2. ISO/IEC 11801 Nomenclature: OM2
   3. Characteristics:

Core Diameter (µm)	50.0 ± 2.5	
Core Non-Circularity	5.0% max	
Cladding Diameter (µm)	125.0 ± 2.0	
Cladding Non-Circularity	1.0% max	
Core-to-Cladding Concentricity (µm)	1.5 max	
Coating Diameter (µm)	242 ± 5	
Wavelength (nm)	850	1300
Maximum Attenuation (dB/km)	3.0	1.0
Minimum Over Filled Launch Bandwidth (MHz*km)	700	500
Minimum Effective Modal Bandwidth (MHz*km)	950	---
Serial 1 Gigabit Ethernet Distance (m)	750	600

Serial 10 Gigabit Ethernet Distance (m)	150	---

J. Multimode 50/125 OM3 Fibers
   1. Standards: EIA/TIA-492AAAC, IEC 60793-2-10 (Type A1a.2 850 nm laser-optimized 50/125 µm graded index fibre)
   2. ISO/IEC 11801 Nomenclature: OM3
   3. Characteristics:

Core Diameter (µm)	50.0 ± 2.5	
Core Non-Circularity	5.0% max	
Cladding Diameter (µm)	125.0 ± 2.0	
Cladding Non-Circularity	1.0% max	
Core-to-Cladding Concentricity (µm)	1.5 max	
Coating Diameter (µm)	242 ± 5	
Wavelength (nm)	850	1300
Maximum Attenuation (dB/km)	3.0	1.0
Minimum Over Filled Launch Bandwidth (MHz*km)	1500	500
Minimum Effective Modal Bandwidth (MHz*km)	2000	---
Serial 1 Gigabit Ethernet Distance (m)	1000	600
Serial 10 Gigabit Ethernet Distance (m)	300	---

K. Multimode 50/125 OM4 Fibers
   1. Standards: EIA/TIA-492AAAD
   2. ISO/IEC 11801 Nomenclature: OM4
   3. Characteristics:

Core Diameter (µm)	50.0 ± 2.5	
Core Non-Circularity	5.0% max	
Cladding Diameter (µm)	125.0 ± 2.0	
Cladding Non-Circularity	1.0% max	
Core-to-Cladding Concentricity (µm)	1.5 max	
Coating Diameter (µm)	242 ± 5	
Wavelength (nm)	850	1300
Maximum Attenuation (dB/km)	3.0	1.0
Minimum Over Filled Launch Bandwidth (MHz*km)	3500	500
Minimum Effective Modal Bandwidth (MHz*km)	4700	---
Serial 1 Gigabit Ethernet Distance (m)	1100	600
Serial 10 Gigabit Ethernet Distance (m)	5500 (1)	---

(1) Assumes maximum 1.0dB maximum total connector/splice loss.

L. Single-mode (Dispersion Un-shifted) OS2 Fibers
   1. Standards: ITU G.652 (Tables A,B, C & D), IEC Specification 60793-2-50 Type B1.3, TIA/EIA 492-CAAB, Telcordia Generic Requirements GR-20-CORE.
   2. ISO/IEC 11801 Nomenclature: OS2
   3. Characteristics:

Mode Field Diameter @ 1310nm (µm)	9.2 ± 0.4

Mode Field Diameter @ 1550nm (µm)	10.4 ± 0.5	
Cladding Diameter (µm)	125.0 ± 0.7	
Cladding Non-Circularity	0.7% max	
Core-to-Cladding Concentricity (µm)	0.5 max	
Coating Diameter (µm)	242 ± 5	
Wavelength (nm)	1310	1550
Maximum Attenuation (dB/km)	0.4	0.3
Serial 1 Gigabit Ethernet Distance (m)	5000	---
Serial 10 Gigabit Ethernet Distance (m)	10000	40000

2.03 INDOOR/OUTDOOR INDUSTRIAL GRADE GENERAL PURPOSE CABLE (TYPE OFN-LS)

A. Provide gel-free loose tube optical fiber cable, suitable for use in harsh industrial environments.

B. Fibers
   1. Number and type of fibers: as indicated on the Drawings
   2. Fibers shall comply with the requirements given elsewhere in this specification.

C. Provide cables with the following Basic characteristics:
   1. Low-Smoke/Zero-Halogen jacket
   2. Suitable for outdoor installation (aerial and duct)
   3. Suitable for indoor general purpose installation in accordance with NFPA 70 Article 770 requirements for Type OFN Optical Fiber Cable.
   4. Approvals and Listings:
      a. NFPA 70 Type OFN-LS
      b. Sunlight Resistant
      c. Suitable for Direct Burial
      d. IEEE 383 Flame Test
      e. Tray Rated
   5. Maximum Tensile Load
      a. Short Term (less than 1 hour): 600 pounds force
      b. Long Term (greater than 1 hour to 30 years): 180 pounds force
   6. Temperature:
      a. Installation: -22°F to +140°F
      b. Operation: -58°F to +167°F
   7. Design and Test Criteria: ICEA S-104-696, UL 13, UL 444, and UL 1277

D. Cable Construction
   1. Optical fibers shall be placed inside a loose buffer tube. The buffer tubes shall
   2. be made of polypropylene. The nominal outer diameter of the buffer tube shall
   3. be 2.5 mm. Each buffer tube shall contain up to 12 fibers. The fibers shall not adhere to the inside of the buffer tube.
   4. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding."
      a. The fibers shall be colored with ultraviolet (UV) curable inks. The UV curable ink shall be applied to the outside of the optical fiber protective coating layer and not be an integral component of the coating layer itself in order to produce more distinguishable colored fiber.

b. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.
c. For dual layer buffer tube construction cables, standard colors shall be used for tubes 1 through 12 and stripes shall be used to denote tubes 13 through 24. The color sequence shall apply to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.
d. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Coloring material shall not cause fibers to stick together.

5. The buffer tubes shall be resistant to kinking.
6. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
   a. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes.
   b. In dual layer cables, any fillers shall be placed in the inner layer.
   c. Fillers shall be nominally 2.5 mm in outer diameter.
7. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to prevent buckling of the cable. The GRP rod shall be overcoated with a thermoplastic, when required, to achieve dimensional sizing to accommodate buffer tubes/fillers.
8. Provide all water blocking yarns or tapes as swellable materials for the intended use of preventing liquid water migration through cables.
9. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z," stranding process. Water blocking yarn(s) shall be applied longitudinally along the central member during stranding.
10. Two polyester yarn binders shall be applied contrahelically and with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.
11. For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The tape shall be held in place by a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus and electrically non-conductive. It shall also be free from dirt and foreign matter.
12. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two-layer core. A water blocking tape shall be applied longitudinally over both the inner and outer layer with each being held in place with a single polyester binder yarn. The water blocking tape shall be nonnutritive to fungus and electrically non-conductive. It shall also be free from dirt and foreign matter.
13. The cable shall contain at least one ripcord under the sheath for easy sheath removal.
14. Flame-retardant tape may be applied to provide resistance to flame propagation.

15. A water blocking tape shall be applied longitudinally around the outside of the flame retardant tape.
16. The tensile strength shall be provided by the central member, and additional dielectric yarns as required. The dielectric yarns shall be helically stranded evenly around the cable core.
17. Cables shall be sheathed with a flame retardant low-smoke zero halogen jacket. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The flame retardant low-smoke zero halogen outer jacket shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
18. Cable jackets shall be marked with the manufacturer's name or file number, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code, fiber count, and fiber type, flame rating and listing marking. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

E. Cable Physical Performance
    1. Tensile Loading and Fiber Strain
        a. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," and FOTP-38, “Measurement of Fiber Strain in Cables Under Tensile Load,” a length of cable shall be tested to the rated tensile load. The rated tensile load shall be 2670 N (600 lbf).
        b. While under the rated tensile load, the fiber shall not experience a measured fiber strain greater than 60% of the fiber proof test level.
        c. After being held at the residual load (30% of the rated tensile load) the fiber shall not experience a measured fiber strain greater than 20% of the fiber proof test level nor an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
        d. After the tensile load is removed, the fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
    2. Compressive Loading Test
        a. When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in).
        b. Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5

mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes.

c. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.40 dB at 1550 nm for single-mode fibers and 0.60 dB at 1300 nm for multimode fiber.

3. Cyclic Flexing
   a. When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The flexing arc shall be + 90 degrees from the reference position.
   b. The fiber shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
   c. No cracks, splits, tears or other opening shall be present on the inner or outer surface of the jacket.
4. Twist Test
   a. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters will withstand 10 cycles of mechanical twisting.
   b. The fiber shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
5. High and Low Temperature Bend
   a. When tested in accordance with FOTP-37, "Fiber Optic Cable Bend Test, Low and High Temperature," the cable shall withstand four full turns around a mandrel at test temperatures of -10°C and +60°C. The mandrel diameter shall be the larger of 20X cable diameter or 150 mm.
   b. The presence of visible cracks, splits, tears, or other openings on either the inner or outer surface of the jacket constitutes failure. None of the sheath components shall show visible cracking when removed successively and examined.
   c. For single-mode fibers, the increase in attenuation shall be ≤ 0.40 dB at 1550 nm. For multimode fibers, the increase in attenuation shall be ≤ 0.60 dB at 1300 nm.
6. Impact Resistance
   a. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand a minimum of 2 impact cycles at 3 locations spaced 150 mm. The impact energy shall be at least 4.4 N*m.
   b. The fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
   c. The presence of visible cracks, splits, tears, or other openings on the outer surface of the jacket constitute a failure. The presence of broken fibers within the specimen constitutes a failure.
7. Temperature Cycling
   a. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation after 2 cycles at extreme operational temperatures (-40 °C to +70 °C) shall not exceed 0.40 dB/km at 1550 nm (single-mode) or 0.60 dB/km at 1300 nm (multimode). The change in attenuation is measured with respect to the baseline values

measured at room temperature before temperature cycling and after the last low and last high temperature.

8. Water Penetration
   a. When tested in accordance with FOTP-82, “Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable”, a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.
9. Cold Impact Test
   a. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand a minimum of 2 impact cycles at 3 locations separated by 150 mm. The impact energy shall be at least 2.94 N*m. The cable shall be conditioned for at least 4 hours at the minimum installation temperature (-10 °C).
   b. The presence of visible cracks on either the inner or outer surface of the jacket constitutes a failure.
   c. No optical measurements are required.

F. Manufacturer
   1. BerkTek

2.04 INDOOR/OUTDOOR PLENUM RATED CABLE (TYPE OFNP)

A. Gel-Free loose tube optical fiber cable suitable for indoor (general purpose, riser, and plenum) and outdoor use.

B. Fibers
   1. Number and type of fibers: as indicated on the Drawings.
   2. Fibers shall comply with the requirements given elsewhere herein.

C. Basic Specifications:
   1. Plenum Rated
   2. Suitable for outdoor installation (aerial and duct)
   3. Suitable for indoor general purpose, riser, and plenum installation in accordance with NFPA 70 Article 770 requirements for Type OFNP Optical Fiber Cable.
   4. Approvals and Listings:
      a. NFPA 70 Type OFNP
      b. UV Resistant
   5. Maximum Tensile Load
      a. Short Term: 300 pounds force
      b. Long Term: 90 pounds force
   6. Temperature:
      a. Installation: +32°F to +140°F
      b. Operation: -40°F to +158°F
   7. Design and Test Criteria: ICEA S-104-696, NFPA 262

D. Cable Construction
   1. Optical fibers shall be placed inside a loose buffer tube. The buffer tubes shall
   2. be made of polypropylene. The nominal outer diameter of the buffer tube shall
   3. be 2.5 mm. Each buffer tube shall contain up to 12 fibers. The fibers shall not adhere to the inside of the buffer tube.

4. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding."
    a. The fibers shall be colored with ultraviolet (UV) curable inks. The UV curable ink shall be applied to the outside of the optical fiber protective coating layer and not be an integral component of the coating layer itself in order to produce more distinguishable colored fiber.
    b. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.
    c. For dual layer buffer tube construction cables, standard colors shall be used for tubes 1 through 12 and stripes shall be used to denote tubes 13 through 24. The color sequence shall apply to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.
    d. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.
5. The buffer tubes shall be resistant to kinking.
6. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm in outer diameter.
7. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to prevent buckling of the cable. The GRP rod shall be overcoated with a thermoplastic, when required, to achieve dimensional sizing to accommodate buffer tubes/fillers.
8. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z," stranding process. Water blocking yarn(s) shall be applied longitudinally along the central member during stranding.
9. Two polyester yarn binders shall be applied contrahelically and with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.
10. For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The tape shall be held in place by a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus and electrically non-conductive. It shall also be free from dirt and foreign matter.
11. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two-layer core. A water blocking tape shall be applied longitudinally over both the inner and outer layer with each being held in place with a single polyester binder yarn. The water blocking tape shall be nonnutritive to fungus and electrically non-conductive. It shall also be free from dirt and foreign matter.
12. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

13. Flame-retardant tape may be applied to provide resistance to flame propagation.
14. A water blocking tape shall be applied longitudinally around the outside of the flame retardant tape.
15. The tensile strength shall be provided by the central member, and additional dielectric yarns as required. The dielectric yarns shall be helically stranded evenly around the cable core.
16. Cables shall be sheathed with a flame retardant jacket. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The jacket shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
17. Cable jackets shall be marked with the manufacturer's name or file number, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code, fiber count, and fiber type, flame rating and listing marking. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

E. Cable Physical Performance
    1. Tensile Loading and Fiber Strain
        a. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," and FOTP-38, “Measurement of Fiber Strain in Cables Under Tensile Load,” a length of cable shall be tested to the rated tensile load. The rated tensile load shall be 1335 N (300 lbf).
        b. While under the rated tensile load, the fiber shall not experience a measured fiber strain greater than 60% of the fiber proof test level.
        c. After being held at the residual load (30% of the rated tensile load) the fiber shall not experience a measured fiber strain greater than 20% of the fiber proof test level nor an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
        d. After the tensile load is removed, the fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
    2. Compressive Loading Test
        a. When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," the cable shall withstand a minimum compressive load of 220 N/cm (125 lbf/in) applied uniformly over the length of the sample. The 220 N/cm (125 lbf/in) load shall be applied at a rate of 2.5 mm (0.1 in) per minute. The load shall be maintained for a period of 1 minute. The load shall then be decreased to 110 N/cm (63 lbf/in).
        b. Alternatively, it is acceptable to remove the 220 N/cm (125 lbf/in) load entirely and apply the 110 N/cm (63 lbf/in) load within five minutes at a rate of 2.5

mm (0.1 in) per minute. The 110 N/cm (63 lbf/in) load shall be maintained for a period of 10 minutes.

c. Attenuation measurements shall be performed before release of the 110 N/cm (63 lbf/in) load. The change in attenuation shall not exceed 0.40 dB at 1550 nm for single-mode fibers and 0.60 dB at 1300 nm for multimode fiber.

3. Cyclic Flexing
   a. When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The flexing arc shall be + 90 degrees from the reference position.
   b. The fiber shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
   c. No cracks, splits, tears or other opening shall be present on the inner or outer surface of the jacket.
4. Twist Test
   a. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters will withstand 10 cycles of mechanical twisting.
   b. The fiber shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
5. High and Low Temperature Bend
   a. When tested in accordance with FOTP-37, "Fiber Optic Cable Bend Test, Low and High Temperature," the cable shall withstand four full turns around a mandrel at test temperatures of 0°C and +60°C. The mandrel diameter shall be the larger of 20X cable diameter or 150 mm.
   b. The presence of visible cracks, splits, tears, or other openings on either the inner or outer surface of the jacket constitutes failure. None of the sheath components shall show visible cracking when removed successively and examined.
   c. For single-mode fibers, the increase in attenuation shall be ≤ 0.40 dB at 1550 nm. For multimode fibers, the increase in attenuation shall be ≤ 0.60 dB at 1300 nm.
6. Impact Resistance
   a. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand a minimum of 2 impact cycles at 3 locations spaced 150 mm. The impact energy shall be at least 4.4 N*m.
   b. The fibers shall not experience an attenuation change greater than 0.40 dB at 1550 nm (single-mode) or greater than 0.60 dB at 1300 nm (multimode).
   c. The presence of visible cracks, splits, tears, or other openings on the outer surface of the jacket constitute a failure. The presence of broken fibers within the specimen constitutes a failure.
7. Temperature Cycling
   a. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation after 2 cycles at extreme operational temperatures (-40 °C to +70 °C) shall not exceed 0.40 dB/km at 1550 nm (single-mode) or 0.60 dB/km at 1300 nm (multimode). The change in attenuation is measured with respect to the baseline values

measured at room temperature before temperature cycling and after the last low and last high temperature.

8. Water Penetration
   a. When tested in accordance with FOTP-82, “Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable”, a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.
9. Cold Impact Test
   a. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand a minimum of 2 impact cycles at 3 locations separated by 150 mm. The impact energy shall be at least 2.94 N*m. The cable shall be conditioned for at least 4 hours at the minimum installation temperature (-10 °C).
   b. The presence of visible cracks on either the inner or outer surface of the jacket constitutes a failure.
   c. No optical measurements are required.

F. Manufacturer
   1. BerkTek

2.05 FIBER OPTIC PATCH CORDS

A. Plenum rated, two-fiber cable. Fiber type as indicated on the Drawings, and/or as required for the application.

B. Tight buffered fiber, surrounded by an all-dielectric strength member and continuous outer jacket. Suitable for operation from +32°F to +158°F.

C. With factory installed connectors on both ends. Connector type(s) as required for the application. Connectors shall comply with the requirements for connectors given elsewhere in this specification.

D. Length as indicated on the Drawings, or as required for the application.

E. Manufacturer
   1. BerkTek

2.06 FIBER OPTIC CONNECTORS

A. Provide only Type ST, and Type SC connectors, unless otherwise indicated or required for proper interface with equipment.

B. Connectors shall be heat-cured epoxy, polished end type. Connectors shall be simplex, unless indicated otherwise or otherwise required for proper interface with equipment.

C. Connector shall provide a strain relief mechanism for installation on a single fiber cable that contains strength elements. The fiber within the body of the connector shall be isolated mechanically from cable tension, bending and twisting. Provide fan-out kits for each cable to protect the un-jacketed fiber strands.

D. Connectors shall comply with EIA/TIA-455-A, as well as TIA/EIA-604-2 (FOCIS-2 for Type ST connectors), TIA/EIA-604-3 (FOCIS-3 for Type SC connectors), and TIA/EIA-604-10A (FOCIS-10 for Type LC connectors).

E. Connectors for multimode fibers shall be rated for OM1, OM2, OM3, or OM4 to match the fibers they are being applied with.

F. When installed in strict accordance with the manufacturer's recommendations, the connectors shall be capable of achieving the following performance.

Performance Requirements for Simplex Multimode Type ST, LC, and SC Connectors			
Test	**EIA/TIA-455-A Test Method (FOTP #)**	**Test Conditions**	**Performance Requirement**
Insertion Loss (IL)	171	Concatenation method	Average: 0.1 dB Max IL : 0.5 dB
Return Loss (RL)	107	Coupler with power source and meter	Minimum RL: ≤-20 dB Minimum RL: ≤-26 dB LOMMF
Low Temp Soak	188	4 days @ 0°C	Max IL : 0.75 dB Min RL: 20 dB
Temperature Life	4	4 days @ 60°C	Max IL : 0.75 dB Min RL: 20 dB
Humidity	5	4 days @ 40°C RH 90-95%	Max IL : 0.75 dB Min RL: 20 dB
Impact	2	8 impacts from 1.8 meters (height)	Max IL : 0.75 dB Min RL: 20 dB
Strength of Coupling Mechanism	185	33 N at 0° for 5 seconds	Max IL : 0.75 dB Min RL: 20 dB
Durability	21	500 rematings, clean every 25	Max IL : 0.75 dB Min RL: 20 dB
Cable Retention 0°	6	0.5 lb. on 900µm buffered fiber for 5 seconds	Delta IL: ≤ 0.5 dB Max IL: 0.75 dB Min RL: 20 dB
Cable Retention 90°	6	0.5 lb. on 900µm buffered fiber for 5 seconds	Delta IL: ≤ 0.5 dB Max IL: 0.75 dB Min RL: 20 dB
Flex	1	±90° for 100 cycles @ 0.5 lb. load on 900µm buffered fiber	Max IL : 0.75 dB Min RL: 20 dB
Twist	36	10 cycles 5 turns, 0.5 lb. load on 900µm buffered fiber	Max IL : 0.75 dB Min RL: 20 dB

Performance Requirements for Simplex Single-Mode Type ST, LC, and SC Connectors			
Test	**EIA/TIA-455-A Test Method (FOTP #)**	**Test Conditions**	**Performance Requirement**
Insertion Loss (IL)	171	Concatenation method	Average: 0.2 dB Max IL : 0.5 dB
Return Loss (RL)	107	Coupler with power source and meter	Minimum RL: ≤-40 dB SPC -55 dB UPC
Low Temp Soak	188	4 days @ 0°C	Max IL : 0.75 dB Min RL: 26 dB
Temperature Life	4	4 days @ 60°C	Max IL : 0.75 dB Min RL: 26 dB
Humidity	5	4 days @ 40°C RH 90-95%	Max IL : 0.75 dB Min RL: 20 dB
Impact	2	8 impacts from 1.8 meters (height)	Max IL : 0.75 dB Min RL: 26 dB
Strength of Coupling Mechanism	185	33 N at 0° for 5 seconds	Max IL : 0.75 dB Min RL: 26 dB
Durability	21	500 rematings, clean every 25	Max IL : 0.75 dB Min RL: 26 dB
Cable Retention 0°	6	0.5 lb. on 900µm buffered fiber for 5 seconds	Delta IL: ≤ 0.5 dB Max IL: 0.75 dB Min RL: 26 dB
Cable Retention 90°	6	0.5 lb. on 900µm buffered fiber for 5 seconds	Delta IL: ≤ 0.5 dB Max IL: 0.75 dB Min RL: 26 dB
Flex	1	±90° for 100 cycles @ 0.5 lb. load on 900µm buffered fiber	Max IL : 0.75 dB Min RL: 26 dB
Twist	36	10 cycles 5 turns, 0.5 lb. load on 900µm buffered fiber	Max IL : 0.75 dB Min RL: 26 dB

G. Manufacturer
   1. Corning Cable Systems Heat-Cure Single-Fiber Connectors

2.07 FIBER OPTIC CABLE SPLICES

A. Only fusion splices are permitted; mechanical splices shall not be used.

B. Splice equipment shall be either by the cable manufacturer, or approved by the cable manufacturer for the fibers in question.

C. Splice equipment shall be capable of producing typical splice loss of not greater than 0.10 dB.

2.08 WALL MOUNTED SPLICE ENCLOSURE

A. Provide wall mounted, fiber optic cable splice housing.

B. Provide metallic enclosure.

C. Provide enclosure with provisions for strain relief of incoming cables, as well as slack fiber management.

D. Provide quantity of splice trays as required, plus 100% spare.

E. Manufacturer
   1. Ortronics

2.09 SPLICE CLOSURE (AERIAL OR DIRECT BURIED)

A. Provide splice closure suitable for use in aerial and direct buried applications.

B. Provide closure with non-metallic outer housing with O-ring sealing system.

C. Provide closure with cable ports suitable to accept heat shrink tubing for sealing of incoming cables. Provide number and size of ports as required.

D. Provide closure with provisions for strain relief of incoming cables, as well as slack fiber management.

E. Provide quantity of splice trays as required, plus 100% spare.

F. Manufacturer
   1. 3M (FDC-HS) Fiber Dome Closure Heat Shrink (Basis of Design)
   2. Corning Cable Systems
   3. Superior Essex

2.10 INNERDUCT

A. Provide continuous innerduct runs from each conduit access point.

B. Plastic Innerduct (Indoor/Outdoor Applications)
   1. UL Listed, Plenum Rated, flexible, non-metallic, corrugated, optical fiber/communication raceway.
   2. Orange in color.
   3. Outside marked with size and sequential length in feet.
   4. Compatible fittings as required.
   5. Provide innerducts in all conduits used for fiber optic cables. Unless noted otherwise, provide innerducts as follows:

a. 2" conduit: two 3/4" innerducts
b. 3" conduit: three 1" innerducts
c. 4" conduit: three 1-1/4" innerducts

6. Provide 900 lb rated pull tape/string in all spare innerducts.
7. Provide gastight and watertight seal at outdoor points of cable entry to innerduct to preclude water vapor or liquid from entering interstitial space.
8. Manufacturer:
   a. Carlon
   b. Endot (Outside Plant Innerduct)
   c.

PART 3 EXECUTION

3.01 PREPARATION

A. Ensure that painted surfaces that will be covered by items of this Section have a primer and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

3.02 INSTALLATION

A. Installation of fiber optic cables and all related accessories and hardware shall strictly conform to the recommended installation procedures of their respective manufacturers.

B. Unless specifically indicated otherwise, each fiber optic cable run shall be installed as one continuous length between the indicated termination points, with no intermediate splices.

C. Provide sufficient strain relief (slack) in all cables, cable conductors, and wiring to avoid stress on all cables, wires, and wiring connections.

D. Conduits, Ducts, and Innerducts
   1. Outside fiber optic cable shall be installed in ducts conforming to Section 02582.

   2. Inside fiber optic cable shall be installed in conduit conforming to Section 16131.
   3. Unless indicated otherwise, minimum conduit size for fiber optic cable shall be 2" for above-ground (indoor and outdoor) applications and 4" for underground applications.
   4. Innerducts shall be provided in all conduits used for fiber optic cables. Provide pull string or tape in all spare innerducts.
   5. Provide pull rope in all empty conduit runs with not less than 36 inches of slack at both ends. Tie rope off to prevent loss into conduit.
   6. Conduits shall be restricted to no more than two 90-degree bends or equivalent without a pull box.
   7. Maintain minimum bending radius of changes in direction as follows:
      a. 10 times diameter of 4” (100 mm) and larger conduits.
      b. 6 times diameter of smaller conduits.
   8. Avoid bends in conduits from pull boxes.

9. At all transition points where a cable runs from inside a conduit into a cable trough, or onto a cable tray or plywood backboard, the end of the conduit shall be fitted with a plastic bushing to prevent abrasive damage to the cable.

E. Cable Tray
   1. Use of cable tray shall be restricted to only where identified on the Drawings.
   2. Provide cable tray conforming to Section 16134.
   3. Cable installed in trays or troughs shall be laid therein and not pulled in place. Cables installed in trays and troughs shall have a minimum amount of crossover and shall not be pulled tightly around bends.

F. Cable Dress Loops
   1. Provide cable dress loops at each location as listed below.
      a. Manholes: 25 feet
      b. Handholes: 15 feet
      c. Equipment Racks: 10 feet.
      d. Wall Mounted Patch Panels & Splice Enclosures: Per the manufacturers installation instructions.
   2. Refer to the Drawings for additional designed excess (spare) cable lengths.

G. Spare Fibers
   1. All spare fibers shall be terminated, neatly coiled and tied with cable ties for future use.
   2. Label all spare fibers as such.

H. Cable Pulling Tension
   1. Calculate expected pulling tension based on the manufacturer's recommendations. If calculated tension exceeds 90% of the cable manufacturer's stated maximum short-term tension, take necessary steps to reduce the expected tension below 90%. Submit the tension calculations for approval prior to installation of the subject cable.
   2. Monitor actual pulling tension throughout installation. Actual tension shall not exceed 90% of the cable manufacturer's stated maximum short-term tension at any time during pulling.
   3. For pulls where the calculated expected tension exceeds 75% of the cable manufacturer's stated maximum short-term tension, utilize a tension monitoring device with recording capability throughout pulling. Submit the recorded tensions to the Engineer immediately after installation.

I. Ensure that the cable manufacturer's stated minimum bend radius of the cable is not exceeded during installation. Cables shall not be bent to a radius less than ten (10) times the diameter of the cable, or less than the manufacturer's recommended minimum bending radius, during installation or as finally installed.

J. At penetrations through fire rated floors, walls, and similar assemblies, provide firestopping as specified in Section 07840.

K. Installation of aerial fiber optic cables shall be in accordance with the manufactures recommended installation methods and components. Do not use helical strand

wrapping machines to attach cable to messenger wire unless the manufacturer's installation instructions allow such use in writing.

L. Lengths of cables which are not installed in conduits and are run inside equipment rooms shall be run in and secured to cable trays or cable ladders using nylon cable ties and attached to walls and backboards using nylon cable clamps or hangers or using a plastic wiring system such as manufactured by Panduit, or Approved Equal. Cables shall be attached or otherwise supported at intervals not to exceed 18 inches. Mechanically fasten all cable accessories, i.e., do not rely only upon adhesive component fasteners.

M. All conduit and cable entrance openings into equipment rooms and huts shall be sealed with a pliable sealing compound after the cable is in place. Sealing compounds for rooms, huts, walls, or other partitions shall be fire retardant per ASTM E 814. Sealing compound shall be used to seal the area around the cable where the cable emerges from the end of a conduit, pipe, or ductbank. Seal all cables where they enter innerducts. All spare conduits shall be sealed or plugged in an approved manner.
   1. Fire retardant pliable sealing compound shall be an intumescent firestop putty, reusable and repenetrable, conforming to ASTM E 814 and UL 1479, Nelson FSP Firestop Putty, or Approved Equal.
   2. Seal all outdoor spare conduits with gastight mechanical expanding sealing plugs.

N. Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions, such as sharp corners on equipment. Cables damaged due to neglect by the Contractor, during installation, shall be replaced by the Contractor, at no additional cost to the Owner.

O. All cables shall be terminated in standard order, according to the EIA/TIA and ICEA color codes. Individual cables shall be identified at each cable termination with permanent, heat shrink labels. All spare fibers in each cable shall be terminated and identified. Identification of cables and conduits shall comply with Section 16075.

3.03 FIELD QUALITY CONTROL

A. Perform telecommunications cabling inspection, verification, and performance tests in accordance with ANSI/TIA/EIA-568-B.

B. Inspection
   1. Prior to installation: visually inspect cable visible defects, as well as for UL or third party certification markings.
   2. After installation: thoroughly visually inspect all accessible portions of the installation for visible defects.

C. Optical Fiber Testing
   1. Perform all testing specified herein for each fiber, including spares, of each installed cable.
   2. All instruments used to perform the testing specified herein shall be calibrated as specified herein.

a. The testing firm is to have a calibration program, which assures that all applicable test instrumentation is maintained within rated accuracy.
b. The accuracy is to be directly traceable to The National Institute of Standards and Technology.
c. Instruments are to be calibrated in accordance with the following frequency schedule.
    1) Laboratory Instruments: 12 months
    2) Leased specialty equipment: 12 months
d. Make dated calibration labels visible on all test equipment.
e. Keep records up-to-date, which show date and results of instruments calibrated or tested.
f. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.
g. Calibrating standard is to be of higher accuracy than that of the instrument tested.

3. For all tests specified herein, submit results for each fiber tested as follows.
    a. Detailed (numerical) results.
    b. Pass/fail based on the requirements given herein and applicable industry standards (also clearly state the numerical pass/fail criteria).
4. Prior to installing optical fiber cable, perform end-to-end attenuation tests using an OTDR while cable is on the reel at the jobsite.
5. Perform tests in accordance with ANSI/TIA/EIA-568-C.3 and the cable manufacturer's recommendations, as well as ANSI/TIA/EIA-526-14A Method B (multimode) and ANSI/TIA/EIA-526-7 Method B (single-mode). Perform verification acceptance tests and factory reel tests.
6. Perform testing at both operational windows (850 and 1300 nm for multimode fibers, 1310 and 1550 nm for single-mode fibers).
7. Perform end-to-end optical attenuation testing, in both directions.
    a. Calculate expected optical attenuation based on the manufacturers' stated worst-case attenuation values for the installed cable, connectors, and splices.
    b. Actual measured attenuation shall not exceed the calculated expected attenuation by more than 20% or 1.0 dB, whichever is less.
    c. Submit both calculated and actual measured attenuations.
8. Perform Optical Time Domain Reflectometer (OTDR) trace testing, in both directions.
    a. Submit graphical results for each test, with all anomalies (connectors, splices, defects, etc.) identified by type, location (distance), and attenuation.
    b. No single connector shall result in more than 0.75 dB attenuation. No single splice shall result in more 0.3 dB attenuation. No single anomaly, other than connectors and splices, shall result in more than 0.5 dB attenuation.

D. Correction of Deficiencies
1. Report all unacceptable values immediately. Correct all deficiencies found in work of this contract and separately report deficiencies in work of items of other contracts.
2. Retest items requiring correction. Correct or have corrected any remaining deficiencies and retest until work is acceptable.

3.04 PROTECTION

A. Protect all new and existing work.

B. During painting, mask all nameplates, all plastic parts, and all items not to be painted.

C. Protect all items during work of other trades including welding and cutting.

D. Schedule installation of fiber optic components to occur later in the construction activity to avoid periods of excessively wet or dirty construction.

E. If necessary, seal and cover cable, enclosures, boxes, openings, and other components to preclude contamination.

F. Leave protective caps in place on unconnected components. Replace caps after testing or other work.

G. Completely clean all system components of dust, dirt, and debris accumulations.

H. Replace components which cannot be cleaned or restored back to a new condition at not cost to the Owner.

END OF SECTION