VOLUME 2

REHABILITATION OF RED LINE METRO RAIL SYSTEM FROM FRIENDSHIP HEIGHTS CROSSOVER TO GROSVENOR - STRATHMORE STATION

RED LINE REHABILITATION 2.1

RFP Technical Specifications for construction part of the Work

Part 1: Tunnel Rehabilitation & Medical Center Station Ceiling Replacement (T)

Part 2: Medical Center Crossover Waterproofing (MCC)

Part 3: Grosvenor Aerial Structure Retrofit (GAS)

Part 4: Grosvenor-Strathmore Platform Slab and Tile Repair (GSS)

RFP Technical Specifications for design-build part of the Work

Part 5: Grosvenor-Strathmore Platform Canopy and Mezzanine Roof Retrofit Design Build (GDB)

Part 6: (Option) Bethesda South Mezzanine Design Build (GDB)

Washington Metropolitan Area Transit Authority

600 5th Street Northwest
Washington, DC 20001

FINAL SPECIFICATIONS SUBMITTAL

Contract No.: FQ15093/GG

April, 2015

THIS PAGE IS INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 02205

REMOVAL AND RESTORATION OF EXISTING FACILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description:
1. This section specifies removing, restoring and reinstalling miscellaneous facilities on public and private property which are removed during construction at the Grosvenor Station.

B. Related Work Specified Elsewhere:
1. Section 02220 - Demolition.
2. Section 03100 - Concrete Formwork.
3. Section 03200 - Concrete Reinforcement.
4. Section 03300 - Cast-in-Place Structural Concrete.
5. Section 03371 – Maintenance of Concrete

C. Definitions:
1. Miscellaneous facilities include, but are not limited to, the following: alarm and sprinkler systems, signs, heating, cooling and electrical facilities, walls, railings, and station furniture.
2. Salvage: To remove and store material and equipment for reuse in this or other Authority contracts.

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

1.02 SUBMITTALS

A. Submit for approval in accordance with the General Requirements, a detailed list of items to be removed with description of methods of protection and replacement of each item.

1.03 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 MATERIALS

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

PART 3 - EXECUTION

3.01 REMOVALS

A. Remove items to extent necessary to permit accomplishment of the work of this contract, minimizing damage to work which is to remain in place.

B. Store removed items in a manner which will prevent damage to the items or to existing facilities to remain.

3.02 JOINTS BETWEEN EXISTING AND RESTORED WORK

A. Make joints between existing and restored work as inconspicuous as practicable.

B. Use saw where applicable to cut straight line at joint between existing and new surfaces.

C. Make joints between existing and restored work equal structurally and in appearance to original undisturbed items.

END OF SECTION

SECTION 02220

DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Selective demolition of platform elements for alteration purposes excluding removal of hazardous materials and toxic substances.

B. Selective demolition of electrical systems.

1.02 REFERENCE STANDARDS

.

A. Reference Standards:
   1. U.S. Government: Federal Transit Administration (FTA): 49 CFR 661 Buy America Requirements.
   2. Codes and Regulations:
      a. Building Codes: 2012 International Building Code and Montgomery County MD approved version of IBC-2012.
      b. Electrical Codes: 2008 NFPA-70 National Electrical Code.
      c. Life Safety Code: 2012 NFPA-101 Life Safety Code and NFPA-130 For Fixed Guideway Systems as applicable.
      d. Energy Code: 2012 International Energy Conservation Code.
      e. Accessibility Standards: ADAAG-2010 and A117.1-2009

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.

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

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. 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.

D. 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 items as indicated on the drawings.

B. Note items requiring removal and replacement such as station furniture, and store in a safe place and protect until reinstalled in the original location.

C. Salvage granite platform edge slabs and glass lenses and deliver to location as designated by the Authority.

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. 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.

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

C. Do not begin removal until built elements to be salvaged or relocated have been removed.

D. 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.

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.

G. Coordinate all power outages with The Authority.

H. Perform demolition in a manner not to delay or interfere with operations of The Authority.

I. Confirm signs, signals and barricades to requirements of Federal, State and local laws, rules, regulations, precautions, orders and decrees.

3.03 EXISTING UTILITIES

A. Protect existing utilities to remain from damage.

B. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to The Authority.

C. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to The Authority.

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.
   4. 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.

B. 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.

C. Services (Including but not limited to HVAC and Electrical): 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.

D. 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.

E. Electrical Demolition

   1. Remove, relocate and extend existing installations to accommodate new construction as indicated and/or as required.
   2. Remove wiring in abandoned conduit systems to source of power supply.
   3. Maintain access to existing electrical installations, which remain active. Modify installations and provide access panels or plates as appropriate.
   4. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified in other Sections of these Specifications.
   5. Lighting:
      a. Disconnect and remove abandoned lighting fixtures. Remove brackets, stems, hangers and other accessories which are not required by replacement fixtures.
   6. System De-activation: Prior to demolition and removal work, de-activate existing electrical systems as indicated.
   7. Use means and methods for permanent disconnection, which render the remaining electrical systems and apparatus in conformity with NFPA70.
   8. Remove all wiring from disconnected circuits, feeders, and equipment unless otherwise specified or indicated. Remove all exposed raceways and related supports. Cut all exposed raceways flush with floor and plug.
   9. 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.
   10. 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.

3.05 DEBRIS AND WASTE REMOVAL

A. Remove debris, construction waste, 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 02411

SELECTIVE CEILING DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section includes the following

1. Demolition and removal of selected areas of the station metal pan ceilings.

1.02 DEFINITIONS:

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

C. Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated to be removed, removed and salvaged and reinstalled.

1.03 SUBMITTALS:

A. Schedule of Selective Demolition Activities; Indicate the following:
1. Detailed sequence of selective demolition and removal work.
2. Coordination for shutoff, capping, and continuation of utility services
3. Use of elevator and stairs.
4. Means of protection for items to remain and items in path of waste removal from building.

B. Pre-demolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolitions.

1.04 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI A10.6 and NFPA 241.

C. Pre-demolition Conference: Conduct conference at Project site to review methods and procedures related to selective demolition including, but not limited to, the following:
1. Inspect and discuss condition of construction to be selectively demolished.
2. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

1.05 JOB CONDITIONS

A. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

B. All work will be performed during non-revenue hours or approved early outs.

C. Protect area adjacent to demolition area from damage; keep adjacent areas clean, free from debris and spillage of demolition materials.

D. Protection and Restoration:
   1. Prevent damage to pipes, conduits, wires, cables, finished concrete surfaces, public address system, security cameras and structures above and below which are not designated for removal. Repair or replace items damaged during the course of this work.

E. Hazardous Materials: It is unknown whether hazardous materials will be encountered in the Work.
   1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Authority Representative.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 EXAMINATION:

A. Verify that electricity has been turned off in the planned work area.

B. Survey existing conditions correlate with requirements indicated to determine extent of selective demolition required.

C. Subcontractor to provide Inventory and record the condition of items to be removed and reinstalled.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict and bring to the attention of the Authority Representative.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs.

F. Perform Surveys as the Work progresses to detect hazards resulting from selective activities.

3.02 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS:

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

B. Service/System requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving area to be selectively demolished as indicated on Contract Drawings.

3.03 PREPARATION:

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with walks, walkways, and other adjacent occupied and used facilities.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent hazards to people and damage to adjacent buildings and facilities to remain.
1. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during elective demolition operations.
2. Cover and protect furniture, furnishing, and equipment that have not been removed.

3.04 SELECTIVE DEMOLITION, GENERAL:

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoin construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
3. Use of cutting torches in not allowed.
4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
5. Dispose of demolished items and materials promptly.

B. Removed and Reinstalled Items:
1. Protect items from damage during transport and storage.
2. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous necessary to make item functional for use indicated.

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Authority Representative, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations and complete.

3.05 CURING AND PROTECTING:

A. General: Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner’s property, remove demolished materials from Project site and legally dispose of them.
1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

3.06 CLEANING:

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations begin.

END OF SECTION

SECTION 02420

ANCHOR BARS

PART 1 GENERAL

1.01 DESCRIPTION:

A. Section Includes: Furnishing, installing, and testing rock anchors with minimum 30-kip allowable capacity at the locations shown on the Drawings.

1.02 QUALITY ASSURANCE:

A. Anchor material shall be in accordance with the Post-Tensioning Institute Guide Specifications for Post-Tensioning Materials, unless otherwise specified herein.

B. Qualifications of Contractor:
1. The Contractor shall have been in business for at least five (5) years, and shall provide evidence to the Engineer that he is fully experienced in all aspects of anchor installation and is able to provide all plant, materials, skilled labor, and supervision to perform the work. The Contractor shall provide to the Engineer evidence of similar work in tunnels or other underground spaces that he has performed.

C. Reference Standards:
1. ASTM International (ASTM):
    a. ASTM A36 – Standard Specification for Carbon Structural Steel.
    b. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
    c. ASTM A775 – Specification for Epoxy-Coated Reinforcing Steel Bars
    d. ASTM C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. [or 50-mm] Cube Specimens).
    e. ASTM C150 – Standard Specification for Portland Cement.
    f. ASTM C939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
    g. ASTM C940 – Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
    h. ASTM C1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
2. American Institute of Steel Construction (AISC).
    a. Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
3. American Public Health Association (APHA).
    a. Test Methods, Sulfides in Water.
4. American Petroleum Institute (API) Standard Specifications:
    a. RP 13B-1 Recommended Practice for Field Testing Water-Based Drilling Fluids.
5. Post Tensioning Institute (PTI):
    a. PTI DC35.1-04: Recommendations for Prestressed Rock and Soil Anchors (updated version expected Fall 2014).

D. 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.

1.03 SUBMITTALS:

A. Submit shop drawings showing anchor spacing, type, size, length, and any accessories.

B. Submit a Certificate of Compliance for all anchor bars used.

C. Submit mill test reports for each heat or lot of material used to fabricate anchor bars.

D. Submit working drawings showing the methods, materials and equipment to be used in the assembly and installation of the anchors.

E. Submit a detailed written description of the proposed anchor construction plan. Include in construction plan the sequence of operations and locations for drilling, anchor bar installation, grouting and testing holes within the outages; the methods to be used to control groundwater during drilling and grouting; and a plan describing the control/disposal of groundwater, drill flush and excess waste grout.

F. Submit applicable anchor corrosion protection details. Minimum required measures are shown on the drawings.

G. Submit final grout mix design with proportions of all materials, water-cement ratio and the results of all tests made on sample mixtures of the grout. The final mix design shall conform to the requirements provided in Section 2.03 Anchor Bar Grout.

H. Submit complete records of the proof testing specified herein.

1.04 JOB CONDITIONS:

A. Do not begin any anchor construction work until written approval is made by the Engineer.

B. Anchors are located below the groundwater level. Water may be encountered during drilling and grouting.

C. Protect existing facilities such as utilities mounted on the tunnel wall from damage during anchor construction work.

PART 2 PRODUCTS

2.01 ANCHOR BARS:

A. Anchor Bars: Reinforcing bars shall meet the requirements of ASTM A615 for 75 ksi bars. Furnish threaded bars in size and grade shown on the Drawings. Coupled bars will not be permitted. Anchor bars shall be epoxy coated.

2.02 ANCHOR HEAD ASSEMBLY:

A. Anchor Head Assembly: Structural stainless steel plate of the dimensions shown on the Drawings.

2.03 CENTRALIZERS:

A. Centralizers shall be capable of positioning the anchor bar in the drill hole such that a 0.5 inch minimum grout cover is achieved around the bar.

2.04 ANCHOR BAR GROUT:

A. Grout for grouting anchor holes shall consist of a mixture of Portland cement and water. On-site mixing of grout is required. No admixtures will be permitted. Cement shall conform to ASTM C150, Type III. The cement grout mix design shall be the responsibility of the Contractor. The water content shall be the minimum necessary for proper placement, but the water-cement ratio shall not exceed 0.50 by weight. Final proportions of materials shall be based on results of tests made on sample mixtures of grout. The Contractor shall perform bleed tests in accordance with ASTM C940 and should not exceed 1%. The minimum 7-day compressive strength of 2-inch cubes, molded, cured, and tested in accordance with ASTM C109 shall be 4,000 psi. Prior to grouting of any anchor bars, the Contractor shall submit to the Engineer, for approval, the final grout mix design including final proportions of all materials, water-cement ratio and the results of all tests made on sample mixtures of the grout.

B. Water: Water furnished for production of anchor bar grout must meet the requirements of ASTM C1602.

2.05 CORROSION PROTECTION MATERIALS:

A. Anchor Bars: At a minimum, all anchor bars shall be epoxy-coated in accordance with ASTM A-775.

B. Corrosion Inhibitor: Apply one of the following corrosion inhibitors to exposed steel of the anchor bars below the bearing plate.
1. Bitumastic Coating. Use Royston Roskote R28 Rubberized Mastic, or approved equal.
2. Petrolatum Tape with Protective Wrap. Use all purpose petrolatum tape with a plasticized polyvinyl chloride sheeting coated on one side with rubber resin, such as Densyl tape with Denso utility wrap outer coating, or approved equal.

2.06 ANCHOR HANDLING:

A. Keep anchor bars free of dirt, detrimental rust, and other deleterious substance.

B. Handle and protect anchor bars prior to installation in a manner as to avoid corrosion and physical damage.

2.07 DRILLING EQUIPMENT

A. Use rotary-percussive drilling equipment and all necessary equipment to properly layout and align the drill holes.

B. At a minimum, supply a digital angle indicator accurate to 0.1 degrees and a transit.

C. Provide a collection system and maintain all necessary environmental controls to remove drill cuttings from the water discharged during all drilling operations.

2.08 WASHING EQUIPMENT

A. If air is used for drilling operations, furnish a special washout bit or attachment of the Contractor’s design capable of directing radial jets of water onto walls of holes at sufficient velocity to ensure that all drilling debris are efficiently removed from the bond zone. Acceptability of equipment provided will be determined by the Engineer, although the safe and efficient operation of the equipment and system will be the Contractor’s responsibility.

2.09 GROUT PLANT AND GROUTING EQUIPMENT

A. The on-site grout plant(s) and grouting equipment shall be capable of supplying, mixing, agitating, pumping, and delivering grout for the anchor bars to the satisfaction of the Engineer. It shall be maintained in fully operational condition at all times. Any construction works, in the opinion of the Engineer, that are lost or damaged due to mechanical failure of equipment or inadequacy of grout supply shall be repaired or replaced at the direction of the Engineer, at the Contractor's expense. Standby equipment shall be available to avoid a complete shutdown of grouting operations due to equipment repairs. The minimum grouting equipment to be furnished shall include the following components:

1. Grout Pumps: Positive displacement pumps, screw type, similar or equal to a Moyno pump, each with a capacity of not less than 25 gpm of grout at a pressure of 100 psi at the grout hole. Each pump will be equipped with a flowmeter to allow accurate recording of the grout volumes placed in each operation in each hole.
2. Grout Mixers: Mechanically driven, high-speed, colloidal type, grout mixers equipped with a tangential return line and capable of effectively mixing and grout having water-cement ratios as low as 0.4 (measured by weight). The mixers shall be equipped with a suitable calibrated water-measuring device designed that after each delivery the hands can be conveniently set back to zero.
3. Grout Holding Tanks: Mechanically agitated holding tanks, capable of effectively stirring and holding in suspension all solid matter contained in the grout. It shall have a minimum capacity equal to 2 times the maximum output of the pump per minute. Agitators shall have paddles capable of revolving at up to 100 revolutions per minute and shall have baffles to prevent vortex formation. Provide a minimum of four baffles and two paddles, one of which is located as near to the bottom of the tank as practicable. Each agitator shall be equipped such that all grout entering the sump from the mixer or returning from the hole passes through a 100-mesh screen. Provide a calibrated dipstick for volume measurements with each sump.
4. Pressure Gages: Provide freshly calibrated new pressure gages with capacities of 0 to 60 psi. Provide sufficient number to cover replacement and recalibration without any delay in work. All gages shall have a minimum face diameter of 3 inches and pressure increments of 1 psi or less. Submit calibration certificates for each gage.
5. Flowmeters: Provide freshly calibrated flowmeter equipped with direct readout in gallons, with smallest reading increment not more than 0.1 gallons. Inlet and outlet connections on the meter shall not be less than 0.75 inches in diameter. Submit calibration certificates.
6. Grout Packers: Provide inflatable rubber packers and accessories required for operation including compressed air or nitrogen supply, regulators, gages and tubing. Maintain a ready supply of packers and other accessories to replace lost or damaged equipment.
7. Grout Circulation Accessories: Provide pipe, fittings, pressure hose, small tools, and accessories as may be necessary to provide a continuous supply of grout and accurate pressure control.

PART 3 EXECUTION

3.01 ANCHOR SEQUENCING

A. Interconnection of adjacent holes is possible due to joints and fractures within the bedrock foundation. The Contractor shall, therefore, sequence his work to ensure that operations at one anchor do not detrimentally affect adjacent anchors.

3.02 DRILLING

A. Equipment: Drill anchor holes using diamond-core or rotary-percussion equipment. Provide all necessary equipment to properly lay out and align all drill holes. At a minimum, supply a digital angle indicator accurate to 0.1 degrees and a transit.

B. Orientation:
1. As shown on the Contract Drawings.

C. Drill Hole Tolerance:
1. Deviations of the “as drilled holes” from their theoretical alignment must not exceed 1 in 50.
2. Drill hole entry must be centered within 1 inch of its plan location.

D. Hole Washing: Air will not be permitted to remove cuttings from completed holes. If water is used for drilling holes, continue washing with drill bit sitting at end of hole until water becomes clean. If drilling with air or if the hole is not free from debris or drill cuttings along the proposed depth of the anchor, washing of the hole shall be performed using the washing methods specified in Section 2.08. All intersected rock seams and crevices containing washable materials shall be washed with clear water to remove as much material as possible. The washing procedure will continue to the satisfaction of the Engineer. Washed holes shall be temporarily sealed with expandable plugs after hole washing is complete. The Contractor will be required to rewash any holes not properly protected prior to anchor bar grouting and installation.

E. Minimum Hole Diameter for all anchors is 3.5 inches.

F. Minimum Hole Length for all anchors is 16 feet.

G. Keep drill rods, bit, and drilling fluid free of oil, grease, and any other material that would be detrimental to the bond between the grout and rock, grout and concrete, or grout and anchor bar.

3.03 INSTALLATION AND ANCHOR GROUTING

A. General: Conform to the requirements of the Post-Tensioning Institute Recommendations for Prestressed Rock and Soil Anchors (2004).

B. Install the anchor bar as shown on the Drawings. Do not subject anchor bars to bends. Exposed lengths of the anchor bars shall be protected at all times prior to covering by concrete placement. Any anchor bar that is damaged prior covering by concrete shall be replaced at the Contractor’s expense.

C. Use centralizers with a maximum spacing of 5 ft. to ensure that the anchor bars do not contact the wall of the drill hole. Demonstrate to the Engineer’s satisfaction that the proposed centralizers prevent damage to the corrugated plastic sheathing.

D. Do not use anchors for grounding electric equipment.

E. Drilling of anchor holes may not be performed until 12 hours after completion of grouting of adjacent anchor holes.

F. Anchor Bar Grouting:
1. After drilling anchor holes, wash hole in accordance with Section 3.02.D.
2. Pack or seal holes in bearing plate and between bearing plate and rock or shotcrete surface so that grout will be retained in the hole.

3. Insert anchors in accordance with Drawings and recommendations of anchor manufacturer.
4. Inject grout into hole at pressure not greater than that necessary to fill hole adequately.
5. Continue injecting grout until there is full return of grout through air vent.
6. If during grouting of anchor, grout is found to flow from points in adjacent rock or shotcrete surface, plug or caulk leaks until leakage is stopped.
7. Maintain records of the grouting operation including the following data:
   a. Type of mix.
   b. Water/cement ratio.
   c. Types of additives (if any).
   d. Type of cement.
   e. Volume of grout per stage and anchor.

G. Corrosion Inhibitor: Apply approved corrosion inhibitor to exposed steel of the bars below the bearing plate. Do not apply corrosion inhibitor to the bearing plate and remove incidental corrosion inhibitor material from the bearing plate.

3.04 ANCHOR TESTING

A. Test rock anchors as specified in 3.04.B. The maximum test load is 40 kips.

B. Proof test the first two anchors. The first two anchors must be successfully proof tested prior to installing the remaining anchors. Proof test a minimum of 25 percent of the remaining anchors, or as directed by the Engineer. Perform proof tests at least 3 days after anchor installation is complete. The locations of the proof tests shall be uniformly distributed within the rock anchor installation area.

1. Proof Test Procedure:
   a. Incrementally load the anchor in accordance with the following schedule. At each increment, record the movement of the bar to the nearest 0.001 inches with respect to an independent fixed reference point. The load shall be held at each increment long enough to obtain the movement reading, but no longer than 1 minute, unless a creep test is . Monitor the jack load with a pressure gauge or load cell. The increments of load shall be:

P = Design load for the anchor (30 kips)

Proof Test
0
0.25P
0.50P
0.75P
1.00P
1.20P
1.33P (Hold for Creep Test)
0

   b. Subject the proof-tested anchors to a creep test to determine whether the anchors are subject to creep. Hold the maximum load (40 kips) for 10 minutes. While the load is maintained constant, the anchor movement in regard to a fixed reference point shall be recorded at 1, 2, 3, 4, 5, 6, and 10 minutes after reaching the maximum load. If the total creep movement between 1 and 10 minutes exceeds 0.040 inches, maintain the maximum load for an additional 50 minutes. Record total movements at 20, 30, 40, 50, and 60 minutes.

3.05 QUALITY CONTROL

A. Quality Control Testing During Production Grouting: The Contractor will be required to conduct certain routine quality control tests on a regular basis on the fluid grout properties during construction. In addition, the Engineer may instruct or conduct additional quality control or quality assurance tests on mixes, at his discretion, at any time during the works to verify the quality of the mixes and their conformity with the specifications.

1. The Contractor shall determine the viscosity and specific gravity on 1 out of every 5 batches, or a minimum of once per day during production grouting of anchors. Viscosity shall be measured using a Flow Cone (ASTM C939), and specific gravity using a baroid mud balance (API Method RP 13B-1). The viscosity of the mix shall be tested within two minutes after being mixed. Should the results of this testing vary by more than 10% from the values determined in the Mix Design Testing, the tested batch of grout shall be classified as unsuitable and will be wasted and replaced at no additional cost.
2. The Contractor shall perform bleed tests in accordance with ASTM C940 once every 10 batches, or a minimum of once per day during production grouting of anchors. The measured bleed shall not exceed 1%.
3. The Contractor shall collect a minimum of at least 2 sets of cubes to perform 7-day and 28-day compressive strength tests (as needed) in accordance with ASTM C109 once every 10 anchors, or a minimum of once per day during production grouting of anchors. Grout not conforming to a minimum 7-day compressive strength of 4,000 psi shall be re-tested at 28 days. The minimum allowable 28-day compressive strength of 2-inch cubes, molded, cured, and tested in accordance with ASTM C109 shall be 4,000 psi. All anchors that contain grout that does not meet the minimum 28-day compressive strength of 4,000 psi shall be proof tested according to Section 3.04. Anchors that do not pass proof testing shall be replaced at Contractor expense.
4. The Contractor shall submit the results of these tests to the Engineer on a weekly basis.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 02625

SUBWAY DRAINAGE SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section specifies providing subway drainage system except drainage pumping system.

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Samples:
      a. Submit proposed materials not less than ten days prior to date of expected first shipment.
   2. Shop Drawings:
      a. Include complete catalog information and shop drawings for material and equipment.
   3. Certification.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. AASHTO: M352.
   3. ASTM: A48, B271, B584, C33, C131, C654, C700, D1785, D2729.

PART 2 PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. Manholes:
   1. Concrete: Class 3500.Manhole frames and covers, inlet frames and grates:
      a. Authority manhole: Cast-iron, ASTM A48, Class 30, with METRO logo. Size as shown.
      b. Rust-resistant cast iron or rust-resistant malleable cast iron, fabricated as shown.
      c. True to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes and defects affecting strength.
      d. Fillets at angles in casting with arises sharp and perfect.
      e. Sandblasted to effectively remove scale and sand, presenting smooth, clean and uniform surfaces. Coated with bituminous coating.
      f. Covers to receive paver tile.
         1) Omit bituminous coating.
         2) Provide positioning lug and receptor permanently part of cover and frame rim so that cover can only be installed (flush) in one position.

B. Drainage Castings:
   1. Drain inlets, cleanouts, floor and scupper drains fabricated from cast iron: ASTM A48, Class 25 with brass parts, Alloy Number 844.
   2. Copper alloy sand castings: ASTM B584.
   3. Copper base alloy centrifugal castings: ASTM B271.

C. Drainage Casting Covers:
   1. Cast iron: ASTM A48, Class 30.
   2. Copper alloy: ASTM 584.

D. Wire Mesh Screen:
1. Bronze or stainless steel wire, minimum .047-inch diameter, 1/4-inch mesh.

PART 3 EXECUTION

3.01 POROUS MATERIAL PLACEMENT:

A. Place material only on stable rock surfaces.

3.02 MANHOLES:

A. Construct cast-in-place concrete manholes as shown.

B. Construct flow channel in manhole where shown.

C. Place axis of manholes directly over centerlines of pipes unless otherwise shown.

D. Set manhole frame and cover or grate to required elevation. Set ballast screen where shown.

3.03 PROTECTION OF DRAINAGE SYSTEM:

A. During the course of construction, maintain drainage lines free of debris and in undamaged condition.

B. Plug or close ends of completed runs of piping until the Engineer approves their use.

C. Cover the inlet end of drainage piping used to convey water to wet wells at the existing drainage pumping stations with wire mesh screen.

3.04 FIELD QUALITY CONTROL:

A. Where drainage piping is located below invert slabs, conduct a ball, shuttlecock, or mandrel test to ensure that the line is free of obstructions subsequent to the placing of porous subgrade material over the line and prior to the placement of the concrete invert slab.

B. Upon completion of the test and determination that the line is free of obstructions, plug, cap or otherwise close the open end or ends of the installed piping to prevent the entrance of debris into the lines.

C. Immediately prior to final inspection of the work, remove debris from manholes, drain inlets, and floor scupper drains. In the presence of the Engineer, prove by one of the methods specified above that the piping is free of obstructions.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section specifies formwork for concrete structures and other facilities.

B. Related Work Specified Elsewhere:

1. Section 03200 – Concrete Reinforcement
2. Section 03300 – Cast-In-Place Structural Concrete
3. Section 03720 – Repair of Existing Concrete

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of the jurisdictional authorities.
2. ACI: 347, Publication # 4
3. Western Woods Producers Association: Western Lumber Grading Rules.
4. AASHTO: M153.
5. ASTM: D1056, D1149, D1692.
6. APA: HDO Plywood Exterior Grade.
7. U.S. Product Standard : PS 1
8. 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. Responsibilities:

1. Design and construction of formwork is the responsibility of the Contractor, subject to review by the Engineer.

C. Design Criteria:

1. Design formwork for vertical loads and lateral pressures in accordance with ACI 347.
2. Design formwork system which is adequately braced and has adequate strength and stability to ensure finished concrete within the specified tolerances.
3. When necessary to maintain the specified tolerances, design camber into the formwork to compensate for anticipated deflection and creep due to the weight and pressure of the fresh concrete, and construction loads.

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. Working Drawings:
   a. Include details of form types, methods of form construction and erection, design computations and location of form joints and form ties, location and dimensions of blockouts and openings in structure, and embeds.
2. Samples:
   a. Each type of premolded expansion-joint filler proposed for use, each six inches by 12 inches: Two.
   b. Snap-off form ties: Two.
3. Certification:
   a. Manufacturer's certificates.
   b. Certified test reports of specified concrete tests.
4. Documentation:
   a. Calculations: Early form removal calculations as certified by a professional engineer registered in the area where the work is to be

performed. Submit in advance for obtaining approval prior to form removal.

PART 2 PRODUCTS

2.01 MATERIALS:

A. General:

1. Wood forms:
   a. All framing lumber stress-graded.
   b. Lumber in direct contact with concrete, dressed on at least the contact side, with dressed or tongue-and-groove edges; other lumber may be dressed or rough.
   c. Where vertical board finish is shown or specified, use the following:
      1) Form board: Tongue-and-groove, Number 1 Common or better, Ponderosa or White pine, in accordance with the Western Lumber Grading Rules book published by WWPA (not the Southern Pine Inspection Bureau grading rules), one-inch nominal thickness, four-inch nominal width, groove S2S milled or beveled one side only and center matched with 45-degree beveled edges to produce sharp V-shaped 3/8-inch wide in concrete. Four-inch tongue-and-groove boards to be toenailed at edge or face-nailed to backer board.
      2) Smooth concrete: Tongue-and-groove, square cut unturned edges, Number 1 Common or better, Ponderosa or White pine, in accordance with the Western Lumber Grading Rules book published by WWPA (not the Southern Pine Inspection Bureau grading rules), one-inch nominal thickness, four inches nominal width, S2S and center-matched.
2. Plywood forms:
      1) APA High-Density Overlay (HDO) plywood;
      1) B or better face veneer Exterior grade Group I for exposed to public view finished concrete.
   b. USPS : PS 1
3. Hardboard:
   a. For concrete not exposed to public view: tempered, smooth-one-side (S1S) panels not less than 3/16-inch thick, in accordance with AHA IS 1.
4. Form ties:
   a. Factory-fabricated, snap-off metal type, of adequate design to minimize form deflection and preclude concrete spalling upon removal.
   b. Fabricated so that set-back in concrete is such that portion of tie remaining after snap-off and removal of exterior portions is at least 1-1/2 inches below concrete surface.
5. Form release agent: Chemically reactive liquid product that will not bond with, stain, or impair concrete surfaces. Follow form panel manufacturers approved product and recommendations for application. Agents containing castor oil are prohibited
6. Preformed expansion joint filler: AASHTO M153.
   a. Type I: Sponge rubber.
   b. Type II: Cork.
   c. Type III: Self-expanding cork.
7. Chamfer strips: Except where other sizes are shown, 3/4-inch by 3/4-inch triangular fillets milled from clear, straight-grain pine, surfaced-each-side, or extruded-vinyl tape.
8. Miscellaneous preformed strips for reveals, rustications and similar joints: Fabricated of wood, metal, plastic or other approved material formed to cross sections shown.
9. Bonding adhesive: As recommended by manufacturer of premolded elastic filler.

PART 3 EXECUTION

3.01 CONSTRUCTION AND WORKMANSHIP:

A. Concrete finishes and usage locations of various types of forms and form lining: As shown or specified.

B. Unless otherwise shown for concrete surfaces exposed to public view, use HDO Plywood in largest practicable continuous panels to produce plane, smooth surface free from grain imprint, patchmarks, and discoloration.

C. Construct adequately braced formwork so that resulting concrete surfaces conform to specified tolerances.

D. Brace forms, falsework and centering adequately to retain forms in position as shown on approved working drawings.

E. Provide mortar-tight forms of wood, plywood, fibrous-glass-reinforced plastic, steel or other approved materials which conform to shapes, lines and dimensions shown and produce smooth surface without fins and projections.

F. Where shown or directed because of lagging or form irregularity, and where concrete surfaces will not be exposed to public view, line inner form surfaces with hardboard as follows:

1. Use widest available width of hardboard.
2. Line areas less than four feet wide with single-width piece of hardboard.
3. Offset lining joints from those in backing.
4. Fasten securely to backing with galvanized or aluminum nails driven flush.

G. Forms shall be clean of any rust, molds, concrete scale, etc.

3.02 FIELD QUALITY CONTROL:

A. Allowable Tolerances:

1. Construct elements except concrete linings of tunnels to meet allowable tolerances of dimensions, elevations and positions shown and specified in Section 03300.

3.03 COATING FORMS:

A. Lightly coat form panels with chemically reactive release agent prior to initial concrete placement and before each subsequent placement.

B. Do not allow excess coating material to stand in puddles in forms nor to come into contact with concrete against which fresh concrete is to be placed.

C. Coat with release agent bolts and rods that are to be completely removed or to be free to move.

3.04 EMBEDDED ITEMS:

A. Ensure that items to be embedded in concrete are free from oil and foreign matter that would weaken bond of concrete to such items.

B. Install in formwork inserts, anchors, sleeves and other items specified elsewhere. Close ends of conduits, piping and sleeves embedded in concrete with caps or plugs.

C. Before depositing concrete, check location and support of piping, electrical conduits and other items which are to be wholly or partially embedded.

3.05 OPENINGS AND RECESSES IN CONCRETE:

A. Provide openings and recesses; place sleeves furnished by other trades.

3.06 JOINTS:

A. Unless otherwise directed, make contraction, expansion and construction joints only where shown. Where concrete will be exposed to public view, use largest practical size sheets to minimize joints.

B. Form keyways as shown.

C. Continue reinforcing steel and wire fabric across joints unless they are shown as being free to move.

D. Make maximum distance between transverse contraction joints 50 feet or as shown, as measured along centerline of track on tangent alignment.

E. Install premolded joint filler at locations shown. Extend filler from bottom of concrete up flush to finish concrete surface or hold down below finish surface as shown.

F. Make splices in premolded filler in manner to preclude penetration of concrete between joint faces.

G. Where premolded joint filler is held below finish concrete face, install in the form a water-soaked wood strip of dimensions shown, to form, after removal, proper size slot to receive sealant compound specified in Section 07900.

3.07 REMOVAL OF FORMS, FALSEWORK AND CENTERING:

A. Maintain forms, falsework and centering in place until the concrete has attained minimum percentage of specified design strength in accordance with Schedule 1.

Structural Member	Minimum Percentage of Specified Design Strength	
	Schedule 1	Schedule 2
Platform Slab Overhangs (Cantilevers)	90	70

B. Early removal of forms, falsework and centering will not be allowed for concrete strength values below Schedule 2, but will be allowed for concrete strength values between Schedule 1 and Schedule 2 only after:

1. The Engineer has approved calculations showing anticipated concrete strengths at time of proposed early removal based on:
    a. Ratio of dead load over live load.
    b. Span, height and shape.
    c. Ratio of rise over span.
    d. Reshoring.
    e. Loads, resultant stresses and deformations to which concrete and reinforcing steel will be subjected at time of removal, subsequent to removal and until concrete has attained design strength.
    f. Prevailing site conditions.
2. Concrete strength attained prior to form removal has been determined by analysis of quality-assurance data in accordance with Section 03300.

C. Do not remove wood board forms within 48 hours of pouring concrete.

D. Do not alter loading conditions on concrete subsequent to removal of forms if it results in exceeding permissible stresses and deformations at attained concrete strengths.

E. The Engineer may permit early removal of concrete support without submittal of calculations prior to attainment of specified design strength if he considers such submittals to be unnecessary.

END OF SECTION

SECTION 03110

CONCRETE FORMWORK

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies formwork and falsework for concrete structures and other facilities.

B. Related Work Specified Elsewhere:

1. Concrete Reinforcement: Section 03210.
2. Self-Consolidating Concrete: Section 03312.
3 Non-Metallic Non-Shrink Grouting: Section 03621.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of the jurisdictional authorities.
2. ACI: 347, Publication #4
3. Western Woods Producers Association: Western Lumber Grading Rules
4. CE: CRD-C 572
5. AASHTO: M153
6. ASTM: D1056, D1149, D1692
7. APA: HDO Plywood Exterior Grade
8. U.S. Produce Standard: PS 1

B. Responsibilities:

1. Design and construction of formwork is the responsibility of the contractor, subject to review by the Engineer.

C. Design Criteria:

1. Design formwork for vertical loads and lateral pressures in accordance with ACI 347.
2. Design formwork system which is adequately braced and has adequate strength and stability to ensure finished concrete within the specified tolerances.
3. When necessary to maintain the specified tolerances, design camber into the formwork to compensate for anticipated deflection and creep due to the weight and pressure of the fresh concrete, prestressing forces and construction loads.
4 Design formwork for the full height of lateral pressure due to the wet concrete.

1.03 SUBMITTALS

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

A. Working Drawings:

1. Include details for form types, falsework, methods of construction and erection, design computations and location of form joints and form ties, location and dimensions of blockouts and openings in structure, camber, embedments, details of post-tensioning blockouts and closure if different than the closure pour indicated in the contract drawings, and removal or partial removal with consideration of the application of post-tensioning forces. All drawings for load-bearing falsework submissions are to be signed and sealed by a Professional Engineer, registered in the State.

B. Samples:

1. Snap-off form ties: Two

C. Certification:

1. Manufacturer's certificates.

2. Certified test reports of specified concrete tests

D. Documentation:

1. Calculations: Early form removal calculations as specified, certified by a professional engineer registered in the area where the work is to be performed. Submit in advance for obtaining approval prior to form removal.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General:

1. Wood Forms:

a. All framing lumber stress-graded.

b. Lumber in direct contact with concrete, dressed on at least the contact side with dressed or tongue-and groove edges; other lumber may be dressed or rough.

c. Smooth concrete: Tongue and groove, square cut unturned edges, Number 1 Common or better, Ponderosa or White pine, in accordance with the Western Lumber Grading Rules book published by WWPA (not the Southern Pine Inspection Bureau grading rules), one-inch nominal thickness, four inches nominal width, S2S and center-matched.

2. Plywood forms:

a. APA grade-marked:

1) B-B Plyform Exterior grade Group I or II for unexposed finished concrete.

b. APA High-Density Overlay (HDO) plywood:

1) B or better face veneer Exterior grade Group I for exposed to public view finished concrete.

c. USPS: PS 1

3. Form ties:

   a. Factory-Fabricated, snap-off metal type, of adequate design to minimize form deflection and preclude concrete spalling upon removal.

   b. Fabricated so the setback in concrete is such that portion of tie remaining after snap-off and removal of exterior portions is at least 1-1/2 inches below concrete surface.

4. Form release agent: Chemically reactive liquid product that will not bond with, stain, or impair concrete surfaces. Follow from panel manufacturers approved product and recommendations for application. Agents containing castor oil are prohibited.

5. Chamfer strips: Except where other sizes are shown, ¾-inch by ¾-inch triangular fillets milled from clear, straight-grain pine, surfaced-each-side, or extruded-vinyl tape.

PART 3 - EXECUTION

3.01 CONSTRUCTION AND WORKMANSHIP:

A. Use HDO Plywood in largest practicable continuous panels to produce plane, smooth surface free from grain imprint, patchmarks, and discoloration.

B. Construct adequately braced formwork so that resulting concrete surfaces conform to specified tolerances.

C. Brace forms, falsework and centering adequately to retain forms in position as shown on approved working drawings.

D. Provide mortar-tight forms of wood, plywood, fibrous-glass-reinforced plastic, steel or other approved materials which conform to shapes, lines and dimensions shown and produce smooth surface without fins and projections.

E. Forms shall be clean of any rust, molds, concrete scale, etc.

F. Falsework supporting forms shall not be supported from roadway pavements, shoulders, or curbs.

G. Falsework supporting forms shall not be attached to the existing pier column unless approved by the Authority.

H. Falsework shall not interfere with existing drainage inlets, pipes, culverts, ditches, etc. unless alternate temporary drainage is provided during construction. Temporary drainage plans shall be submitted to the Authority for approval. All drainage shall be restored to its pre-project condition prior to project completion.

I. Formwork and falsework for retrofits over adjacent roadways with vertical clearances less than 20' shall be tested by temporary preloading with a load equal to 1.25 times the weight of the wet retrofit concrete. Formwork and falsework deflections under the preloaded condition shall be within the specified tolerances for the finished retrofit. Results of the test shall be submitted to the Authority for approval.

3.02 FIELD QUALITY CONTROL:

A. Allowable Tolerances:

1. Variation from plumb not to exceed ¼".
2. Variation from level not to exceed ¼".
3. Variation from plan dimensions not to exceed ¼".

3.03 COATING FORMS:

A. Lightly coat form panels with chemically reactive release agent prior to initial concrete placement and before each subsequent placement.

B. Do not allow excess coating material to stand in puddles in forms nor to come into contact with concrete against which fresh concrete is to be placed.

C. Coat with release agent bolts and rods that are to be completely removed or to be free to move.

3.04 EMBEDDED ITEMS:

A. Ensure that items be embedded in concrete are free from oil and foreign matter that would weaken bond of concrete to such items.

B. Install in formwork inserts, anchors, sleeves and other items specified elsewhere. Close ends of conduits, piping and sleeves embedded in concrete with caps or plugs.

C. Install continuous dovetail-anchor slots where shown.

D. Complete test on piping and other items before starting concrete placement.

E. Before depositing concrete, check location and support of piping, electrical conduits and other items which are to be wholly or partially embedded.

3.05 OPENINGS AND RECESSES IN CONCRETE:

A. Provide openings and recesses: place sleeves furnished by other trades.

3.06 PROTECTION OF FORMS, FALSEWORK, AND CENTERING:

A. Protect forms, falsework, and centering from traffic at all times. Provide protection that has been NCHRP-350 crash tested and accepted at a minimum TL-3.

3.07 REMOVAL OF FORMS, FALSEWORK AND CENTERING:

A. Maintain forms, falsework and centering in place until the concrete has attained a minimum of 80% of the specified design strength.

B. Maintain falsework in secure position until post-tensioning operations are completed in accordance with construction sequence.

C. Early removal of forms, falsework and centering will not be allowed.

D. Do not remove wood board forms within 48 hours of pouring concrete.

E. Do not alter loading conditions on concrete subsequent to removal of forms if it results in exceeding permissible stresses and deformations at attained concrete strengths.

F. The Engineer may permit early removal of concrete support without submittal of calculations prior to attainment of specified design strength if he [she] considers such submittals to be unnecessary.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section specifies reinforcement for concrete structures and other facilities.
B. Related Work Specified Elsewhere:
   1. Section 03100 – Concrete Formwork
   2. Section 03300 – Cast-In-Place Structural Concrete
   3. Section 03720 – Repair of Existing Concrete
C. Definitions:
   1. Cover: Thickness of concrete between outside surface of reinforcement and outside face of concrete.
D. Epoxy coated reinforcing bars specified for all new cantilever segments.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. ACI: SP-66, 318.
   3. CRSI: Manual of Standard Practice; Placing Reinforcing Bars.
   4. ASTM: A615, A775
   5. 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. Allowable Tolerances:
   1. Cut and bend reinforcing steel to conform to dimensions shown within the following tolerances:
      a. Sheared length: Plus-or-minus one inch.
      b. Stirrups, ties and spirals: Plus-or-minus 1/2 inch.
      c. All other bends: Plus-or-minus one inch.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Detail reinforcing in accordance with ACI SP-66.
      b. Bar lists showing the individual weight of each bar, total weight of each bar size and total weight of bars on list. Base calculated weights on theoretical unit weights shown in ASTM A615, Table 1.
   2. Certification:
      a. Manufacturer's certificates.
      b. Mill tests on each heat showing chemical and physical analyses performed in accordance with ASTM A615, as modified by ACI 318.
      c. Record of mill tests traceable to individual reinforcement bars supplied to the project.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Ship reinforcing steel in bundles limited to one size and length.
B. Tag each bundle at mill with waterproof tag showing name of mill, heat number, grade and size of bars and identifying number.
C. Protect reinforcing steel and wire fabric from damage; foreign matter such as dirt, oil and grease; and rust-causing conditions.

PART 2 PRODUCTS

2.01 MATERIALS:
- A. Reinforcing Steel Bars:
  - 1. ASTM A615, Grade 60, modified in accordance with ACI 318.
  - 2. Epoxy Coating: ASTM A775, as shown.
- B. Welded Steel-Wire Fabric: ASTM A185.
- C. Metal Accessories: As recommended by CRSI Manual of Standard Practice. Where concrete surfaces will be exposed to public view in finish structure, use supports with plastic-protected legs or stainless steel legs.

PART 3 EXECUTION

3.01 CUTTING AND BENDING:
- A. Perform cutting and bending in the shop. Bend steel cold. Do not bend or straighten bars so as to damage material.
- B. Do not bend bars in the field except to correct minor errors and damage occurring during shipping and handling.
- C. Field cutting is allowed with pre-approved cutting methods. Apply approved epoxy coating to cut edges.

3.02 BAR SUPPORTS AND SPACERS:
- A. Support bars by means of bolsters or chairs with no less than minimum required by ACI SP-66.
- B. Do not use stones, clay bricks, wood blocks or pieces of broken concrete to support reinforcing steel.
- C. Do not place bars or fabricated mats on layers of fresh concrete as work progresses.

3.03 PLACING AND FASTENING:
- A. Arrange and place reinforcing steel as shown.
- B. Secure reinforcement positively against displacement during placing of concrete.
- C. Wire or clip bars together as recommended in CRSI Placing Reinforcing Bars.
- D. Before placement, ensure that reinforcement is free from dirt, mill scale, rust scale, oil, grease and other foreign matter.
- E. Where existing reinforcement is to remain for incorporation into new construction, carefully straighten and adjust as needed, using methods which will not adversely affect the structural characteristics of the reinforcement.

3.04 SPLICING:
- A. Furnish reinforcing bars in full lengths as shown on the Contract Drawings and approved shop drawings.
- B. Do not splice bars unless approved in writing.
- C. Make splices when authorized, in accordance with ACI 318, except make all butt splices by welding with a capacity of not less than 125 percent of minimum yield strength of bar. Mechanical connections for tensile splice shall be by Cadweld connection.

3.05 ELECTRICAL BONDING:
- A. No electrical bonding is required for epoxy coated rebar.

3.06 INSPECTION:
- A. Placement of concrete prior to approval of reinforcement is prohibited.

3.07 CONCRETE PROTECTION FOR REINFORCEMENT (COVER):
- A. Above-Ground Structures:
  - 1. Ancillary structures including elevated concrete slabs: ACI 318.

3.8 EPOXY COATING:
- A. Preparation of surface: Perform the following in order given:

1. Clean surface contaminated with oil and grease using naphtha or xylol.
2. Remove weld slag, rust and mill scale from surfaces by wire brushing.
3. Coat surfaces immediately with methyl-methacrylate primer.
4. Apply coating only to surfaces which are dry and free of contaminants.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 03210

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

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

B. Related Work Specified Elsewhere:

1. Concrete Formwork: Section 03110
2. Self-Consolidating Concrete: Section 03312.
3. Non-Metallic Non-Shrink Grouting: Section 03621.

1.02 QUALITY ASSURANCE:

A. Allowable Tolerances:

1. Fabrication: Deviations from indicated dimensions in excess of the following will not be permitted:
   a. Sheared length: Plus or minus one inch.
   b. Stirrups ties and spirals: Plus or minus 1/2 inch.
   c. Bent length: All other bends plus or minus one inch.
2. Placement: Conform to the requirements specified in ACI 318 95, Article 7.5.
3. Bar Supports and Wire Ties: Chairs, ties and supports shall be sized and spaced to maintain reinforcing steel cover as identified on the Contract Plans.

B. Referenced Standards:

1. American Concrete Institute (ACI):
   a. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
   b. ACI 318, Building Code Requirements for Reinforced Concrete.
2. American Society for Testing and Materials (ASTM):
   a. ASTM A82, Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. ASTM A185, Specification for Steel Welded Wire Fabric, Plain for Concrete Reinforcement.
   c. ASTM A615/A615M, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, including Supplementary Requirement (S1).

d. ASTM A663/A663M, Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.

e. ASTM A775/A77M

f. ASTM D3962/D3963M

g. ASTM D3963/3963M, Specification for Epoxy-Coated Reinforcing Steel.

3. Concrete Reinforcing Steel Institute: CRSI, Manual of Standard Practice for Reinforcing Concrete Construction.

1.03 SUBMITTALS:

A. Submit the following:

1. Shop Drawings:

a. Prepare shop drawings of concrete reinforcement in accordance with American Concrete Institute's "Manual of Standard Practice for Detailing Reinforced Concrete Structures", ACI 315.

b. Indicate bending diagrams, splicing and lap of rods, and shapes, dimensions and details of bar reinforcing and accessories.

c. On each shop drawing, show the weight of each bar, the total weight of the bars in each size and the total weight of the reinforcement shown on that list.

2. Test Reports:

a. Submit two copies of reports showing the results of tests. Conduct testing in accordance with the American Society for Testing and Materials Specifications for the methods of testing.

b. Test Requirements may be waived, based upon certified copies of mill test reports.

3. Certification:

a. Manufacturer’s certificates.

b. Mill tests on each heat showing chemical and physical analyses performed in accordance with ASTM A615 as modified by ACI 318.

c. Qualification of welders in accordance with AWS D1.5.

1.04 PRODUCT 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.

2. Identify bundles of reinforcing steel with stamped metal tags wired to steel showing name of mill, heat number, grade and identification number.

3. Ship reinforcing steel in bundles limited to one size and length.

1.05 JOB CONDITIONS:

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

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Metal Reinforcement:

1. Reinforcement Bars:

a. ASTM A615, Grade 60, Deformed, which shall satisfy the exceptions in ACI Building Code.

b. Epoxy-Coated (when indicated): ASTM A775/A775M.

(1) SECTION 4-Materials. Add the following sentence to ASTM A775/A775M, NOTE 3:

"Steel reinforcing bars exhibiting any silver-like defects after the heating and coating process, will be rejected unless satisfactorily repaired."

(2) SECTION 10 – Permissible Coating Damage and Repair of Damaged Coating. Add the following sentence to ASTM A775/A775M, subarticle10.2:

"Repair by mechanical wire brush cleaning and painting with an approved epoxy paint using the paint manufacturer's approved procedure. Repair any bar with signs of rust. Do not cover more than 5% of the total bar surface area with patching material."

(3) Coating Color: Apply in light color shades that will reveal rusted or undercoated areas of steel.

2. Wire: ASTM A82.

3. Metal Accessories (Bar Supports and Tie Wires): Conform to CRSI Manual of Standard Practice for Reinforcing Concrete Construction consistent with epoxy coated reinforcement. Where concrete surfaces will be exposed to public view in the finished structure, use supports with plastic-protected stainless steel legs. Color of plastic is to match finished concrete surface.

B. Rebar Splicing Coupler: ASTM A615, Grade 60:

1. Positive connecting, taper threaded type butt splicer (coupler) with a capacity of not less than 125 percent of the minimum yield strength of the bar.

2. Tensile strength: ACI 318 (90 percent of ultimate tensile strength of reinforcement bars (minimum).

2.02 FABRICATION:

A. Conform to the accepted shop drawings.

B. Perform cutting and bending of reinforcement bars before shipping to site. Bend bars cold. Do not use bars with kinks or bends not indicated on Contract Drawings.

C. Do not field bend bars partially embedded in concrete.

D. Perform bar shape fabricating in a manner that will not injure the material or lessen the member strength.

E. Use a designed bending machine, either hand or power-operated.

F. Taper thread bar ends requiring mechanical splices. Use coupler manufacturer's bar threader to ensure proper taper and thread arrangement.

PART 3 - EXECUTION

3.01 INSPECTION:

A. Notify the Engineer in writing, 48 hours before placing concrete so he can inspect placement of metal reinforcement.

3.02 INSTALLATION:

A. Placing:

1. Place metal reinforcement accurately as shown on the approved shop drawings.

2. Support and securely brace reinforcement against displacement through the use of bolsters or chairs in accordance with ACI 318. Pulling reinforcement up through the concrete or walking reinforcement into the concrete is unacceptable.

3. Terminate reinforcement 2 inches from face of expansion joints.

4. When obstructions interfere with the placement of reinforcing, pass such obstructions by placing reinforcing around and not bending the reinforcing to clear the obstructions.

5. Do not lay metal reinforcement on formwork.

6. Reinforcing steel in bottom of slabs that rest on earth may not be supported by concrete brick, chairs with sand pads, stones, clay bricks, wood blocks or pieces of concrete.

7. In piers, hold reinforcing steel in position by means of pier sleds, bar supports or spacers wired to reinforcing steel.

8. Epoxy coated reinforcement shall be handled and placed in strict accordance with ASTM A775/A775M to ensure minimum coating damage.

B. Repair of Epoxy Coating:

1. Repair of Epoxy Coating: Satisfactorily repair damage to epoxy coating either as described in ASTM D3963, Section 11.1 or by mechanical wire brush cleaning and painting with an approved epoxy paint using the paint manufacturer's approved procedure. Repair any reinforcement with visible signs of rust. Do not cover more than 5 percent of the total reinforcement surface area with patching material.

C. Splicing:

1. Do not splice metal reinforcement except as indicated on approved shop drawings and then splice as indicated on the Plans or in accordance with ACI 318.

2. Welding of crossing bars (tack welding) is not permitted without approval of the Engineer.

3. Secure metal reinforcement at intersections with not less than 16 gauge annealed wire or appropriate size clips.

4. When mechanical splice systems are used, construct sample and actual splices in the presence of the Engineer. The Engineer will select, for each size of reinforcement bar used, 3 to 5 splices either sample or actual, to be tested for verification of physical properties. Submit verification samples to the Engineer within 7 days.

5. When epoxy coated reinforcement bars are being spliced, use an epoxy coated mechanical splice system and paint the entire splice area with a compatible coating.

6. Do not encase mechanical splices in concrete until visual examination and required testing have been completed and approved.

D. Cleaning: Metal reinforcement, at the time concrete is placed, shall be free from rust, rust scale or other coatings that will destroy or reduce bond.

E. Concrete Protection:

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

2. On exterior exposed work, no ties or spacers will be permitted to remain within 3/4 inches of the finished surfaces.

3.03 INSPECTION:

A. Placement of concrete prior to approval of reinforcement work is prohibited.

3.04 FIELD QUALITY CONTROL:

A. Unacceptable Materials: Remove from the worksite, reinforcement with any of the following defects:

1. Bar lengths, depths and bends exceeding fabrication tolerances.

2. Bends or kinks not indicated on the Contract Drawings.

3. Bars with reduced cross-section due to excessive rusting or other cause.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03214

REPLACEMENT OF QUARRY TILE WITH CONCRETE PAVER

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes elements of work specified in Section 01000 Scope of Work.

B. This section specifies the removal of all quarry paver tiles at aboveground station (where platforms are exposed to weather) and replacement with 2" thick concrete pavers, embossed with A hexagonal tile pattern and 2" thick truncated dome concrete pavers.

C. This work includes: Remove granite edge stone from platform, remove existing paver tiles and approximately 2" thick concrete setting bed protecting all embedded conduits in the setting bed, repair the exposed platform structural slab. Install new structural topping slab. Install new construction, contraction and expansion joints. Install waterproofing, reset and align new and existing granite edge stone, and install new platform expansion joint. Set concrete pavers and truncated dome concrete pavers, in a concrete mortar bed. Caulk control joints in pavers, joints in pavers and granite edges and lenses.

D. Related work specified elsewhere.

1. Section 03300 - Cast-in-Place Structural Concrete.
2. Section 03371 - Reinforced Concrete Repair.
3. Section 03400 - Precast Structural Concrete.
4. Section 04415 - Granite.
5. Section 05810 - Expansion Joint Cover Assemblies.
6. Section 07125 - Membrane Waterproofing.
7. Section 08800 – Glass Lenses.

1.02 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards and Specifications:

1. Codes and regulations of the jurisdictional authorities.
2. Americans With Disabilities Act (ADA).

B. Regulatory Agency Sustainability Approvals:

1. Buy America Act:

a. Except for those products which are exempt under the specific statutory waivers stipulated in 49 CFR 661, all other products supplied under this section must comply with the requirements of the Buy America Act.

C. Quality Assurance Program:

1. Demonstration Installation Provide a demonstration installation consisting of a 20 square-foot area installed in the work as otherwise directed.

a. Purpose: Approval of procedures and qualification of installation personnel.

b. Perform work as shown in accordance with approved shop drawings and working drawings using specified materials

2. Do not proceed with remainder of the work until the demonstration installation, procedures and personnel are approved.

D. Field Quality Assurance:

1. Require manufacturers to provide a field representative to verify components for site conditions.
2. Perform work in accordance with approved quality assurance program.
3. Changing procedures and personnel without approval is prohibited.

1.03 REFERENCE STANDARDS

A. Reference Standards:

1. U.S. Government:

a. Federal Transit Administration (FTA):

1) 49 CFR 661 Buy America Requirements.

1.04 SUBMITTALS

A. General: Submit the following items for approval in accordance with the Special Conditions.

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. Samples:

1. Three panels showing concrete paver, concrete paver mortar, grout joints, construction joint sealants, color and range, and texture.

2. Three loose concrete pavers for each different color, size and finish to be installed, to demonstrate match with existing tiles at each station.

D. Shop Drawings: Show layout of concrete paver, direction of flashed edges if any, locations of structural expansion joints and concrete paver expansion joints, and details of installation.

E. Product Data. Manufacturers' catalogs, recommendations and specifications for materials to be used in the work. Include testing laboratory reports demonstrating compliance math requirements. Submit product data with shop drawings.

F. Certification:

1. Mortar, grout, and sealer manufacturers' certifications that materials furnished are suitable for intended use, are fully compatible with each other, and meet specified standards.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site in their original unopened containers clearly labeled with manufacturers' name and brand designation, referenced specification number, type, grade, class and color, as applicable.

B. Store materials on pallets or raised planking so as to prevent water intrusion, dampness and deterioration. Store loose materials, sand and aggregates so as to prevent intrusion of foreign materials.

C. Handle materials so as to prevent breakage of containers and damage to products.

D. Store materials on designated platform areas so as not to exceed floor loading of 150 psf.

E. Do not work with flammable materials such as polyurethane adhesive components or keep such materials on METRO property during revenue hours. Deliver quantities of such materials as are needed for the day's work and remove any excess from METRO property before revenue hours begin. Acquire permits for the use of flammable materials as required by jurisdictional Fire Marshal.

F. Granite: Comply with requirements of Section 04415.

G. Protect all mortar mixes, additives and grouts from freezing or excessive heat. If necessary, provide heated, dry storage facility.

1.06 JOB CONDITIONS

A. Environmental Conditions: Do not start concrete paver work unless the ambient temperature of the area in which the work occurs is at least 50℉ and rising, and is maintained at not less than 50℉ without interruption while the work is being done and for at least three days after completion of setting and grouting the concrete paver and granite aprons.

B. Substrate Conditions: Do not start concrete paver work unless surfaces receiving concrete paver are in satisfactory condition to receive work and acceptable to the Authority Representative.

PART 2 PRODUCTS

2.01 MATERIALS

A. Material shall be from the following manufacturer or as approved equal. See also Section 07125.

B. Waterproofing: Elasto-Seal CM100 by Henry Company or approved equal. Roll-applied waterproofing shall be applied evenly per the manufacturer's recommendations.
C. Protective Sheet for Waterproofing: Base Sheet/Protective Sheet modified PLUS G100 s/s by Henry Company or approved equal. "Filter Fabric GR08," by the Henry Corporation.
D. Polymer-modified mortar mix: Portland cement, graded aggregate and polymer mortar bed mix, requiring only the addition of potable water in the field. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
   1. "3701 Fortified Mortar Bed," by Laticrete International, Inc.
   2. Reinforcement: Wire Reinforcing: 2 inch x 2 inch (50 x 50 mm) x 16 ASW gauge or 0.0625 inch (1.6mm) diameter galvanized steel welded wire mesh complying with ASTM A185 and ASTM A82.
   3. Bond Coat: "254 Platinum," by Laticrete, or as recommended by mortar manufacturer.
E. Mortar Setting Bed Cement: Lehigh Portland Cement Type I/II per ASTM C150 and AASHTO M-85 D. Latex Additive For Setting Bed Cement: Mapei Keracrete.
F. Concrete Paver: Hanover Architectural Products Prest Paver 2'-0 ¾" x 2'-4 5/8" x 2" (sizes are nominal between joint centers); similar in color to Color: Matrix #M1449 #13 Finish; scored 7 3/16" hex pattern; no bevel. Solid paving units, made from normal- weight concrete with a compressive strength not less than 8000 psi, flexural strength not less than 1100 psi, water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
G. Concrete Paver (ADA): Hanover Architectural Products Prest Paver Detectable Warning; 2'-0 ¾" x 1'-11 ¾" x 2"(sizes are nominal between joint centers); color to be Color: Matrix # M3047 Tudor Finish to be approved determine by W MATA. Dome size and spacing to conform to ADAAG 2004.2010. Solid paving units, made from normal-weight concrete with a compressive strength not less than 8000 psi, flexural strength not less than 1100 psi, water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.
H. Grout: SpectraLOCK PRO by Laticrete. Colors shall match adjacent concrete pavers.
I. Admixture for Sanded Grout: Laticrete 3701 Mortar Admixture.
J. Paver Under Pylons: Hanover Architectural Products A Hanover Prest Paver, 2'-0" x 2'-0" x 2" (installed on a diagonal to field of pavers)(sizes are nominal between joint centers); Color : Limestone Gray with Tudor Finish.
K. Cleaner: Power-wash with water only.
L. Sealer: Hanover Architectural Products Natural Sealer Intensifying Sealer roll applied in field per manufacturer's recommendations.

PART 3 EXECUTION

3.01 PREPARATION

A. Fabricate barricades in accordance with the plans submitted and approved as required by the Special Conditions.
B. Erect barricades around work areas in accordance with the approved plans and specified safety requirements.
C. Remove granite edge stone from platform in accordance with applicable section of 04415. Salvage all granite edge stone where possible. Relocate all granite edge stone from inbound and outbound side of the platform to a storage yard designated by AR. Order new granite edge stone identical to those that were not salvageable and as per Section 04415 and the Contract Drawings.
D. Protect embedded conduits and convenience outlets (if any) in the setting bed and remove setting bed, expansion joints, pylons, benches, shelters, and all other items interfering directly or indirectly with installation of new concrete pavers. If the conduits and cable are thicker than new mortar bed then contractor to proposed a solution to AR for rerouting of such electrical/communication conduit and/or cable.

E. Repair exposed platform structural slab in accordance with contract drawings and Specification Section 03371. Install new structural topping slab.

3.02 INSTALLATION OF CONCRETE PAVERS

A. General Requirements:

1. Do not begin concrete paver and pylon paver base installation until elevation and slope of the concrete overlay has been approved.
2. Install concrete pavers and pylon paver bases before such items as pylons, platform shelters and dioramas are reinstalled, but after such items as manholes, expansion joints and outlet cover plates have been set and anchored at finish elevations.
3. Install concrete pavers and pylon paver aprons on clean, cured, fine-broom finished concrete setting bed. Do not proceed with work until concrete setting bed is satisfactory to the concrete paver setter and the Authority Representative.
4. Saw cut concrete pavers. Breaking is prohibited.
5. Install only new concrete pavers and pylon paver-aprons, which have been sized and finished at the fabrication plant. Reuse salvageable granite slabs on both sides of the platform.
6. Follow manufacturer's recommendations, except as otherwise required by this specification.
7. Set concrete paver and pylon paver aprons and clean their top surface in accordance with the approved Quality Assurance Program.
8. Remove excess mortar between concrete pavers to accommodate grouting for full depth of concrete paver.
9. Grouting:
   a. Protect concrete pavers from staining during grouting by tape or other approved method. Fill joints, except concrete paver expansion joints and structural expansion joints. Keep grout out of these joints with temporary formwork or filler strips.
   b. Fill joints full, with a slight concave produced by tooling to compact grout.
   c. Clean top surface so that all grout is removed in accordance with the approved Quality Assurance Program.
   d. Roll apply sealant in the field in accordance with manufacturer’s recommendation.

3.03 CLEANING AND PROTECTION

A. Thoroughly and carefully clean work by approved means and leave in good condition, free from mortar and grout stains or other defacement.

B. When installed work is being protected from patron traffic, ensure that the safety and patron access requirements of the Special Conditions are met.

C. Protect grouted surfaces from pedestrian traffic and cure by means of plastic curing sheet and approved plywood sheeting.

D. Where passenger traffic is required during curing, place temporary walkways when and where determined and directed by the Authority Representative.

END OF SECTION

SECTION 03300

CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION:

A. This section specifies providing Portland-cement cast-in-place concrete.

B. Related Work Specified Elsewhere:

1. Concrete formwork: Section 03100.
2. Concrete reinforcement: Section 03200.
3. Repair of existing concrete: Section 03720

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of the jurisdictional authorities.
2. ACI: 201.2R, 211.1, 304, 309, 318, 318.1.
3. AASHTO: M182, T26.
4. NIST: Handbook 44.
5. USBR: Concrete Manual.
6. FS: HH-I-521, K-P-146.
7. ASTM: A47, A48, C31, C33, C39, C40, C42, C87, C88, C94, C131, C150, C171, C172, C260, C295, C309, C311, C330, C494, C535, C586, C595, C618, C685, C881, C989, C1107, C1260, D98.
8. CPMB (Concrete Plant Manufacturer's Bureau): Concrete Plant Standards.
9. 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. Testing Laboratory:

1. Furnish the services of an independent testing laboratory. Employment of an independent laboratory does not relieve the Contractor of the obligation to perform the work in accordance with requirements of the Specifications and Drawings. Submit certified results of the tests performed.

2. Furnish proof that the laboratory satisfies the requirements of the American Council of Independent Laboratories' Recommended Requirements for Independent Laboratory Qualification. Laboratory need not be a member of the American Council of Independent Laboratories.

3. Certify that testing equipment has been calibrated by an accredited calibration agency at not more than 12-month intervals using devices of accuracy traceable to the National Institute of Standards and Technology (NIST) or accepted values of material physical constants.

C. Properties of Concrete:

1. General:

a. Design mixes to produce concrete of proper workability, durability, strength, maximum density, minimum shrinkage and permeability.

b. Design mixes to have minimum water content per cubic yard of concrete, cement content corresponding to appropriate water-cement ratio, largest permissible maximum size specified of coarse aggregate available and optimum percentage of fine aggregate.

c. Use maximum size of coarse aggregate in accordance with ACI 211.1.

d. Use same brand from same source throughout the work.

e. Use aggregates from same source throughout the work.

f. Use ground-iron blast-furnace slag and fly ash from the same sources respectively throughout the work.

2. Durability:

a. Maximum water cementitious materials ratio as per ACI 318, Chapter 4 and ACI 201.2R.

b. Use a suitable combination of approved air-entraining admixture and water reducer to reduce water content and permeability of the concrete provided such admixtures do not adversely affect other specified properties of concrete.

c. Use a calcium nitrite-based corrosion inhibitor as specified in Section 03300.2.01.K in all cast-in-place concrete at platform overhang slab replacement locations.

3. Workability

a. Use approved chemical admixtures as needed for workability so that concrete can be placed, consolidated, and finished without segregation or excessive bleeding.

4. Strength:

a. Design mix for each class and type of concrete of each specified strength based on overdesign factor in accordance with ASTM C94.

b. Design each class of concrete in accordance with the following:
    1) Not more than the following percentages of strength tests to have values less than specified strength.
    2) Ultimate-strength method: 10 percent.
    3) Average of the following numbers of consecutive strength tests to be equal to or greater than specified strength:
        a) Ultimate-strength method: Three.

c. When number of tests totals six or less, average to be in accordance with Note 21 of ASTM C9

5. Appearance:

a. Cured concrete exposed to public view shall be uniform in color, texture and finish with no discernible form or patch marks, grain imprint, joint irregularities or

discoloration. Use only manufacturer approved chemically reactive release agents on HDO plywood forms.

b. Final selection and approval for color shall be made by the Engineer.

D. Method of Proportioning:

1. Proportion mixes as described in ACI 211.1.

2. Approximate mixing-water and air-content requirements for mixes of different slumps and nominal maximum sizes of aggregates as specified in ACI 211.1, Table 5.3.3.

3. Do not vary proportions of ingredients of approved mixes without written approval.

E. Ready-Mixed Concrete: ASTM C94.

1.03 SUBMITTALS

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

1. Product Data: Manufacturer's literature completely describing each material, standard, test data, installation instructions and special instructions or safety precautions applicable to the materials:

a. Samples:

1) Membrane-forming curing compound: Two of each type, each one pint.

2. Certification:

a. Ingredients:

1) Submit with mix design, laboratory test reports and mill or manufacturer's certificates verifying that ingredients conform to specified requirements. Use ingredients in design mix which are representative samples of materials to be used in the work.

2) Submit test results whenever the aggregates, cement or other additives to be used in the concrete come from a different lot, source, other area of the quarry, different quarry or from other than the representative stockpile or batch from which the original material was tested and approved.

b. In case the source, brand or characteristic properties of ingredients need to be varied during the term of the Contract, submit revised laboratory-mix report in accordance with procedures specified for original mix design.

c. Batch tickets:

1) Before unloading at the site, submit certification or delivery ticket from concrete supplier with each batch delivered to the site bearing the following information:

a) Name of supplier.
b) Name of batching plant and location.
c) Serial number of ticket.
d) Date.
e) Truck number.
f) Specific job designation: Contract number and location.
g) Volume of concrete in cubic yards.
h) Class and type of concrete.
i) Time loaded.
j) Type and brand of cement.
k) Weight of cement and fly ash or ground-iron blast-furnace slag.
l) Maximum size of aggregates.
m) Weights of coarse and fine aggregates.
n) Maximum amount of water to be added and amount of water added at the site.
o) Kind and amount of admixtures.

3. Documentation:

   a. Proposed methods for controlling concrete temperature and plans for placing concrete taking into account sun, heat, wind, ambient air temperature or other limitations of facilities that will prevent proper finishing or curing.

   b. Quality control reports. Submit as specified after installation.

   c. Design mixes:

      1) Prior to placing concrete, submit design mixes for each class and type of concrete, certifying that proposed concrete ingredients and proportions will result in concrete mix meeting specified requirements.

      2) Include for each class and type of concrete as many mix designs as there are combinations of different ingredients or types of ingredients anticipated to cover requirements of the work.

      3) Establish mix designs through an approved design laboratory.

      4) Design concrete mix for protection against alkali-aggregate reactivity.

      5) The Contractor may present for approval a concrete mix previously approved for Authority work provided such mix is made with proposed ingredients that meet requirements and provided that concrete has complied with compressive-strength requirements based on control record of at least 30 consecutive-strength tests recently obtained.

4. Submit current Approved ICC Evaluation Reports for adhesive anchors.

5. Submit anchor installer's certification of training completion.

6. Contractors or Installers shall be certified, or otherwise qualified by the anchor Manufacturer verifying that the necessary training has been provided to install products per Manufacturer's requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Aggregates :

1. Transport and stock pile aggregate separately according to sources and gradations. Handle so as to prevent segregation, loss of fines and contamination by earth or other foreign materials.

2. If aggregates show segregation or if different grades become mixed, rescreen before placing in proportioning bins.

3. Do not combine aggregate from different sources or of different gradations except to obtain different gradations.

4. Do not transfer aggregates directly from trucks, railroads cars or barges to proportioning bins when moisture content is such that it will affect accurate proportioning of concrete mixture. In such cases, stockpile aggregate until excess moisture drains off.

B. Packaged Cement:

1. Deliver to project site in original sealed packages labeled with weight, name of manufacturer, brand and type.

2. Store packages in watertight building.

3. Do not use cement which has been reclaimed by cleaning bags

4. Do not use cement which has been exposed to moisture or contaminated.

5. Deliver packages conforming to weight specified.

6. Packaged cement will be subject to testing.

C. Bulk Cement:

1. Store bulk cement separately from other cement and protect to prevent exposure to moisture and contamination.

2. In ready-mix plant, provide facilities to maintain separation of cement meeting specified requirements from other cement.

3. Provide in cement manufacturer's plant, facilities for sampling cement at weighing hopper or in feed line immediately before entering hopper.

D. Ready-Mixed Concrete: ASTM C94.

E. Blast-Furnace Slag or Fly Ash for use with Portland Cement:

1. Transport in covered carriers.

2. Store in watertight bins or silos to provide protection from dampness and contamination. When compartmented bins are used, conduct periodic, but not less than weekly checks between adjacent bins to avoid contamination of either of the stored materials.

F. Concrete Additives, Sealers and Corrosion Inhibitor. As required by the manufacturer.

G. Waterproofing Coating for use at Platform Slab Edge. As required by the manufacturer.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Cementitious Materials:

1. Portland Cement: ASTM C150, Type I

a. Alkali content not to exceed 0.6 percent. Note that effective alkali calculations (or similar) that account for mitigating cementitious materials effects will not be accepted in lieu of this requirement.

2. Blended Hydraulic Cement: ASTM C595 Type IS and IP.

B. Ground-Iron Blast Furnace Slag: ASTM C989, Grade 100 or 120.

1. Alkali content for slag shall not exceed 1.0 percent unless tested per ASTM C1567.

C. Fly Ash: Shall conform to ASTM C618

1. Alkali content for fly ash shall not exceed 5.0 percent unless tested per ASTM C1567.

D. Aggregates: Fine and coarse aggregates shall conform to ASTM C33.

1. Evaluation of Alkali Aggregate Reactivity (AAR):

a. Perform a petrographic examination in accordance with ASTM C295. The petrographic analysis shall identify constituents of the fine and coarse aggregate reactive.

1) Alkali Silica Reactivity (ASR) – Fine and coarse aggregate containing more than the following quantities of constituents are unacceptable:

a) Optically strained, microfractured microcrystalline quartz exceeding 5 percent (a common constituent of granite and granite gneiss).

b) Chert, Metaquarzite, Chalcedony or combination thereof exceeding 3 percent. However, fine aggregate may contain up to 8 percent provided additional testing (ASTM C1260, etc.) confirms their acceptability.

c) Tridymite or cristobalite exceeding 1 percent.

d) Opal exceeding 0.5 percent.

e) Natural volcanic glass in volcanic rocks exceeding 3 percent.

2) Alkali Carbonate Reactivity (ACR) – Fine and coarse aggregates characterized by a microscopic texture consisting of dolomitic rhombs floating in a fine-grained matrix of calcite, quartz, and clay (e.g.

argillaceous or clay-rich dolomitic limestone) are unacceptable unless additional testing confirms their acceptability.

b. If the project aggregates are determined to contain mineral components associated with ASR, then the aggregates shall be tested for potential reactivity in accordance with ASTM C1260. Note that when ASTM C295 test results are not available, WMATA may (at their discretion) accept the aggregate based only on the ASTM C1260, ASTM C1293, and ASTM C1567 test results described below.

1) If ASTM C1260 expansion is less than 0.08 percent at 16 days, then the aggregate is acceptable.

2) If ASTM C1260 expansion is greater than 0.08 percent and less than 0.40 percent at 16 days, then the degree of reactivity shall be measured by testing in accordance with ASTM C1293. Alternatively, project specific cements and pozzolans may be evaluated using ASTM C1567.

a) ASTM C1293 Testing:

(1) If ASTM C1293 expansion is less than 0.04 percent at one year for cement or at two years for pozzolans or slab, then the aggregate is acceptable.

(2) If ASTM C1293 expansion is greater than 0.04 percent and less than 0.12 percent at one year for cement or two years for pozzolans or slab, then further evaluation of mitigation techniques by testing in accordance with ASTM C1567 shall be required.

(3) If ASTM C1293 expansion is greater than 0.12 percent at one year for cement or two years for pozzolans or slab, the aggregates shall not be used.

b) ASTM C1567 Testing:

(1) If ASTM C1567 expansion is less than 0.1 percent at 16 days, then the aggregate is acceptable.

(2) If ASTM C1567 expansion is greater than 0.1 percent at 16 days, then the mix proportions shall be adjusted to further mitigate expansion. The final mix design shall pass the ASTM C1567 test requirements above.

c) If ASTM C1260 expansion is greater than 0.40 percent at 16 days then the aggregate shall not be used.

3) If the project aggregates are determined to contain mineral components associated with ACR, then the aggregates shall be tested in accordance with ASTM C586.

a) If ASTM C586 expansion is less than 0.10 percent at 28 days, then the aggregate is acceptable.

b) If ASTM C586 expansion is greater than 0.10 percent at 28 days, then additional testing per ASTM C1105, ASTM C1293, or ASTM C1567 shall be required.

(1) ASTM C1105 Testing: Expansion greater than 0.25 percent at 6 months is unacceptable.

(2) ASTM C1293 Testing: See ASTM C1293 testing and acceptance criterion above.

(3) ASTM C1567 Testing: See ASTM C1567 testing and acceptance criterion above.

4) Aggregate which fails the acceptance criterion above may be reclassified as acceptable if prior field performance demonstrates that the aggregate is nonreactive. Submit service records (materials records, batch quantities, exposure conditions, and petrographic evaluation) demonstrating that the aggregate is nonreactive when using the project specific mix design. Acceptance of aggregate based on service records will be at WMATA's discretion.

E. Water:

1. Natural potable water with no pronounced taste or odor.

2. Containing no impurities, suspended particles, algae or dissolved natural salts in quantities that will cause:

a. Corrosion of reinforcing steel.
b. Volume change that will increase shrinkage cracking.
c. Efflorescence.
d. Excessive air entraining.

3. pH: Not less than five.

4. When tested in accordance with AASHTO T26, standard mortar-briquette tests to show no indication of unsoundness, no change in setting time in excess of plus-or-minus 30 minutes and no reduction in strength in excess of 10 percent.

F. 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 CJ.
    b. ADEKA; Ultraseal.
    c. Or equal.

G. Sealing Compound: Liquid-type membrane-forming curing and sealing compound, clear, ASTM C 1315, Type I, Class A.

1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.

2. Moisture loss shall not be more than 0.40 Kg/sq. meter when applied at 300 sq. ft./gal.

3. Contractor is to submit written certification of compatibility with other treatments and finishes to be applied to the concrete.

4. Acceptable Manufacturers:
    a. Super Diamond clear VOX, Euclid Chemical Co.
    b. Kure-N-Seal 25LV, Sonneborn.
    c. Lumiseal WB Plus, L&M Construction Chemical, Inc.
    d. Or approved equal.

H. Ready-Mixed Concrete: ASTM C94, Option C.

I. Admixtures:
1. In accordance with the following:
    a. Air-entraining admixtures: ASTM C260.
    b. Chemical admixtures: ASTM C494.

2. Approved brands: Chlorides may be present in admixtures provided total chloride in mixing water of proposed concrete mixture, including chloride ions contributed by admixture or admixtures, aggregate and mixing water is not in excess of 150 ppm.

3. Meeting requirements of reference standards or documented to have five-year minimum history of demonstrably satisfactory performance for similar structures under equivalent conditions.

J. Ferrous Aggregate:

1. Cast-iron particles, ASTM A47, or ASTM A48, free of oil, grease, soluble alkalis and organic materials.

2. Aggregate graded as follows:

Sieve Designation	Percentage by Weight
US Standard Square Mesh	Passing Individual Sieves
3/8 inch	—
Size 4	100
Size 8	90 - 100
Size 16	75 - 90

Size 30	45 - 60
Size 50	15 - 25
Size 100	10 – 20

3. If recommended by manufacturer and approved, in lieu of the above gradation use lower percentage of aggregate passing Size 100 sieve.

K. Abrasive Aggregate: 60 to 75 percent silicon-carbide abrasive, bonded by vitreous ceramic material, black, graded from 12 to 30.

L. Curing Materials:

1. Plastic sheeting: Polyethylene, ASTM C171.
   a. Curing sheet: Type 1.1.1 and 1.1.2.
   b. Vapor barrier: Clear 10-mils thickness.

2. Burlap sheet: AASHTO M182, Class 3 or 4.

3. Tarpaulin: FS K-P-146.

4. Blanket insulation: FS HH-I-521.

5. Membrane-forming curing compound: ASTM C309, Type 1-D, 100 resin with fugitive dye, and Type 2.

M. Epoxy Mortar:

1. Epoxy: ASTM C881, Type III-C, grey.

2. Sand: Clean, dry, well-graded particles, passing Size 16 sieve, with the following additional requirements:

Individual Sieve Size	Percent by Weight Retained on Sieve
30	26 to 36
50	18 to 28
100	11 to 21
Pan	25 to 35 (range shown is applicable when 60 to 100 percent of pan is retained on Size 200 sieve)

N. Chairs for Reinforcement: Plastic or stainless steel.

O. Corrosion-inhibitor in concrete. The corrosion-inhibitor shall be calcium nitrite-based admixture DCI or approved equal. Use four (4) gallons per cubic yard of the corrosion inhibitor when the water-cement ratio is 0.40 or less and use three and a half gallons (3-1/2) per cubic yard when water-cement ratio is 0.38 or less.

P. Waterproofing coating for use at platform slab edge: Crystalline waterproofing coating to protect concrete and reinforcing steel from water infiltration via crystalline formations in the pores and capillary tracts in concrete while permitting the concrete to breathe.

1. Crystalline Penetration: Crystallizing capability of waterproofing material shall be evidenced by independent SEM (Scanning Electron Microscope) photographs documenting penetration of crystal-forming waterproofing material to a depth of 2 inches (50 mm).

2. Permeability: Independent testing shall be performed according to U.S. Army Corps of Engineers CRD C48-73 “Permeability of Concrete.”

    a. Concrete samples (treated and untreated) to have design strength of 2000 psi (13.8 MPa) and thickness of 2 inches (50 mm). No admixtures permitted.

    b. Coatings to have maximum thickness of 0.05 inches (1 mm) per coat with up to two coats permitted.

    c. Samples to be pressure tested to 175 psi (405 foot head of water) or 1.2 MPa (123.4 m head of water).

    d. Treated samples, after crystalline growth has occurred, shall exhibit no measurable leakage.

3. Chemical Resistance: Independent testing shall be performed according to ASTM C267 “Chemical Resistance of Mortars” and ASTM C39 “Compressive Strength of Cylindrical Concrete Specimens.”

    a. Concrete samples (treated and untreated) to have design strength of 4000 psi (27.6 MPa). No admixtures permitted.

    b. Coatings to have maximum thickness of 0.05 inches (1 mm) per coat with up to two coats permitted.

    c. Untreated and treated specimens to be immersed for a minimum of 84 days in following chemical solutions: hydrochloric acid (3.5pH), brake fluid, transformer oil, ethylene glycol, toluene, caustic soda.

    d. Treated specimens shall exhibit no detrimental effects after exposure, and shall have a minimum of 14% increase in compressive strength versus untreated control specimens.

4. Acceptable Manufacturer:

    a. Xypex Chemical Corporation
    b. Or approved equal.

Q. Adhesive Anchoring System: Provide adhesive anchors that meet ACI 318 Appendix D requirements for cracked concrete and that have a current approved ICC-ES Evaluation Report. The adhesive anchor setting system shall be composed of anchors and fasteners as specified, and a self-contained cartridge system capable of dispensing epoxy components in the proper mixing ratio.

1. Anchor Assembly

a. Standard Anchor Rod Assembly: Chamfered end threaded stud rod of ASTM F1554 Grade 36 steel with nut and washer. Stud size as indicated on Drawings.

b. Stainless Steel Anchor/Fastener: Chamfered end threaded stud rod of AISI Type 304 stainless steel, with nut and washer of AISI Type 316 stainless steel.

c. Deformed Reinforcing Bar conforming to ASTM A615.

d. Anchor element shall meet a tested elongation of 14% and a reduction of area of at least 30% per ACI 318 Appendix D.

2. Adhesive Cartridge: The dual cartridge shall contain both hardener and resin and shall be dispensed from the dual cartridge through a static mixing nozzle.

a. The Pre-mixed adhesive shall be injected directly into the prepared anchor hole. The anchor/fastener shall be inserted in the adhesive in accordance with the adhesive manufacturer's installation instructions. Only injection tools and static mixing nozzles as recommended by manufacturer shall be used.

3. Use of Fast-Setting Epoxies is expressly prohibited.

4. Use of Adhesive Anchors for overhead or direct tension applications is prohibited.

5. Adhesive anchors shall not resist gravity loads in fire-rated construction.

6. Acceptable Manufacturers:

a. Hilti HIT-RE 500-SD, www.hilti.com.
b. Hilti HIT-HY 150 MAX-SD, www.hilti.com.
c. Simpson Strong Tie SET-XP, www.simpsonanchors.com.
d. Approved equal.

2.02 SAMPLING:

A. Sample concrete ingredients prior to use and have them tested by an approved laboratory in accordance with methods specified. Subsequently test materials as often as necessary to verify that materials conform to specified requirements and that quality of product is maintained.

B. Make arrangements for the Engineer to witness sampling and testing. Submit record of test results.

C. Ready-Mixed Concrete: ASTM C94.

2.03 GROUT MIXES:

A. Portland-cement grout:

1. Prepare grout composed of Portland cement, sand and water.

2. Use Portland-cement grout under bearing plates, in recesses, holes and surfaces under structural members and at other locations shown.

3. Do not use staining ingredients in grout exposed to view.

4. Formulation: Two parts sand and one-part cement measured by volume.

5. Mix grout with sufficient water to permit placing and packing, approximately 45 minutes prior to use.

B. Nonshrink grout: ASTM C1107.

C. Shrinkage-compensating grout:

1. Use shrinkage-compensating grout for setting structural members, anchor bolts, embedded items or items of equipment and machinery on hardened concrete.

2. Prepare nonstaining shrinkage-compensating grout with Portland cement and use in accordance with manufacturer's recommendations.

3. Prepare shrinkage-compensating grout for use up to two inches thick as follows, measured by volume:

a. One-part Portland cement, Type I or II.

b. One-part fine natural-sand aggregate, graded as specified.

c. One-part ferrous aggregate, graded as specified, combined with Type-A chemical admixture, oxidation agent and water in sufficient amount to permit placing and packing.

D. Premixed shrinkage-compensating grout:

1. In lieu of specified shrinkage-compensating grout, use premixed ready-to-use formulation when approved. Approval will be based on manufacturer's certification that:

a. Material will perform as specified.

b. Composition and proportioning of grout materials is essentially as specified for shrinkage-compensating.

c. Formulation has been used successfully in like applications for at least five years.

2. Proportion ingredients in accordance with the manufacturer's recommendations.

E. Mixing water:

1. Proportion mixing water in accordance with grout manufacturer's recommendation or to produce flowable mixture without segregation or bleeding.

F. Curing:

1. After grout has attained initial set, keep damp for 24 hours minimum.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL:

A. Classes of Concrete:

1. Classes of concrete are designated by numerals corresponding to their specified 28-day compressive strength in pounds per square inch as determined by ASTM C94.

2. Concrete classes used in this project are specified. Unless otherwise indicated, use Class 5000.

3. Each class of concrete may comprise one or more mixes determined by maximum size of aggregate, cement factor and types of admixtures used.

    a. Portland cement may be used alone or mixed with either ground-iron blast-furnace slag or fly ash. Do not use fly ash in architectural concrete exposed to public view.

    b. Maximum allowable ground-iron blast-furnace slag: 50 percent of the total weight of the Portland cement and ground-iron blast-furnace slag mixture.

    c. Maximum allowable fly ash: 20-percent of the total weight of the Portland cement and fly-ash mixture.

4. Concrete with fly ash or ground-iron blast-furnace slag may be used at locations shown on the drawings.

B. Types of Concrete:

1. Types of concrete are designated as Concrete Other than Lightweight and Lightweight Structural Concrete.

C. Minimum Cement Factor:

1. Observe minimum cement factor for various classes of concrete other than lightweight, as follows:

Class of Concrete	Minimum Cement Factor Bags Per Cubic Yard Of Concrete
5,000	6.5
3,500 - 4,000	6.0
2,500 - 3,000	5.0

* one bag of cement = 94lbs. of cement

2. If a mix of Portland cement and ground-iron blast-furnace slag or Portland cement and fly ash is used, the mix is the basis of determining the bags per cubic yard of concrete.

D. Air Entrainment:

1. Determine air content of concrete in accordance with ASTM C94.

E. Testing of Concrete:

1. General:

a. Provide the Engineer with molds and concrete, and cast specimens for testing. In addition, furnish necessary testing equipment and tools to perform sampling, slump tests and yield tests. Furnish boxes for shipping samples.

2. Perform strength tests by making not less than one set of standard cylindrical test specimens for each 100 cubic yards of concrete or any portion thereof for each structure.
   a. For each work shift, when concrete is delivered, make at least one set of specimens. A set of test specimens consists of at least three standard cylinders from a batch.

   b. Perform slump tests, unit weight and air content tests with no less frequency than that of strength-specimen sets.

3. Concrete strengths:

a. Determine strengths from standard test specimens according to ASTM C31 and ASTM C172 and cured and tested in accordance with ASTM C39 by the testing laboratory. Core drilling and testing in accordance with ASTM C42. Consider the effects of corrosion-inhibiting admixture and other admixtures on the strength of the concrete, in the concrete mix design. The corrosion-inhibiting admixture and other admixtures must be present in the concrete used for the test of the proposed mix strength.

b. Compute and evaluate in accordance with ASTM C94.

F. Variability of Constituents in Concrete:

1. Take representative samples of concrete mortar.

2. Maximum allowable unit-weight variation of air-free mortar taken from consecutive batches as discharged from mixer:

a. Average of two mortar weights: 0.8-percent maximum.

b. Average of six mortar weights: 0.5-percent maximum.

3. Maximum allowable weight variation of coarse aggregate per cubic foot of concrete taken from consecutive batches as discharged from mixer.

    a. Average of two weights: Five-percent maximum.

G. Batching Plant:

1. Arrangement:

    a. Provide separate bins or compartments for each size or classification of aggregate and for bulk Portland cement, ground-iron blast-furnace slag or fly ash.

2. Compartments:

    a. Provide compartments of ample size, so constructed that materials will be kept separated under working conditions. Equip batching plant so that flow of each material into its batcher is stopped automatically when designated weight has been reached.

    b. Weigh aggregates in separate weight batches with individual scales or cumulatively in one batcher on one scale. Weigh bulk cement on separate scale in separate weight batcher. Weigh ground-iron blast-furnace slag or fly ash on the same scale in the same weight batcher containing the bulk cement. Weigh and record bulk cement first; then add to the bulk cement, weigh and record the ground-iron blast-furnace slag or fly ash. Weigh and record the cumulative bulk cement and ground-iron blast-furnace slag or the bulk cement and fly ash.

    c. Water amount may be measured by weight or volume. If measured by weight, do not weigh cumulatively with other ingredients.

    d. Interlock batching controls so that charging mechanism cannot be opened until scales have returned to zero. Satisfy these requirements by semi-automatic batching system as defined in the Concrete Plant Standards of the CPMB, with specified interlocking, or by automatic-batching system as defined in the Concrete Plant Standard.

    e. Arrange plant so as to continuously facilitate inspection of operations. Provide facilities for obtaining representative samples of aggregate from each bin or compartment for test purposes.

    f. Deliver materials from batching equipment within limits specified in ASTM C94.

    g. Subject to approval, accomplish batching in accordance with ASTM C685, in lieu of weight batching, provided batching plant complies with requirements of CPMB Concrete Plant Standards.

3. Water batcher and admixture dispensers:

a. Provide equipment for batching water and air-entraining or other admixtures at batching plant except in cases where mixing is to be performed at jobsite in paving mixers or in truck mixers.

b. Provide water-measuring device capable of measuring mixing water within specified requirements for each batch. Provide mechanism for delivering water to mixers so that leakage does not occur when valves are closed.

c. Interlock filling and discharge valves for water batcher so that discharge valve cannot be opened before filling valve is fully closed.

d. Introduce admixtures in solution form.

e. Provide measuring devices for admixtures capable of ready adjustment to permit varying quantity of admixture to be batched. Interlock dispenser for admixtures with batching and discharging operations so that batching and discharging of mixture will be automatic.

f. If noninterlocked dispensers are permitted, check calibration of dispensers at directed intervals. Record results of such calibration for inspection by the Engineer.

4. Moisture control:

a. Provide plant capable of ready adjustment to compensate for varying moisture contents of aggregate and to change weights of materials being batched. Provide approved electric moisture meter for measurement of moisture in fine aggregate. Calibrate as often as directed.

b. Moisture content of fine aggregate not to exceed eight percent. Arrange sensing element so that measurement is made near batcher.

5. Scales:

a. Provide accurate measurement facilities for and control of each of the materials entering each batch of concrete. Provide accurate weighing equipment in accordance with NIST Handbook 44.

b. Include in each weighing unit a visual springless dial to indicate scale load at each stage of weighing operation or include beam scale with beam balance indicator to show scale in balance at zero load and at each beam setting, indicator to have undertravel and overtravel equal to at least five percent of capacity of beam.

c. Provide standard test weights and other auxiliary equipment necessary to verify operating performance of each scale or other measuring device.

d. Make periodic tests in the presence of the Engineer at directed intervals. Upon completion of each check test and before further use of indicating, recording and control devices, make adjustments,

repairs or replacements as necessary to ensure satisfactory performance.

6. Recorders:

   a. Provide accurate recorder for producing digital printout of scale readings corresponding to each concrete ingredient of each concrete batch, including zero initial readings; indicate presence of each individual admixture by corresponding code in lieu of weight or volume record.

   b. Record water in gallons where batched by volume. In addition, on each printout show date and time of batching, identification number identical to that of concrete delivery ticket and codes for mix design and for project section.

   c. Prepare printout in duplicate and submit one copy with its corresponding concrete ticket at the time and site of concrete placement.

   d. House each recorder in locked cabinet.

   e. Place recorders in position convenient for observation by plant operator and the Engineer.

7. Protection:

   a. Protect weighing, indicating and control equipment against exposure to dust and weather; isolate against vibration or movement caused by other operating equipment.

8. Dry batching:

   a. When bulk cement and aggregates are hauled from central batching plant to mixers, place cement, ground-iron blast-furnace slag or fly ash for each batch in an individual compartment which, during transit, will prevent cement from intermingling with aggregates and will prevent loss of cement.

   b. Provide bins of batch trucks with suitable covers to protect materials.

   c. Provide batch compartments of sufficient capacity to prevent loss in transit and to prevent spilling and intermingling of batches as compartments are being emptied.

H. Allowable Concrete Finish Tolerances:

1. Finish concrete elements to dimensions, elevations and positions shown within the tolerances specified for each:

   a. Station platforms:

      1) Vertical: Plus-or-minus 1/4 inch.
      2) Horizontal, measured from centerline of track to edge of platform: Plus 1/4 inch or minus zero.

3.02 MATERIAL PREPARATION:

A. Mixing Concrete:

1. Operations:

a. Provide concrete mixers that discharge concrete of uniform composition and consistency.

b. Combine coarse aggregates of different gradation and identical sources, provided corresponding concrete mix has been approved. The use of alternate batches of gravel, crushed gravel or crushed stone of a single size is prohibited.

c. Adequacy of mixing will be determined by the Engineer by means of mixer performance tests in accordance with USBR Concrete Manual, Designation 26, Variability of Constituents in Concrete, in the appendix.

d. The Engineer may reduce size of batch to be mixed or increase mixing time when charging and mixing operations fail to produce concrete which conforms to specified requirements and which has uniform coloration and consistency.

e. Add water prior to, during and following mixer-charging operations. Do not overmix or add water to maintain consistency.

f. Use of concrete to which water in excess of amount permitted by approved design mix has been added to overcome conditions caused by excessive retention in mixer is prohibited.

2. Central-mixed concrete:

a. Arrange mixers in centralized mixing plant so that mixing action in mixers can be conveniently observed by the Engineer and plant operator.

b. Do not load mixers in excess of rated capacity. Mix concrete ingredients in batch mixer for not less than period of time specified for various mixer capacities after each ingredient except full amount of water is in mixer. Reduce mixing time if thorough mixing as specified can be obtained in less time and if approved.

c. Mixing time:

Cubic-Yard Capacity of Mixer	Mixing Time
2 or less	1-1/2 minutes
3	2 minutes

4	2-1/2 minutes
More than 4	To be determined per ASTM C94 tests by the Engineer

d. Equip each mixer with mechanically operated batch counter and timing and signaling device to indicate completion of mixing period.

3. Truck-mixed concrete: Use equipment and procedures that conform to the requirements of ASTM C94 and ACI 304, Chapter 5, with the following additional requirements:

a. Introduce materials, including water and mixtures, into the mixing drum only at the central batching plant, or
b. Transport aggregates from the central plant to the jobsite in the mixing drum and add measured and recorded cement, admixtures and water into the drum prior to mixing at discharge point.
c. When ice is used, add it with the water and counted as part of the water-cement ratio.
d. Place concrete within 90 minutes after cement is introduced into the mixing drum.
e. Accomplish initial mixing by 70 to 100 revolutions with drum rotating at the manufacturer's recommended speed. 30 revolutions at mixing speed will be required, if the addition of water is permitted. Do not exceed total of 300 mixing and agitating revolutions.

4. Temperature control:

a. Use preparation methods capable of producing concrete with temperature 85F maximum and 55F minimum at time of placement.
b. Do not heat concrete ingredients to temperature higher than that necessary to keep temperature of mixed concrete as placed within specified temperatures.
c. Do not heat water in excess of 140F.

B. Admixtures:

1. Introduce admixtures in solution form.
2. Air-entraining admixture: Use for concrete exposed to weathering or in contact with rock or moist soil.
3. Chemical admixtures:
   a. Employ admixtures without interfering with specified air-content dosage of air-entrained concrete.
   b. Except as otherwise specified or approved, use of water-reducing, set-retarding or set-accelerating admixtures is prohibited.
   c. If introduction of certain admixtures to improve concrete strength is approved, do not reduce cement content below minimum amounts specified.

C. Consistency:
   1. For concrete to be compacted by approved mechanical vibrators, maintain slump range at point of delivery within the following limits:
      a. Reinforced concrete: Two to four inches.
      b. Concrete placed by pumping: Four to five inches.
      c. Do not use concrete if slump exceeds maximum by 1/2 inch or more.

3.03 CONVEYING:

A. General:

1. Provide equipment for conveying concrete from mixer with continuous flow of concrete to point of placement without segregation.
2. Provide arrangement at discharge end of conveyor to prevent segregation.
3. Design long conveyor runs to discharge concrete into hopper, without segregation, before it is deposited in forms.
4. Ensure that pumps, pneumatic equipment, pipes, chutes and troughs are cleaned of dirt and concrete before use.

B. Chutes and Troughs:

1. Use only ferrous-metal-lined chutes and open troughs. Where steep slopes are unavoidable, equip chutes or troughs with baffles to minimize segregation of aggregates. Keep chutes or open troughs clean of hardened concrete by flushing with water after each use.
2. Discharge water used for cleaning outside lines of structure. Lay out chutes or open troughs with slope one-foot vertical to two feet horizontal maximum and one-foot vertical to three feet horizontal minimum.
3. Discharge chutes 20 feet or more in length into hopper before final distribution.

C. Adjustable Length Pipes (Elephant Trunks):

1. Use flexible pipes of ferrous metal, rubber or plastic, six inches minimum diameter so as to prevent segregation of concrete.
2. Position chutes or flexible pipes so that concrete is delivered in continuous flow to points not more than five feet horizontally and five feet vertically from final location. In vicinity of expansion and contraction joints, reduce horizontal distance to three feet maximum.
3. Clean flexible pipes and elephant trunks after each use.

D. Buggies:

1. Construct runways for buggies so they will not come into contact with or be supported by reinforcing steel of structure.

E. Pumping and Pneumatic Conveying Equipment:

1. Use pumping and pneumatic conveying equipment, designed to handle without segregation types, classes and volumes of concrete to be conveyed.

2. Operate pump or pneumatic equipment so that continuous stream of concrete without air pockets is produced. Position discharge end of line as near final position of concrete as possible but in no case more than five feet away.
3. At conclusion of placement, clean equipment. Discharge debris and flushing water outside of forms.

3.04 PLACEMENT:

A. General:

1. Prior to placing concrete, remove debris and extraneous material from interior of forms.
2. Place first lift of concrete on wet surface. Consolidate by dragging vibrator along edges of joints. Make sure there is no free or standing water over the surface.
3. Place concrete continuously and as rapidly as possible after mixing. Do not use vibrators for shifting mass of fresh concrete.
4. Place concrete in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams or planes of weakness. Cover each layer of concrete with fresh concrete within 45 minutes.
5. Do not place concrete which has attained initial set or concrete which has contained mix water for more than 90 minutes.
6. Remove temporary spreaders in forms when concrete has reached elevation which makes them unnecessary.
7. Place column concrete using adjustable-length flexible pipes or elephant trunks to avoid dropping concrete over five feet. In monolithic placements, do not deposit concrete in supported elements such as beams, girders and slabs until concrete previously deposited in columns or walls has completed its settlement shrinkage, but not to the point at which concrete in supporting members will not permit vibrator to sink into its mass of its own weight.
8. Placing will not be permitted when sun, heat, wind or limitations of facilities will prevent finishing and curing.
9. Concrete temperature at time of placement:
    a. 55F, minimum.
    b. 85F, maximum.
10. Unless approved, do not continue concreting when descending ambient air temperature falls lower than 40F.
11. Prior to placing fresh concrete against rock or previously placed concrete, take necessary steps, such as flushing with water, to ensure removal of foreign matter which would adversely affect bond.
12. Maintain wire fabric and other reinforcing in proper position on chairs during concrete placement.

B. Consolidation:

1. Consolidate concrete thoroughly as it is placed in order to secure a dense mass. Work concrete well around reinforcement, embedded items and into the corners of forms. Consolidate concrete in accordance with ACI 309.
2. Use internal vibrators unless external vibrators are approved.
3. Use vibrators capable of generating frequencies of not less than 7,000 impulses per minute. Verify that vibrators have power and amplitude factor so as to visibly affect mass of concrete of one-inch slump over radius of at least 18 inches. Prevent formation of laitance and accumulation of excessive water on surface of

concrete as it is deposited. Remove excessive water by pumping or other approved means.

4. When consolidating concrete in haunches, girders, beams or slabs, ensure that vibrator penetrates and revibrates previously placed concrete in top of supporting members.
5. Do not use vibrators where internal vibration might cause damage to embedded items; in such cases spading is required.

3.05 CURING AND PROTECTING:

A. General:

1. Protect freshly placed concrete from excessively hot or cold temperatures. Maintain without drying for period of time necessary for hydration of cement and proper hardening of concrete.
2. Provide sufficient tarpaulins to cover completely or enclose forms and working areas prior to and during placing and finishing operations.
3. Cure newly placed concrete continuously for seven days at ambient temperature in excess of 55F.
4. Cure concrete in subway structures by normal curing method specified.
5. During curing period keep steel and wood forms wet. If forms are removed during curing, use one of the following methods of curing immediately and continue for remainder of the curing period.

B. Normal Curing and Protection:

1. Use one of the following methods for flat surfaces, weather permitting:

a. Use ponding on horizontal surfaces providing surface is continuously submerged for required curing period.
b. Apply continuous sprinkling with nozzle or nozzles which, during first 24 hours, atomize flow of water providing a mist and not a spray. Do not apply moisture under pressure directly upon concrete; avoid flowing or washing on surfaces while susceptible to erosion.
c. Cover entire surface of concrete with double thickness burlap sheet, laid directly on concrete and kept continuously wet. Maintain in good condition.
d. Sprinkle concrete surface as specified for at least 18 hours and immediately cover with waterproof curing sheet, free from holes or tears. Hold in position so that entire surface of concrete is fully and continuously covered.
e. Do not damage burlap, waterproof sheet or concrete surfaces.

C. Membrane-Forming Curing Compound:

1. Use curing compound when approved for circumstances where application of moisture is impracticable and where such compounds will not jeopardize appearance of concrete. Except as otherwise specified, use Type-1 compound, uniformly applied over surface at thickness recommended by manufacturer. Thoroughly mix compound and apply within one hour after mixing.
2. Where surfaces are subject to sunlight, apply Type-2 compound. Except for surfaces exposed to public view and architectural finished concrete.

3. Do not apply wax-resin curing compounds to surfaces requiring bond for additional concrete or where bonded surface coating such as paint, tile, dampproofing, waterproofing or roofing is to be applied.
    a. Do not apply curing compound to floors to be chemically sealed.
4. Warm or stir curing compound if necessary for satisfactory application in accordance with manufacturer's recommendations. If film of compound is damaged before expiration of curing period, repair immediately with additional compound.
5. Finish surfaces prior to application of curing compound. Do not use curing compound on construction joints.
6. Apply curing compound in two coats. Apply first coat immediately after stripping of forms and acceptance of concrete finish.
7. If surface is dry, thoroughly wet concrete with water and apply curing compound just as surface film of water disappears. Apply second coat after first coat has set.
8. Protect coating against damage for at least 10 days after application. If damage occurs, apply additional coating.
9. If use of curing compound results in streaked or blotchy appearance, cease operations and use other method of curing until cause of defective appearance is corrected.

D. Protection of Rod Reinforcement:

1. After forms are removed, coat rod reinforcement and dowels extending beyond concrete surfaces with application of neat cement paste.
2. Remove hardened cement paste and resultant debris immediately prior to extension of reinforcement or installation of formwork.

3.06 COLD WEATHER CONCRETING:

A. Do not place concrete when ambient temperature is less than 55º F and falling. Do not place concrete unless the form temperature at the time of placement is at least 40º F.

B. When ambient temperature is 40º F and falling, carry out one of the following procedures to protect placed concrete:

1. Heating:
    a. Enclose forms or structures and heat to maintain concrete and air within enclosure at not less than 55º F for seven days after placement.
    b. Maintain relative humidity at not less than 40 percent during curing period when heat is applied to enclosures. Arrange stoves, salamanders or heaters so as to provide uniform distribution of heat. Vent combustion gases to outside air. Do not let hot air blow across concrete surfaces.
    c. After seven-day curing period, reduce temperature within enclosure gradually at maximum rate of 20º F per day until outside temperature has been reached.
    d. Provide continuous and adequate fire protection and watchmen when heating units are in operation.

2. Form insulation:
    a. Insulate forms with blanket insulation of approved type and thickness to maintain concrete at 55º F minimum for seven days.

b. Protect top of placed concrete by tarpaulins or other approved waterproof material over insulation.

C. Do not allow concrete to freeze in a saturated condition prior to achieving a strength of 5,000 psi.

3.07 HOT WEATHER CONCRETING:

A. When temperature in forms is 75º F or above, carry out the following procedures to protect placed concrete:

1. Protect concrete from direct sunlight.
2. Keep forms moist by means of cool-water sprinkling or application of wet burlap or cotton mats.
3. At 90º F or above cool aggregates with water spray hoses.
4. Cool truck barrels with water spray system.

3.08 JOINTS:

A. General:

1. Unless otherwise shown make construction joints bonded joints by roughening surface to expose aggregates. Clean and roughen surface by wet sandblasting, by cutting with high-pressure water jet with a minimum pressure of 2,000 psi or by other approved means. Perform cleaning after concrete has hardened to prevent raveling of surface.
2. Exercise caution in cleaning concrete to prevent damage to waterstops.
3. Treat overlays on slabs the same as for rock or other bonded joint.
4. Place construction joints at locations shown, or at locations approved by the Engineer.

B. Horizontal Construction Joints:

1. Joints within 18 inches of tops of faces are prohibited.
2. Trowel top surface of concrete adjacent to forms smooth to minimize visible joints on exposed faces. Remove laitance and other objectionable materials from joint surface to expose sound concrete as soon as concrete is firm enough to retain its form.
3. Immediately after placement of concrete, remove accumulations splashed on exposed reinforcement and surfaces of adjacent forms before concrete attains initial set.

3.09 CONCRETE FINISHING:

A. When forms are removed, do not remedy voids, stone pockets and other defects until the Engineer has inspected them and given directions.

B. Finish concrete surfaces as shown and as follows:

1. Number-1 Form Finish:

a. Immediately following form removal, remove fins and irregular projections from surfaces exposed to view or those that will receive waterproofing.
b. Prepare pointing mortar not more than 30 minutes prior to use.
c. Cure mortar patches as specified under curing and protection.
d. Leave contraction joints and articulated joints in completed work carefully tooled and free of mortar and concrete.
e. Leave joint filler exposed for its full length with clean and true edges.
f. Apply this finish to structures, unless otherwise shown.

2. Number-2 Wet-Rubbed Finish:
    a. Start rubbing of concrete after removal of forms and as soon as its condition will permit. Keep concrete thoroughly saturated with water before starting this work.
    b. Allow sufficient time to elapse before wetting down to allow pointing mortar to thoroughly set. Rub surfaces with medium-coarse carborundum stone.
    c. Continue rubbing until form marks, projections and irregularities have been removed, voids are filled and uniform surface is obtained.
    d. Leave paste produced by rubbing in place. Obtain final finish by rubbing with fine carborundum stone and water after concrete above surface being treated has been cast. Continue rubbing until entire surface is of smooth texture and uniform color. After final rubbing is completed and surface has dried, rub with burlap to remove loose powder and objectionable marks.

3. Number-3 Broomed Finish:

    a. Where floors and other areas are shown to have rough finish, strike-off surface with screeds and wood floats at elevation shown.
    b. Before concrete has achieved initial set, broom transversely to flow of traffic with stiff, medium-bristle broom especially made for intended purpose to develop corrugations not more than 1/8-inch deep.

4. Number-4 Steel-Troweled Finish:

    a. Where floors are shown to have a steel-troweled finish, screed concrete to established grades and compact with wood or power-driven disc float.
    b. After surface has hardened sufficiently, finish with steel trowel to dense hard finish, free of trowel marks.
    c. Do not use dry cement or mixture of dry cement and sand to absorb water.

5. Number-5 Wood-Float Finish:

    a. Screed inverts of subway structure, floors not specified or shown to be finished otherwise, areas below floating slabs and areas to receive dampproofing, waterproofing or roofing to a true and uniform surface conforming to shape and elevations shown.
    b. Follow with wood-float finish to tolerances specified.
    c. On slabs and floors, where drainage is shown, maintain accurate slopes for drainage.
    d. Protect floors and slabs until final acceptance.

6. Number-6 Sandblast-Sealer Finish:

a. Where concrete surfaces are shown to receive sandblast finish and a sealer, prepare sample using sandblast finish on file in the Engineer's office as criterion.
b. Prepare samples with degree of sandblasting which will produce uniform texture on surface of concrete. Blast to achieve smooth, sanded surface approximately equivalent to 100-120 grit sandpaper finish.
c. Sandblasted surfaces will be inspected before sealing and compared with approved samples.
d. Apply concrete surface sealer to sandblast finish in accordance with approved procedures.

7. Number-7 Natural-Board Finish:

a. After stripping forms, cut back form ties as specified. Touch-up holes created by form ties and damaged or defective finish using grout closely matching surrounding concrete. Accomplish grouting and repairs as specified. Knock-off heavy elongated fins, but do not rub down.

8. Number-8 Abrasive-Aggregate Finish:

a. After screeding and floating as for Number-4 Finish, apply abrasive aggregate at rate of not less than 0.6 pound per square foot.
b. Sprinkle evenly in two applications using one half the amount for each application. Apply second half at right angle to first.
c. Follow with wood float; lightly tamp or roll surface to embed aggregate flush with concrete surface.
d. Lightly steel trowel to smooth, even finish.
e. After curing, rub surface using abrasive brick with water to slightly expose abrasive aggregate.

C. Do not sprinkle water or cement on surfaces to be trowel finished.

3.10 DEFECTIVE CONCRETE:

A. Concrete will be considered defective unless it is structurally sound, watertight, properly finished and within specified tolerances.

B. Concrete in place that is deemed structurally defective will be checked by the Engineer by drilled core specimens. If testing of core specimens shows that strength is less than 85 percent of specified strength, costs incurred in taking and testing of core specimens will be borne by the Contractor.

C. Replace, strengthen or correct defective concrete as directed.

3.11 PROTECTION FROM AND REMOVAL OF STAINS:

A. Protect concrete structure from rust staining by structural-steel members or from other substances during the work.

B. If staining should occur, remove stains and restore concrete to its original color.

3.12 DAMAGED WORK:

A. Before final acceptance of the work, neatly repair damaged surfaces, corners of concrete and concrete finish.

B. Where surface repairs are permitted, finish damaged areas to smooth, dense watertight condition.

C. Replace concrete that is not satisfactorily repaired.

3.13 CORRECTIVE WORK:

A. Submit corrective action patching procedure.

B. If correction of defects is approved, remove defective concrete; key area to be repaired, soak surface with water and patch with approved materials. Patch architectural concrete so as to match existing. Use bonding agents applied to the substrate or mixed with patching material only as approved by the Engineer.

C. Clean surface cavities produced by form ties, other holes, honeycomb spots, broken corners or edges and other defects. Saturate with water and point with mortar paste consisting of cement and fine aggregate mixed in proportions to give same appearance as original concrete.

D. Prepare pointing mortar not more than 30 minutes prior to use. Cure mortar patches properly. Carefully tool contraction and articulated joints in completed work and keep them free of concrete. Where necessary, leave joint filler exposed for its full length with clean and true edges.

E. Tolerance deviations and other surface defects may also be corrected, if approved, by grinding high areas and swales.

F. Where necessary or when directed, repair leakage in excess of specified maximum allowable, by means of contact grouting, chemical grouting or other approved means.

G. Where corrective work is unsatisfactory, completely remove such work and replace with new work complying with specified requirements.

3.14 EPOXY MORTAR REPAIRS:

A. Surface Preparation:
   1. Remove defective concrete with chipping hammers or other approved equipment. To prevent removing extra material and causing cracks, saw-cut concrete area to be removed into maximum six-inch square checkerboard pattern 4-1/2 inches deep.

   2. Prepare exposed concrete surface by sandblasting clean and allowing to dry thoroughly. Surface drying may be accomplished by air jet. Ensure that compressed air used in cleaning and drying is free from oil or other contaminating materials.

   3. Maintain concrete surface in sufficient depth at temperature of 65º F minimum during first four hours after placement of epoxy bond coat. Preheating may be done with radiant heaters or other approved means. Do not preheat concrete in

excess of 200º F with final surface temperature below 105º F at time of placing epoxy materials.

B. Application of Epoxy Bonding Agents:

1. Prepare epoxy bonding agent in accordance with manufacturer's recommendations.

2. Apply epoxy bonding agent to prepared dry concrete surface at coverage of 80 square feet per gallon maximum or as recommended by manufacturer
3. Epoxy bonding agent may be applied by any convenient and safe method which will yield effective coverage, such as squeegees, brushes or rollers.

4. During application of epoxy bonding agent, ensure that material is confined to area being bonded; avoid contamination of adjacent surfaces. Extend epoxy bond coat slightly beyond edges of repair area.

C. Application of Epoxy Mortar:

1. Mix epoxy components in accordance with manufacturer's recommendations.
2. Proportion: 5-1/2 parts sand by weight to one-part epoxy.
3. Mix components with slow-speed mechanical device.
4. Prepare mortar in small batches so that each batch can be completely mixed and placed within approximately 30 minutes.
5. Do not add thinners or dilutants to mortar mixture.
6. Immediately after application of epoxy bonding agent, place, tamp, flatten and smooth epoxy mortar.
7. Work mortar to grade.
8. Steel-trowel finish. Trowels may be heated to facilitate finishing.

D. Curing:

1. Cure epoxy mortar repairs immediately after completion at 60º F minimum until mortar is hard.
2. Initiate post-curing of four hours minimum at surface temperature of 90º F minimum, 110º F maximum.
3. Heat may be applied by using portable propane heaters, infrared heaters or other approved sources positioned to attain necessary surface temperature.
4. Do not subject epoxy-bonded epoxy mortar to moisture until after specified post-curing has been completed.

3.15 CONCRETE OVERLAYS AND TILE SETTING BEDS:

A. General:

1. Water blast (3,000 - 5,000 psi) or sand blast the substrate.
2. Keep slabs continuously wet for 24 hours prior to concrete placement. Substrate to be air blown just prior to concrete placement.
3. Place concrete in two pours of equal thickness. Place welded-wire-fabric reinforcement on first pour and then place second pour.
4. Use a vibratory screed on overlays.
5. Float slab and apply light broom finish. Cure slabs with water.
6. Remove laitance by methods in number one above if the overlay requires a bonding surface for tile or other treatments.
7. Continuously moist cure of overlay (setting bed) for seven (7) days.

3.16 WATERPROOFING COATING AT PLATFORM SLAB EDGE:

A. Surface Preparation:

1. Concrete surfaces must be clean and free of laitance, dirt, films, paint, coatings, and other foreign matter.
2. Concrete surfaces must be thoroughly wetted, remove excess surface water before application.
3. Concrete surfaces to be prepared per manufacturer's recommendations.

B. Application:

1. Apply with semi-stiff bristle brush.
2. Apply one coat with a thickness of 1/16 inch.
3. Do not apply coating in rain or during freezing conditions.
4. Apply coating per manufacturer's recommendations.

C. Curing:

1. Cure per manufacturer's recommendations.

3.17 ADHESIVE ANCHOR INSTALLATION

A. General: Install adhesive anchors in strict accordance with manufacturer's published instructions and those listed in the applicable ICC-ES Evaluation Report and in accordance with the following. Adhesive anchors shall not be installed in overhead and direct tension applications.

B. Install anchors only after concrete has reached its minimum specified 28-day compressive strength.

C. Anchors shall be installed in dry concrete.

D. Drilling Holes: Use rotary hammer type drill and drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed. Use carbide-tipped drill

a. Prior to setting cartridge and anchor stud clean drilled holes free of loose material. Clean holes by blowing from the back of the borehole with oil-free compressed air (min. 90 psi at 3.5 CFM), fully retracting the air extension 2 times. Brush 2 times with properly sized round steel brush. Blow again with compressed air 2 times or until return air stream is free of noticeable dust.

E. Anchor Rod Installation: Following cartridge installations in in-prepared drill holes, set anchor rod to the required depth. Set anchor rod truly perpendicular (normal) to the base plate of item being anchored.

F.

G. Minimum Installation Criteria: Unless otherwise noted on Contract drawings, embed adhesive anchors as shown below. Anchors shall meet the manufacturer's published centerline to centerline spacing and edge distance requirements.

Adhesive Anchor Diam.	3/8	1/2	5/8	3/4	7/8	1

(Inches)						
Embedment Depth (Inches)	4	5	6	7	8	10

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 03312

SELF-CONSOLIDATING CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies the materials and procedures for producing self-consolidating concrete (SCC).

B Material is to be suitable for pumping from the ground to the retrofit location(s) indicated.

C. Related Work Specified Elsewhere:

1. Concrete Formwork: Section 03110.

2. Concrete Reinforcement: Section 03210.

3 Non-Metallic Non-Shrink Grouting: Section 03621.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. ASTM International (ASTM)

a. C 1064/C 1064M – Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

b. C 1116/C 1116M – Specification for Fiber-Reinforced Concrete

c. C 1240 – Specification for Silica Fume Used in Cementitious Mixtures

d. C 1550 – Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel)

e. C 1579 – Test Method for Evaluation Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert)

f. C 1582/C 1582M – Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete

g. C 1585/C – Test Method for Measurement of Rate of Absorption of Water by Hydraulic-Cement Concretes

h. C 1602/C 1602M – Specification for Mixing Water Used in the Production of Hydraulic-Cement Concrete

i. C 1608/C 1609M – Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)

j. C 1610C 1610M – Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique

k. C 1611/C 1611M – Test Method for Slump Flow of Self-Consolidating Concrete

l. C 1621/C 1621M – Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring

m. E 329 – Specification for Agencies Engaged in Construction Inspection and/or Testing

2. American Concrete Institute (ACI):

a. 301 - Specifications for Structural Concrete

b. 305.1 - Specification for Hot Weather Concreting

c. 306.1 – Standard Specification for Cold Weather Concreting

d. 308.1 – Standard Specification for Curing Concrete

e. 318 – Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary

1.03 DEFINITIONS

A. Self-Consolidation Concrete (SCC): A highly flowable, non-segregating concrete that can spread into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation.

B. Passing Ability: The ability of SCC to flow under its own weight (without vibration) and fill completely all spaces within intricate formwork, containing obstacles, such as reinforcement.

C. J-Ring Test: Test used to determine the passing ability of SCC, or the degree to which the passage of concrete through the bars of the J-Ring apparatus is restricted.

D. J-Ring Flow: The distance of lateral flow of concrete using the J-Ring in combination with a slump cone (upright or inverted).

E. Slump Flow: Test method used to measure the unconfined flow and stability of SCC using a slump cone (upright or inverted).

F. Slump Flow Spread: The numerical value in inches (mm) of flow determined as the average diameter of the circular deposit of SCC at the conclusion of the slump flow test (measured at the point of placement).

G. T50 Value: Time (in seconds) the edge of the concrete mass takes to reach 50 cm (500 mm, 20-inch) diameter from the time the mold is first raised in the slump flow test (measured at the point of placement).

H. Stability: The ability of a concrete mixture to resist segregation of the paste from the aggregates.

I. Static Segregation (Segregation Factor): Segregation of the mortar from the coarse aggregate that occurs after placement while the concrete is still in a plastic state.

J. Visual Stability Index (VSI) Rating: An assessment of the homogeneity of concrete based on the visual inspection of the concrete sample at the end of the slump flow test (measured at the point of placement).

K. Mass Concrete: Any volume of concrete with dimensions large enough to require that measures be taken to cope with generation of heat from hydration of the cement and attendant volume change to minimize cracking.

1.04 SUBMITTALS

A. Submit the following:

1. Mix Design Acceptance.

Submit a copy of each completed mix design to the Representative before its use in the work. The Authority reserves the right to review any design through plant production before its use in Authority work at no additional cost to the Authority. The concrete design submitted for review is required to comply with the specified concrete class requirements, supported by slump flow, air content, and compressive strength test data.

The Authority will accept concrete designs on the basis of the 6-hour, 24 hour, 3 day and 28-day strength tests.

Submit documentation, including temperature control design calculations, that the proposed mix design satisfies ACI 301-05, Section 8 requirements for Mass Concrete

A higher class concrete may be used in place of an indicated lower class concrete if the higher class concrete conforms to all of the requirements of the indicated lower class, and if approved by the Authority.

2. SCC Placement Plan for conditional approval by the Authority. The submission shall include procedures for accommodation of temperature fluctuations in the field in hot/cold weather conditions during placement and curing of the concrete.

3. Certification: Manufacturer's certification stating that the products delivered meet or exceed Project Specifications.

4. Product Data.

5. Ready-mixed concrete delivery tickets.

1.05 DELIVERY, STORAGE AND HANDLING

A. Ready-mixed concrete truck driver shall provide batch ticket to the Authority Representative or his [her] representative at the time of concrete delivery. Contents of the batch ticket shall be as specified in ASTM C 94/C 94M.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cement: Shall conform to ASTM C 150, Type 1.

1. Alkali content for cement shall not exceed 0.6 percent. Note that effective alkali calculations (or similar) that account for mitigating cementitious materials effects will not be accepted in lieu of this requirement.

B. Aggregates: Fine and coarse aggregates shall conform to ASTM C 33.

1. Evaluation of Alkali Aggregate Reactivity (AAR):

a. Perform a petrographic examination in accordance with ASTM C295. The petrographic analysis shall identify constituents of the fine and coarse aggregate and shall also identify aggregate found to be potentially alkali aggregate reactive.

(1) Alkali Silica Reactivity (ASR) - Fine and coarse aggregate containing more than the following quantities of constituents are unacceptable:

i. Optically strained, microfractured microcrystalline quartz exceeding 5 percent (a common constituent of granite and granite gneiss).

ii. Chert, Metaquarzite, Chalcedony or combination thereof exceeding 3 percent. However, fine aggregate may contain up to 8 percent provided that additional testing (ASTM C1260, etc.) confirms their acceptability.

iii. Tridymite or cristobalite exceeding 1 percent.

iv. Opal exceeding 0.5 percent.

v. Natural volcanic glass in volcanic rocks exceeding 3 percent.

(2) Alkali Carbonate Reactivity (ACR) - Fine and coarse aggregates characterized by a microscopic texture consisting of dolomitic rhombs floating in a fine-grained matrix of calcite, quartz, and clay (e.g. argillaceous or clay-rich dolomitic limestone) are unacceptable unless additional testing confirms their acceptability.

b. If the project aggregates are determined to contain mineral components associated with ASR, then the aggregates shall be tested for potential reactivity in accordance with ASTM C1260. Note that when ASTM C295 test results are not available, WMATA may (at their discretion) accept the aggregate based only on the ASTM C1260, ASTM C1293, and ASTM C1567 test results described below.

(1) If ASTM C1260 expansion is less than 0.08 percent at 16 days, then the aggregate is acceptable.

(2) If ASTM C1260 expansion is greater than 0.08 percent and less than 0.40 percent at 16 days, then the degree of reactivity shall be measured by testing in accordance with ASTM C1293. Alternatively, project specific cements and pozzolans may be evaluated using ASTM C1567.

i. ASTM C1293 Testing:

(a) If ASTM C1293 expansion is less than 0.04 percent at one year for cement or at two years for pozzolans or slag, then the aggregate is acceptable.

(b) If ASTM C1293 expansion is greater than 0.04 percent and less than 0.12 percent at one year for cement or two years for pozzolans or slag, then further evaluation of mitigation techniques by testing in accordance with ASTM C1567 shall be required.

(c) If ASTM C1293 expansion is greater than 0.12 percent at one year for cement or two years for pozzolans or slag, the aggregates shall not be used.

ii. ASTM C1567 Testing:

(a) If ASTM C1567 expansion is less than 0.1 percent at 16 days, then the aggregate is acceptable.

(b) If ASTM C1567 expansion is greater than 0.1 percent at 16 days, then the mix proportions shall be adjusted to further mitigate expansion. The final mix design shall pass the ASTM C1567 test requirements above.

(3) If ASTM C1260 expansion is greater than 0.40 percent at 16 days then the aggregate shall not be used.

c. If the project aggregates are determined to contain mineral components associated with ACR, then the aggregates shall be tested in accordance with ASTM C586.

(1) If ASTM C586 expansion is less than 0.10 percent at 28 days, then the aggregate is acceptable.

(2) If ASTM C586 expansion is greater than 0.10 percent at 28 days, then additional testing per ASTM C1105, ASTM C1293, or ASTM C1567 shall be required.

i. ASTM C1105 Testing: Expansion greater than 0.25 percent at 6 months is unacceptable.

ii. ASTM C1293 Testing: See ASTM C1293 testing and acceptance criterion above.

iii. ASTM C1567 Testing: See ASTM C1567 testing and acceptance criterion above.

d. Aggregate which fails the acceptance criterion above may be reclassified as acceptable if prior field performance demonstrates that the aggregate is nonreactive. Submit service records (materials records, batch quantities, exposure conditions, and petrographic evaluation) demonstrating that the aggregate is nonreactive when using the project specific mix design. Acceptance of aggregate based on service records will be at WMATA's discretion.

C. Water: Shall conform to ASTM C 1602/C 1602M.

D. Admixtures: Furnish from one manufacturer. Not all admixtures listed below are required at Medical Center Crossover Waterproofing Part 2.

1. Characteristics: Compatible with each other and free of intentionally-added chlorides

2. Air-Entraining Admixture:

a. Shall conform to ASTM C 260

3. Water-Reducing Admixture:

a. Shall conform to ASTM C 494/C 494M Type A.

4. Mid-Range Water-Reducing Admixture:

a. Shall conform to ASTM C 494/C 494M Type A.

5. High-Range Water-Reducing Admixture:

a. Shall conform to ASTM C 494/C 494M Type F [or ASTM C 1017/C 1017M Type 1.

6. Accelerating Admixture (not required for Part 2):

a. Shall conform to ASTM C 494/C 494M Type C or E.

7. Retarding Admixture:

a. Shall conform to ASTM C 494/C 494M Type B or D.

8. Hydration Control Admixture (not required for Part 2):
    a. Shall conform to ASTM C 494/C 494 M Type B or D.
9. Workability-Retaining Admixture (not required for Part 2):
    a. Shall retain concrete workability without affecting time of setting or early-age strength development.
    b. Shall conform to ASTM C 494/C 494M Type S.
10. Permeability-Reducing Admixture (not required for Part 2):
    a. Shall be an integral crystalline capillary waterproofing admixture for concrete.
    b. Shall satisfy the following requirements, when used at the manufacturer's recommended dosage:
        (1) Reduction in capillary absorption: Not less than 40 percent relative to a companion untreated concrete mixture, when tested in accordance with ASTM C 1585.
        (2) Reduction in water penetration: Not less than 40 percent relative to a companion untreated concrete mixture, when tested in accordance with DIN 1048.
        (3) The admixture shall not affect the setting time, strength or durability properties of concrete.
    c. Shall be certified to NSF/ANSI 61.
11. Viscosity-Modifying Admixture:
    a. Shall conform to ASTM C 494/C 494M Type S.
12. Corrosion-Inhibiting Admixture (not required for Part 2):
    a. Shall be a nominal 30 percent solution of calcium nitrite or an amine/ester-based organic corrosion-inhibiting admixture.
13. Shrinkage-Reducing Admixture (not required for Part 2):
    a. Shall conform to ASTM C 494/C 494M Type S.
14. Alkali-Silica Reaction Inhibiting Admixture (not required for Part 2):
    a. Shall contain a nominal lithium nitrate content of 30 percent.
    b. Shall conform to ASTM C 494 /C 494M Type S.
15. Other admixtures shall be approved by the Authority Representative.

E. Supplementary Cementitious Materials (SCM):
1. The substitution of supplementary cementitious materials for cement shall be made on the basis of mass.
2. Fly Ash: Shall conform to ASTM C 618.
    a. Alkali content for fly ash shall not exceed 5.0 percent unless tested per ASTM C1567.
3. Slag Cement: Shall conform to ASTM C 989.

a. Alkali content for slag shall not exceed 1.0 percent unless tested per ASTM C1567.

4. Silica Fume: Shall conform to ASTM C 1240 (not required for Part 2).

a. Alkali content for silica fume shall not exceed 1.5 percent unless tested per ASTM C1567.

5. Metakaolin: Shall conform to ASTM C 618, Class N (not required for Part 2).

F. Fibers:

1. Microsynthetic Fibers:

a. Shall conform to ASTM C 1116/C 1116M.

b. Shall provide a minimum crack reduction ratio (CRR) of 40 percent when tested in accordance with ASTM C 1579.

2. Macrosynthetic Fibers:

a. Shall conform to ASTM C 1116/C 1116M.

b. Shall have an equivalent flexural strength ratio ($R_{e,3}$) of 30 percent when tested in accordance with ASTM C 1609/C 1609M.

3. Steel Fibers:

a. Shall conform to ASTM C 820/A 820M.

b. Shall have an equivalent flexural strength ratio ($R_{e,3}$) of 30 percent when tested in accordance with ASTM C 1609/C 1609M.

G. Evaporation Reducer (not required for Part 2):

1. Shall be a monomolecular film-forming liquid for application to fresh concrete to prevent rapid drying of the surface.

H. Epoxy Resin Concrete Sealer:

1. General. An epoxy-type base polymer, thermosetting resin as follows:

a. Composed of 100% reactive constituents (condensation products of the reaction of epichlorohydrin with bisphenol A).

b. Essentially pure, diglycidyl-ether of bisphenol A, containing no more than trace amounts of hydrolyzable chlorine.

c. Epoxide equivalent between 465 and 530.

d. Reacting system consisting of a blend of condensation polymers of dimerized and trimerized unsaturated, fatty-acids and an aliphatic polyamine.

e. Pigmentation added so the cured coating conforms to the Federal Color Standard 595, Color – Grey (16473 to 16492). Care shall be taken to ensure color consistency between retrofits.

2. Physical Requirements of the Mixed Epoxy System.

a. Viscosity - 300 centipoises to 700 centipoises at 72°F

b. Pot Life - a minimum of 7 hours at 75°F

c. Minimum solids content - 48%

d. A cured system that does not exhibit amine blushing or sweating.

e. When the pigmented finished coats are tested for abrasion, according to ASTM D 968, a minimum of 25 L of sand is required to abrade a 1-mil thickness of coating. A 2 ½-mil dry film thickness of the coating, tested by ASTM D 522, is required to pass a ⅛-inch diameter mandrel test, without splitting the film or causing loss of bond.

3. Packaging and Marking:

a. Furnish the two components in separate containers that are nonreactive with the contained materials. If directed, provide a container size so the recommended final mixture proportions can be obtained by combining one container of a component with one or more containers of the other component. Have containers marked as base polymer and reacting system, showing the mixing directions and usable temperature range. Have each container marked with the name of the manufacturer, the lot or batch number, the date of packaging, pigmentation, if any, and the quantity in pounds and gallons.

Indicate the potential hazards on the package, according to the Federal Hazardous Products Labeling Act.

4. Certification:

a. Provide either a copy of the manufacturer's dated test report or a statement, accompanied by a copy of the dated test results, showing the system has been sampled and tested.

2.02 CONCRETE MIXTURES:

A. Mixture Specifications:

1. Water-to-cementitious materials ratio shall be minimized and is not to exceed 0.45 by mass.

2. Supplementary Cementitious Materials: The weight of SCM shall not exceed the percentages listed in the following table for concrete exposed to freezing and thawing and in continuous contact with moisture and exposed to deicing chemicals (ACI 318 (ACI 318M) Exposure Class F3).

Material	Maximum percent of SCM by mass of total cementitious materials
Fly ash or other pozzolans	25
Slag cement	50
Silica fume	10
Total of fly ash or other possolans, slag cement and silica fume	50*
Total of fly ash or other pozzolans and silica fume	35*

*Fly ash or other pozzolans and silica fume shall not constitute more than 25 and 10 percent, respectively, of the total mass of cementitious material

B. Slump Flow:

1. Slump low shall be measured in accordance with ASTM C 1611/C 1611M.
2. Typical ranges of slump flow are outlined in the following table.
3. The design slump flow of SCC mixture shall be established after consideration of the project requirements.
4. The slump flow of SCC used on the project shall be 24"-30" plus or minus 2 inches.

C. Visual stability Index (VSI): VSI Rating (in accordance with ASTM C 1611/C 1611M) shall not exceed 1.

D. J-Ring Flow: Difference between slump low and J-Ring flow (as measured by ASTM C 1621/C 1621M) shall not be more than 2 inches.

E. Stability: The stability of the concrete shall be determined in the laboratory prior to approval of SCC mixture using test method ASTM C 1610/C 1610M. Concrete mixtures shall have a maximum static segregation (segregation factor) of 15 percent.

F. Compressive strength: 5000 psi or 6000 psi at 28 days as indicated in the Contract Drawings. The concrete shall reach 70% of the 28 day compressive strength after 6 hours of curing, 95% of the 28 day compressive strength after 24 hours of curing, and 100% of the 28 day compressive strength after 72 hours of curing. Compressive strength of self-consolidating concrete at Medical Center Crossover Waterproofing (Part 2) shall reach 4000psi at 28 days.

G. Air content shall be less than 3%.

H. The nominal size of coarse aggregate shall be ¾".

I. Furnish to the Authority Representative a mixture proportion for the SCC to be used.

1. Proportion mixture according to project specific criteria (Compressive Strength, Air Content, Slump Flow, T50, VSI, J-Ring Value and Segregation Factor).
2. Use the same components in the trial batches as that to be used in the project including coarse and fine aggregates, inert non-cementitious fillers, water, source and

type of cement, supplementary cementitious materials and admixtures including any site-added admixtures intended to be used.

PART 3 – EXECUTION

3.01 PREPARATION OF EXISTING COLUMN

A. Removal of Deteriorated Concrete: Prior to the installation of the formwork inspect the existing column within the limits of the retrofit for spalling, unsound concrete, alligator cracking or cracking with efflorescence. If any spalling, unsound concrete, alligator cracking or cracking with efflorescence is encountered remove the concrete as per the limits defined in the Contract Drawings.

B. Surface Roughening: Roughen the surface of the existing column to an amplitude of ¼″ within the limits defined in the Contract Drawings. Roughening of the surface shall be performed using a chisel tip on a chipping hammer followed by light media-blasting to remove any loose material.

3.02 FORMWORK

A. Concrete form work shall be in accordance with Section 03 10 00. Additional measures shall be taken to seal the formwork to prevent leakage of cement paste or mortar.

3.03 BATCHING

A. Concrete shall be factory batched. Batching on site and small batch bag mixes are prohibited.

B. Materials shall be batched in accordance with ASTM C 94/C 94M [ASTM C 1116/C 1116M].

In addition to the use of a moisture probe, the moisture content of the aggregates shall be determined once a day prior to batching in accordance with ASTM C 70 or ASTM C 566. Aggregate samples shall be taken as close as possible to the area where moisture probe is located. Use of microwave over or hot plate to dry the aggregates is permitted in addition to using an oven.

C. Volume of concrete batched shall be such that no spillage occurs during transport.

3.04 TRANSPORTING

A. Concrete shall be transported in accordance with ASTM C 94/C 94M.

3.05 COLD WEATHER CONCRETING

A. Concrete shall be placed and protected in accordance with ACI 306.1.

3.06 HOT WEATHER CONCRETING

A. Concrete shall be placed and protected in accordance with ACI 305.1.

3.07 FIELD QUALITY CONTROL

A. General:

1. The contractor shall notify the Authority prior to the SCC placement at each pier. The SCC placements shall be coordinated with Authority Operations such that train traffic be slowed to 15 mph during SCC placement, no train traffic be allowed on the structure during the first 4 hours of curing, and train traffic be slowed to 15 mph for sufficient time to allow the concrete to achieve a compressive strength of 2,000 psi.

2. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for the first 24 hours or for additional time as may be required before transporting samples to the test lab.
3. Provide concrete for testing of slump flow, air content, density (unit weight) and temperature and, for making cylinders.
4. Water shall not be added to the concrete at the job site.
5. Field addition of admixtures, if needed for logistics reasons, shall be approved by the Authority Representative.

B. Consult with the admixture manufacturer in developing quality control operations appropriate to the project.

C. Field testing and inspection shall be performed in accordance with ACI 301 (ACI 301M).

D. Concrete tests shall be conducted by an ACI Concrete field Testing Technician Grade I, or equivalent, knowledgeable in testing self-consolidating concrete.

E. Tests shall be conducted on each lot of concrete mixture placed.

F. The testing agency shall provide the following services:

1. Inspect concrete placement.
2. Sample the concrete in accordance with ASTM C 172.
3. Test concrete slump flow in accordance with ASTM C 1611/C 1611M. Cone can either be used upright or inverted. Same procedure shall be followed throughout the project.
4. Record the Visual Stability Index (VSI).
5. Test passing ability in accordance with ASTM C 1621 C 1621M. Cone shall be used in the same way as in slump flow test.
6. Determine the air content of concrete sample for each strength test in accordance with ASTM C 231 or ASTM C 173/C 173M, except the concrete shall be filled in one lift and not consolidated. Light tamping of the sides of the air-meter is permitted.
7. Determine the density (unity weight) of concrete sample for each strength test in accordance with ASTM C 138/C 138M, except that the concrete shall be filled in one lift and not consolidated.
8. Record the temperature of concrete for each strength test in accordance with ASTM C 1064/C 1064M.
9. Cast concrete specimens for compressive strength test as follows:

   Cast and cure at least ten 6-inch by 12-inch (150 mm by 300 mm) cylinders per lot of SCC. One lot of SCC is considered to be an adequate quantity to complete one pier retrofit or mock-up. Cast and cure cylinders in accordance with ASTM C 31/C 31M, except that the concrete shall be placed in one lift and not consolidated. However, light tapping of the sides of the cylinders with an open hand is permitted.
10. Record the fresh concrete data for each set. The datasheet shall include the following:
    a. Mixture number
    b. Specified 28-day strength

c. Date and time of batching

d. Time of testing

e. Location of placement

f. Truck number

g. Ticket number

h. Slump flow, VSI, passing ability, air content, density (unit weight) and temperature of concrete

i. Ambient temperature

j. Names and quantities of admixtures added on site, and, name and title of the person who authorized the addition

k. Set number, if more than one set of cylinders are cast on a single day

l. Name of the testing agency

m. Name and signature of the inspector who conducted the test, and

n. Any additional observations or comments.

11. Mark the cylinders and write the date of casting on each cylinder.

12. Store and protect the cylinders from job site to the laboratory in accordance with ASTM C 31/C 31M.

13. Transport the cylinders and write the date of casting on each cylinder.

14. Cure the cylinders in the laboratory in accordance with ASTM C 31/C 31M.

15. Test cylinders for compressive strength in accordance with ASTM C 39/C 39M.

    a. Test two cylinders at 6 hours, two cylinders at 24 hours, two cylinders at 3 days and two cylinders at 28 days for acceptance.

    b. The testing agency shall provide testing equipment at the project site for compression testing of cylinders at 6 hours and 24 hours.

16. Base strength value on the average of at least two 6-inch by 12-inch (150 mm by 300 mm) cylinders tested at the respective time periods.

17. Test report shall include all the information in Item 10 above and compressive strength data, and shall be signed by the laboratory manager.

18. Strength of concrete shall be deemed satisfactory if both of the following requirements are met (ACI 318 [ACI 318M]):

    a. Every arithmetic average of any two consecutive compressive strength test equals or exceeds the specified compressive strength, and

    b. No compressive strength test falls below the specified compressive strength by more than 500 psi (3.5 MPa).

       If any strength test of laboratory-cured cylinders falls below the specified compressive strength by more than the values specified above, remedial measures shall be taken as recommended by the Authority Representative.

G. Damaged or Defective Retrofits

1. Each retrofit cast will be jointly inspected by the Authority Representative and Contractor after casting and form removal. Identify and categorize all defects during these inspections. Examine the defects and furnish to the Authority Representative a solution in writing that proposes:

   a. Measures that the Contractor will take to prevent recurring defects in future retrofits.

   b. The repair method for all defects discovered as a result of the inspection as required herein. If recurring defects continue, following implementation of the Contractor's preventive measures, or as detected at any time during the construction, the Contractor will cease operations producing such defective retrofits. The Contractor will then examine the defects and propose to the Authority Representative, in writing:

      (1) The measures the Contractor will take to prevent recurring defects in future retrofits.

      (2) The method of repair of all defects discovered as a result of the inspection as required herein. The Authority Representative will determine what constitutes damage or defect, whether the damage or defect is isolated or recurring, and will categorize the damage or defects. Two categories of defects are recognized by the Authority Representative for this purpose:

         i. Cosmetic: Cosmetic defects or damages are those which do not affect the ability of the retrofit to resist construction or service loads or reduce its life expectancy. This category of defect includes a superficial discontinuity such as non-structural cracks, generally less than or equal to 0.012-inches wide, small spalls or honeycombed areas, or any defect that does not extend beyond the centerline of any reinforcing steel, or to any elements of the post-tensioning system.

            Cosmetic defects of other types and causes may also be designated by the Authority Representative.

            Repair of cosmetic defects are to be made in such a manner that the aesthetics and the structural integrity of the retrofits are restored.

         ii. Structural: This category of defect includes any defect that will impair the ability of the retrofit to adequately resist construction or service loads or reduce its life expectancy. Any defect or damage that extends beyond the centerline of any reinforcing steel or into any element of the post-tensioning of the retrofit is considered a structural defect. Examples of such defects include cracks wider than 0.012-inches, large spalls and honeycombed areas, and major segregation or breakage of concrete. Structural defects of other types and causes may be designated by the Authority Representative.

            Repair of structural defects must be such that the aesthetics and structural integrity of the retrofit be completely restored to an expected condition had the defect or damage not occurred.

H. Repairs

1. Cosmetic repairs are only to be made as per this specification. If the Contractor elects to propose an alternate method, the written proposal is to identify those areas required to be repaired prior to post-tensioning, and those that may be repaired after post-tensioning.

   Structural repairs are to be made by the following procedures prepared by the Contractor. The repair procedure must be signed and sealed by a Registered Professional Engineer representing the Contractor, be submitted in writing to the Authority Representative, and include the following minimum information:

   a. A detailed description and sketch of the defect.

   b. The magnitude and type of the most critical construction and service loading condition to which the defective area will be subjected.

   c. Detailed reinforcement requirements, material types, surface treatments, curing methods, and general repair procedures proposed.

   d. The specific nondestructive testing method and procedure by which the Contractor is to demonstrate to the Authority Representative that the defect no longer exists and the retrofit has been restored to a condition to be expected had the defect or damage not occurred.

2. Repair Procedures

   a. Deep Voids: Voids extending beyond the centerline of a reinforcing bar, into a post-tensioning element, and/or with a depth greater than 2" and with a surface area greater than 6 square inches will be considered “Structural Repairs” requiring repair in accordance with the following:

      (1) Saw cut the perimeter of the affected area to a depth of at least ½". Chip away all partially consolidated material until sound concrete is encountered. If reinforcing steel passes through the void, expose the full diameter plus ½". Clean the exposed portions of reinforcing steel of any misplaced concrete. Remove any remaining dirt, oil, paint, or other deleterious substances by 3,000 psi water blasting. Remove all other debris with compressed air. Prior to patching concrete, prepare parent concrete to a saturated surface dry condition without any standing water or per the recommendations of the patch material manufacturer. Attach wood or steel forms as necessary to contain the patching concrete.

      (2) Coat all surfaces of the void with an Engineer approved bonding agent (or other suitable material as approved by the Engineer). Fill the void with concrete of the same mix design and strength as the retrofit; cover and allow to cure properly using the curing procedures discussed in these specifications. To ensure proper bond, place concrete within the time limit specified by the bonding agent manufacturer.

      (3) Finish the patched area to match the surrounding concrete. Use similar constituent materials, such that color differences between the repaired area and existing concrete are minimized.

(4) Commercially available concrete patching systems may be used if submitted to, and approved by, the Engineer.

b. Shallow Voids (less than the specified cover). Voids shallower than cover depth and smaller than 6 square inches in surface area will be considered “Cosmetic Repairs” requiring repair in accordance with the following:

(1) Saw cut the perimeter of the void to a depth of ½". Chip away all partially consolidated material until sound concrete is encountered. Remove any dirt, oil, paint, or other deleterious substances by 3,000 psi water blasting. Remove all other debris with compressed air.

(2) Prior to patching concrete, prepare parent concrete to a saturated surface dry condition without any standing water or per the recommendations of the patch material manufacturer.

(3) Fill the void per the recommendations of the manufacturer, using an approved non-sag mortar or other suitable material approved by the Engineer.

(4) Finish the patched area to match the existing concrete. Minimize color differences between the repaired area and existing concrete.

c. Cracks - Cracks are classified as Structural or Non-Structural. Structural cracks are those induced by external forces that produce internal stresses exceeding the tensile strength of the concrete. Nonstructural cracks are those that appear as a result of component material characteristics, environmental effects, and local constraints or shrinkage. Notify the Engineer of any cracks. The Engineer will determine the crack classification. Do not seal or repair structural cracks without approval from the Engineer.

(1) Treat non-structural cracks as follows:

i. Seal cracks 0.007 to 0.012 inches wide with an epoxy sealer. Seal cracks from 0.012 inches to 0.024 inches wide by injecting with epoxy according to the procedure outlined below. Cracks wider than 0.024 inches will require further investigation.

(a) Procedure for Epoxy Injection:

(i) Drill holes and install plastic injection ports at approximately 8 inches on center.

(ii) Seal crack between ports with an epoxy (or other similar material) approved by the Engineer.

(iii) Inject crack with epoxy (or other similar material) approved by the Engineer using a hand pump. Begin injection from the lowest port and continue until epoxy runs out of the next highest port. Move to the next port and repeat the process until the entire crack is filled.

d. Entrapped Air Pockets (Bug Holes). Entrapped air pockets are considered “Cosmetic”. Fill entrapped air pockets in the exterior surface of the concrete and sack the surface with burlap. Use a non-shrink, non-sag mortar approved by the

Engineer, and follow the recommendations of the manufacturer. Cure properly using curing procedures discussed in this specification.

e. This work may not be the basis for any request for extension of time or additional compensation.

3.08 CONSOLIDATION

A. Consolidation is typically not necessary for SCC. However, the contractor shall have internal vibrators as recommended in ACI 301 (ACI 301M) on site in case internal vibration is needed due to delays in placement or the concrete has a lower than expected slump flow and has to be placed to prevent the formation of a cold joint.

B. Prior approval by the Authority Representative shall be obtained if minimal vibration (external or internal) is required for proper consolidation due to congested reinforcement or space restrictions.

3.09 FINISHING

A. Top Surface: Concrete finishing shall be smooth in all areas except under grout pads. Provide roughened finish to CSP of 5 to 9 in accordance with ICRI 310.2 under grout pads.

B. All other surfaces: After the forms are removed, correct irregularities in the exposed concrete surfaces. Exposed surfaces are surfaces above normal ground level or water level, when applicable, and surfaces that will not be concealed by other construction. Irregularities include fins, protrusions, individual holes larger than 25 mm (1 inch) in any dimension, and clusters of smaller holes.

3.10 CURING AND PROTECTION

A. Curing and protection of concrete shall be in accordance with ACI 308.1 and as noted.

B. Curing and Protection of Concrete. Begin curing as soon as the concrete has been placed and is sufficiently hardened.

Do not count as a curing day, a day on which the curing temperature drops below 50°F at any time during that day. If at any time during the curing period, the curing temperature falls below 35°F, the Authority will consider the work unsatisfactory and will reject it.

1. Definitions of Temperatures.

a. Air Temperature: The measured temperature in the degrees Fahrenheit (F) in the shade, not in the direct rays of the sun, and away from artificial heat.

b. Curing Temperature: Curing temperature is the temperature of the air immediately adjacent to concrete. Where concrete is not covered by forms or other protective coverings, or where protective coverings are considered inadequate, the curing temperature will be the air temperature. During cool and cold weather, the curing temperature is the temperature inside the forms, protective coverings, or housings.

The curing temperature for the first 24-hour period after placing concrete will be considered as not more than the temperature of the concrete at the time of its placement in the forms.

2. Records of Temperature: Provide high-low thermometers to maintain an accurate daily record of air and curing temperatures during cool and cold weather. In the presence of

an Authority Representative, take curing temperatures on the surface of the concrete, at representative locations on a structure. Submit these temperature records daily to the Authority Representative.

3. Normal Curing and Protection

   a. Water Curing. Use a fog-spray, perforated pipe or hose watering system to keep forms and curing covers saturated during the curing period. Use covers of either burlap-backed, white polyethylene sheeting, or a double thickness of burlap. Place covers without marring the finished surface. Secure covers to prevent their being lifted and displaced. Saturate the covers prior to use and keep in a saturated condition for the curing period. Cure for a minimum of 3 days.

      Cure for at least the minimum time stated above and until minimum compressive strengths are attained as determined from molded cylinder specimens testing.

      As soon as the concrete has hardened sufficiently, place curing covers on the exposed concrete. If the double thickness of burlap method is used, place burlap so each strip overlaps one-half its width.

      As soon as forms or sections of forms are loosened or removed, cover the exposed concrete surfaces with pre-saturated curing covers, then keep saturated for the remainder of the curing period.

4. Cool Weather Curing and Protection

   a. If the forecasted air temperature during concrete curing is expected to drop to 50°F but not below 35°F, or if concrete is placed at an air temperature below 50°F but above 35°F, follow the requirements for normal curing and protection. In addition, cover burlap with polyethylene sheeting; and place insulating mats, or place hay or straw, to a depth of at least 12 inches, over concrete not covered by forms. Keep the insulation mats, hay, or straw in place as required to maintain proper curing temperatures.

5. Cold Weather Curing and Protection

   a. If the forecasted air temperature is expected to drop to 35°F or lower, during concrete curing, or if concrete is to be placed at air temperatures below 35°F, comply with the requirements specified for normal curing and protection, and use heating and/or insulation, as necessary, to maintain the curing temperature for the duration of the curing period.

      If forms are removed before the end of the curing period, provide additional heating or insulation, as necessary, to maintain the curing temperature for the remainder of the curing period.

      After the concrete has cured for the required length of time, gradually lower its temperature to that of the surrounding air. Do not allow the temperature of the concrete to drop more than 20°F in any 24-hour period for the first 3 days after the curing period. Continue to record the air temperature and curing temperature during this 3-day period.

      (1) Heating. Furnish and place sufficient canvas and frames, or another type of housing to enclose and protect the fresh concrete and forms. Before placing

the concrete, furnish necessary fuel and sufficient acceptable heating apparatus; preferably steam-heating equipment.

Keep the air surrounding the fresh concrete at a temperature above 50°F but not more than 80°F. Keep the concrete covers moist during the curing period.

(2) Insulating Mats or Foam Insulation may be used to maintain curing temperature. Apply the mat insulation tightly against the forms. Seal the ends of the mat to exclude air and moisture. Overlap the insulation on previously placed concrete by 1 foot.

When using steel forms, place the insulation tightly against the forms. In addition, insulate the framework of the steel forms, either by the use of the insulating mat material or foam insulation, or by draping polyethylene sheets or tarpaulins over the exposed members, to effectively reduce the heat loss.

Immediately repair tears in the mat liner. Where tie rods extend through the insulated form, place close-fitting washers on the rod against the mat and secure, to provide adequate protection.

Cover the tops of curing concrete with the insulation mat, tightly secured to prevent loss of heat.

For the areas around protruding reinforcement that cannot be protected with the insulation mat, cover with a double thickness of burlap. Cover with enough straw or hay to prevent loss of heat from the concrete during the curing period. In addition, cover insulated areas with tarpaulins.

When foam insulation is used, use a minimum thickness of 1 1/2 inches. The Contractor may use cracked molded foam boards only after repairs are made with an adhesive.

Keep the insulation protection in place for the full curing period, but do not allow the concrete temperature to rise above 160°F.

Do not expose fresh concrete to subfreezing temperatures. Provide standby heat, if directed. Failure to properly place the insulation material or failure to maintain the necessary concrete temperature will be cause for the Representative to deny continued use of the material on the project, for curing in cold weather, and require the use of heating.

3.11 APPLICATION OF EXTERNAL LOADS TO CONCRETE

A. Application of post-tensioning loads shall not occur until after the concrete curing period has been completed and the concrete has reached the compressive strength as indicated in the Contract Drawings.

3.12 SEALING

A. Apply epoxy resin protective coating for concrete surfaces to all exposed concrete surfaces of the retrofits as follows:

1. Do not apply epoxy to any given retrofit until 28 days after the final placement of concrete or grout at that retrofit or before any portion of the retrofit has achieve its 28

day strength. Do not use membrane-forming curing compounds where epoxy treatment is to be applied.

2. Protect surrounding areas, landscaping features, plantings and surfaces not to be sealed from possible spatters, spills, and drips during application of the sealer. In the event that sealer spatters, spills, or drips onto a surface not to be sealed, clean the sealer from the surface immediately in accordance with the manufacturer's instructions.

3. Restrict public access to areas below surfaces being sealed and an appropriate safety margin during the sealer application.

4. Measure and mix, as recommended by the manufacturer of the epoxy, in a clean mixing container. Thoroughly mix the epoxy using a 400 rpm to 600 rpm (low speed, ± 2-inch) electric drill, and paddle-type mixer. After mixing, let the material stand for an induction period of one hour before application.

5. Apply the mix by brush or roller. If applied by roller, use a first-quality, long-nap roller for rough surfaces and a short-nap roller for smooth surfaces. Spray application is not permitted.

   Apply two thin, uniform coats of the mixed material, each approximately 2 mils to 3 mils dry film thickness (4 mils to 5 mils wet thickness). Apply the second coat 24 hours after the application of the first coat. Use a rate of coverage as recommended by the manufacturer of the epoxy resin sealer. Apply at temperatures between 60°F and 90°F.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 03315

COATING CONCRETE SURFACES

PART 1 – GENERAL

1.01 DESCRIPTION:

A. This section specifies furnishing and applying epoxy protective coatings to concrete surfaces.

1.02 QUALITY ASSURANCE:

A. FS: TT-C_535, TT-P-115

B. ASTM: D1005, D4400

1.03 SUBMITTAL:

A. Laboratory analysis showing that the material meets the requirement listed below.

PART 2 – PRODUCTS:

2.01 MATERIALS:

A. Epoxy: The protective coatings shall be two component epoxy systems for use on concrete. One component shall be a clear or pigmented condensation product of the reaction of epichlorohydrin with bisphenol A, the resin of which shall be composed of 100 percent reactive constituents. The other component shall be a clear polyamide hardener.
   1. Pot Life: 8 hours minimum when tested FS TT-C-535.
   2. Dry Film Thickness: Tested ASTM D1005
      a. First coat shall be a minimum of 2 mils.
      b. Second coat shall be a minimum of 3 mils.
   3. Sagging: Pass test ASTM D4400 for recommended film thickness.
   4. Flexibility: Shall not crack, check or delaminate when tested FS TT-P-115.

PART 3 – EXECUTION

3.01 PREPARATION:

A. Abrade all surfaces to be coated by abrasive blasting, water blasting, or other mechanical means to provide a surface profile for improved adhesion.

B. Ensure that the surface is sound, clean, thoroughly dry, and free of oil, grease, curing compound, and other foreign matter before applying the first epoxy protective coating.

3.02 MIXING AND APPLICATION:

A. Mix and apply according to the manufacturer's recommendations. Apply by brush or roller.

B. Apply two coats to the abutment stem from the ground line to the bearing seat.
   1. Each application shall follow a dry weather period of at least two consecutive days and be within the time frame recommended by the manufacturer.
   2. Mask adjacent areas not to be coated or otherwise protect to prevent staining.

3.03 REPAIRS:

A. Repair all damage to the structure resulting from the coating operations, including damage to the epoxy protective coating. Perform epoxy protective coating repairs according to the manufacturer's recommendations.

END OF SECTION

SECTION 03371

MAINTENANCE OF CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section includes requirement for power washing to clean the concrete tunnel lining at the limits shown including the invert. The cleaning will remove oil, solvent, grease, dirt, dust, bitumen, rust, loose particles and foreign matter, including efflorescence from all concrete surfaces and cables that exhibit heavy build ups of efflorescence..

1. Clean concrete surfaces in tunnels and crossover vaults including end walls by means of pressure washing, chipping and grinding.
2. Contain, collect and dispose of solid materials dislodged or generated during the cleaning and repair activities.
3. Notification and monitoring requirements associated with National Pollutant Discharge Elimination System (NPDES) permit MD0069035.

B. Definitions:

1. The cleaning will be done in accordance with SSPC-SP 12, Surface Preparation and Cleaning of Steel and other Hard Materials by High- and Ultrahigh- Pressure Water Jetting Prior to Recoating. The recoating portion does not apply. The surfaces should be cleaned to WJ-4 (see SSPC manual) which removes all loose rust, mill scale and coatings. No existing coatings are present, therefore, the portion regarding existing coatings does not apply.

1.02 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards and Specifications:

1. Codes and regulations of the jurisdictional authorities.
2. SSPC: Unless otherwise specified, SSPC requirements govern the performance of the work of this section.

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.

1.03 SUBMITTALS

A. Submit safe work plan and procedures for approval of the AR.

1.04 JOB CONDITIONS

A. Solid Materials Runoff Control: The Contractor shall implement solid materials runoff control procedures at all times during cleaning and repair activities. All solid materials generated shall be contained using filter fabric placed over storm water drainage grates in the area of operation or using filter and/or absorbent booms to prevent these

materials from entering the tunnel water drainage system. The filter fabric shall be positioned above and anchored to the storm water drainage grates such that solid materials can be captured and retained, and not flow into the storm water drain pipe below.

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

C. If heavy buildups of efflorescence cannot be removed with power washing, then hand tools and/or power tools should be used on concrete surfaces. Only non-metallic hand tools may be used on electrical cables to prevent damage to the cable insulation.

D. Remove debris resulting from cleaning work to locations outside Authority's right-of-way.

E. Dispose of debris and solid materials generated during cleaning/repairs off site only with permission of property owner where such debris is to be deposited in accordance with codes and regulations of the jurisdictional authorities. Based on laboratory analysis of bulk and airborn dust samples collected at various locations throughout the WMATA tunnel system in 2009, none of the samples contained asbestos, metals, or other contaminants of concern exceeding their associated U.S. Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). However, the Contractor shall perform toxicity characteristics leaching procedure (TCLP) laboratory analysis of representative solid materials generated to confirm these materials are not a characteristic hazardous waste prior to off-site disposal.

F. Do not burn debris at demolition site.

1.05 PRESSURE WASHING EQUIPMENT

A. The equipment used to clean the concrete surfaces shall be a High Pressure water jet system manufactured by Jet Stream, Flow International, Butterworth or equal having capabilities specified. It shall:

1. Be capable of delivering water pressures from 3500 psi to 20,000 psi. Contractor shall limit applied pressure to avoid damaging sound concrete and other systems in the tunnel to remain in operation.

2. Provide for the collection and filtration of the cleaning debris. No cleaning debris shall be allowed to enter the track drainage system, public storm drains or streams. All particulates shall be disposed of at a site and in a manner approved by the jurisdictional authorities.

PART 2 - PRODUCTS

2.01 MATERIALS

A. 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. Filter fabric to cover storm water grates shall have a 70 size capable of retaining 90% of the solids.

PART 3 - EXECUTION

3.01 CLEAN CONCRETE WALLS

A. The surface of the concrete walls shall be cleaned to remove calcite deposits, epoxy from previous repair efforts, rust and water stains prior to repair. Surface preparation may be accomplished by pressure washing, mechanical means or cleaning agent approved by the Authority Representative.

B. WMATA shall be notified by the Contractor at least 7 days prior to tunnel cleaning activities, so WMATA can then notify the Maryland Department of the Environment (MDE) Compliance Program as required in NPEDS Permit MD0069035. Prior to cleaning, filter fabric shall be placed over drainage grates in the area of cleaning to prevent solid materials or sediment from entering the tunnel water drainage system. Filter booms shall be placed parallel to the open drainage trench areas. The filter fabric shall be positioned above and anchored to each drainage grate such that solid materials can be contained, collected and removed for subsequent off-site disposal. Background water samples inside of the storm water pipe or trench shall be collected below representative drainage grates prior to cleaning activities each day and tested on-site for total suspended solids (TSS), pH and temperature. During tunnel washing activities, additional representative performance water samples shall be collected in the drainage grates (after passing through the filter fabric) and tested for TSS. pH and temperature for comparison. Performance samples shall be collected after the first 30 minutes of cleaning and at subsequent 4 hour intervals. The representative performance samples shall not exceed the NPDES permit daily maximum concentrations of 45 mg/L for TSS and 8.5 for pH. NPDES permit required effluent discharge monitoring at designated outfalls 001 through 008 shall be performed by the Contractor and submitted within five business days to WMATA' AR.

C. The pressure and distance must be varied based on the buildup of deleterious materials to be removed. A flat nozzle at the higher pressures should be employed to ensure that concrete surfaces and the cast iron liner joint caulking and sealing materials are not damaged

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 03372

MANHOLE CLEANING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies the cleaning of the existing manholes within the track bed.
B. Related Work Specified Elsewhere:
1. Maintenance of Concrete: Section 03371.

1.02 SCOPE OF WORK

A. The contractor shall provide all labor, materials, equipment, and incidentals necessary to perform the cleaning of manholes as specified in this specification.
B. The intent of manhole cleaning is to remove all sludge, dirt, sand, rocks, grease, and other solids.

PART 2 – MATERIAL – NOT USED

PART 3 - EXECUTION

3.01 ACCEPTABLE METHODS:

A. Manhole cleaning shall be performed with hydraulically propelled, high velocity jet or mechanically powered equipment. Acceptable methods of cleaning are as follows:
1. Normal line cleaning shall be performed by high velocity water jetting or movable dam used to loosen and transmit material for extraction.
2. Heavy line cleaning shall be performed by mechanical equipment when water jetting is unsuccessful.
B. Selection of equipment for each type of operation shall be made by the Contractor with the concurrence of the Engineer and shall be based on the type of work to be performed, field conditions, type of debris removed, depth of flow, and pipe material.
C. All drains shall be cleared and proofed prior to power washing.

3.02 HEAVY SEWER MANHOLE CLEANING:

A. Cleaning equipment that uses a high velocity water jet for moving debris shall be capable of producing a minimum volume of 50 GPM with a pressure of 3500 PSI. Any variations to this pumping rate must be approved, in advance, by the Engineer. A working pressure gauge shall be used on the discharge of all high pressure water pumps. The Contractor shall operate the equipment so that the pressurized nozzle continues to move at all times. The pressurized nozzle shall be turned off or reduced any time the hose is held or delayed in order to prevent damage to the manhole.

3.03 MATERIAL REMOVAL:
A. All sludge, dirt, sand, rocks, grease, and other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole or wet well of the section being cleaned. Passing material from one manhole section to another manhole section shall not be permitted except when using high velocity jet equipment. The maximum limit before material is removed shall be approximately 600 feet.

3.04 DISPOSAL OF MATERIAL:

A. All debris, solids, or semi-solids resulting from the cleaning operations shall be removed from the site and disposed of at a legally permitted site for that purpose. At a minimum all materials shall be removed from the site at the end of each work period. Under no circumstances will the Contractor be allowed to accumulate debris, etc., on the site of work beyond the stated time, except in totally enclosed containers and as approved by the Engineer.
B. Contractor shall be responsible for all fees and tipping charges for disposal.
C. The Contractor must follow all current applicable local, state, and federal rules and laws regarding the appropriate disposal of waste materials from cleaning operations.
D. Under no circumstances shall sewage or solids removed in the cleaning process be dumped into streets, ditches, catch basins, storm drains, sewer manholes, wet wells, cleanouts, or dumps.

3.05 INSPECTION:

A. Inspection of all cleaning operations will be made on a daily basis by the Engineer.

3.06 ACCEPTANCE:

A. Inspection shall be performed to ensure the satisfaction of the Engineer that proper cleaning of the manhole has been performed. If inspection shows the cleaning to be unsatisfactory to the Engineer, the Contractor shall be required to re-clean and re-inspect the manhole until the cleaning is acceptable at no additional cost to the owner.

END OF SECTION

SECTION 03380

POST-TENSIONED CONCRETE

PART 1 – GENERAL

1.01 DESCRIPTION:

A. This section specifies furnishing, installing, stressing, and grouting of post-tensioning systems in accordance with the details shown on the Contract Drawings and the requirements of this specification. It also includes the furnishing and installing of any appurtenant items necessary for the particular post-tensioning system used, including but not limited to anchorage assemblies, additional reinforcing bars required to resist stresses caused by anchorage assemblies, ducts, vents, inlets, outlets, grout, and anchorage protection per the Contract Drawings used for the pressure grouting of ducts.

Except as modified herein, all construction and materials are to conform to the specifications and other Special Provisions for the project, hereinafter referred to as the "Project Specifications."

The post-tensioning system has not been fully detailed in the plans since specific details such as anchorage assemblies, local zone reinforcing, ducts, etc. are dependent on the manufacturer's proprietary system as selected by the contractor. Therefore, the contractor is to submit detailed shop drawings of the selected system per the requirements of these special provisions and the Project Specifications.

B. Related Work Specified Elsewhere:

1. Self-Consolidating Concrete: Section 03312.
2. Concrete Reinforcement: Section 03210.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. AASHTO Standard Specifications for Highway Bridges, 17th Edition - 2002
2. WMATA Manual of Design Criteria for Maintaining and Continued Operation of Facilities and Systems, May 2008
3. Guide Specifications for Grouting of Post-Tensioned Structures, PTI Committee on Grouting Specifications
4. Acceptance Standards for Post-Tensioning Systems, PTI
5. Post-Tensioning Tendon Installation and Grouting Manual, FHWA

1.03 Definitions and Terminology

A. Anchor plate: The part of the anchorage hardware that bears directly on the concrete and through which the tendon force is transmitted.

B. Anchorage: An assembly of various hardware components that secure a tendon at its ends after it has been stressed and imparts the tendon force into the concrete.

C. Anticipated Set: Anticipated set is that set which was assumed to occur in the design calculation of the post-tensioning forces immediately after load transfer.

D. Bar: Post-tensioning bars are high strength steel bars, normally available from 5/8" to 1-3/4" diameter and usually threaded with very coarse thread.

E. Bleed: The autogenous flow of mixing water within or its emergence from, newly placed grout; caused by filtering effects and settlement of the solid materials within the mass.

F. Coupler: The means by which the post-tensioning force may be transmitted from one partial-length post-tensioning tendon to another.

G. Duct: Material forming a conduit to accommodate post-tensioned tendon installation.

H. Enhanced Grout: Grout will contain both mineral admixtures for partial cement replacement and chemical admixtures to provide improved corrosion protection and highly resistance to bleed.

I. Final Set of Grout: A degree of stiffening of the grout mixture greater than the initial set, indicating the time in hours and minutes required for the grout to stiffen sufficiently to resist to an established degree, the penetration of a weighted needle test.

J. Fluidity: A measure of time, expressed in seconds, necessary for a stated quantity of grout to pass through the orifice of the flow cone.

K. Grout: A mixture of cementitious materials and water, with or without mineral additives or admixtures, proportioned to produce a pumpable consistency without segregation of the constituents; injected into the duct to fill the space throughout the post-tensioning steel, anchorages and ducts.

L. Initial Set of Grout: A degree of stiffening of the grout mixture less than the final set, indicating the time in hours and minutes required for the grout to stiffen sufficiently to resist to an established degree, the penetration of a weighted needle test.

M. Inlet (also inlet pipe or grout injection port): Small diameter tubing or duct used for injection of grout into a duct.

N. Outlet (also ejection pipe or grout outlet vent or vent): A small diameter tubing or duct used to allow the escape of air, water, grout and bleed water.

O. Post-Tensioning: The application of a compressive force to the concrete by stressing tendons or bars after the concrete has been cast and cured. The force in the stressed tendons or bars is transferred to the concrete by means of anchorages.

P. Post-Tensioning Scheme or Layout: The pattern, size and locations of post-tensioning tendons provided by the Designer on the Contract Plans.

Q. Post-Tensioning System: A proprietary system where the necessary hardware (anchorages, wedges, strands, bars, couplers, etc.) is supplied by a particular manufacturer or manufacturers of post-tensioning components.

R. Set (Also Anchor Set or Wedge Set): Set is the total movement of a point on the strand just behind the anchoring wedges during load transfer from the jack to the permanent anchorages. Set movement is the sum of slippage of the wedges with respect to the

anchorage head and the elastic deformation of the anchor components. For bars, set is the total movement of a point on the bar just behind the anchor nut at transfer and is the sum of slippage of the bar and the elastic deformation of the anchorage components.

S. Strand: An assembly of several high strength steel wires wound together. Strands usually have six outer wires wound in long-pitch helix around a single straight wire of a similar diameter.

T. Tendon: A single or group of post-tensioning elements and their anchorage assemblies, which impart post-tension to a structural member or the ground. Also included are ducts, grouting attachments and grout. The main post-tensioning element is usually a high strength steel member made up of a number of strands, wires or bars.

U. Thixotropic: The property of a material that enables it to stiffen in a short time while at rest, but to acquire a lower viscosity when mechanically agitated, the process being reversible. Grouts having thixotropic properties can be highly resistant to bleed. Admixtures that may produce thixotropic properties include anti-bleed admixtures, fly ash and silica fume.

V. Wedge: A small conically shaped steel component placed around a strand to grip and secure it by wedge action in a tapered hole through a wedge plate.

W. Wedge Plate: A circular steel component of the anchorage containing a number of tapered holes through which the strands pass and are secured by conical wedges.

X. Wire: A single, small diameter, high strength steel member and, normally, the basic component of strand, although some proprietary post-tensioning systems are made up of individual or groups of single wires.

1.04 SUBMITTALS

A. The Contractor is to submit detailed shop drawings that include, but are not limited to:

1. A complete description of, and details covering, each of the post-tensioning systems to be used for permanent and temporary tendons. This includes:

a. Designation of the specific post-tensioning steel, anchorage devices, bar couplers, duct material and accessory items.

b. Properties of each of the components of the post-tensioning system.

c. Details covering assembly of each type of post-tensioning tendon.

d. Equipment to be used in the post-tensioning sequence.

e. Location of tendon stressing equipment.

f. Procedure and sequence of operations for securing and post-tensioning tendons.

g. Procedure for releasing the post-tensioning steel elements.

h. Parameters to be used to calculate the typical tendon force such as: expected friction coefficients, anchor set, and post-tensioning steel relaxation curves.

2. A table detailing the post-tensioning jacking sequence, jacking forces, and elongations of each tendon at each stage of erection for all post-tensioning.

3. Complete details of the post-tensioning anchorage system including certified copies of reports covering tests performed on post-tension anchorage devices as required in Section 2.01, Materials, and details for reinforcing steel needed to resist stresses imposed in the concrete by the anchorage system.

4. For post-tensioning tendon grouting operations: proposed pre-packaged grout, grout manufacturer's data sheets and instructions, grouting equipment details, mixing and placing methods, the locations and details of all inlets and outlets for grouting, and the direction of grouting proposed.

5. Data and calculations to substantiate the post-tensioning system and procedures to be used including stress-strain curves typical of the post-tensioning steel to be furnished, required jacking forces, elongation of tendons during tensioning, seating losses, short-term post-tension losses, long term post-tension losses, temporary overstress, stresses in post-tension anchorages including distribution plates, and reinforcing steel needed in the concrete to resist stresses imposed by post-tension anchorages. Data and calculations are to show a typical tendon force after applying the expected friction coefficient, anticipated thermal affects, and anticipated losses for the stressing system to be used, including anchor set losses.

   Elongation calculations are to be revised when necessary to properly reflect the modulus of elasticity of the wire or strand as determined from in-place friction testing in accordance with the Section 2.01, Materials.

6. Complete details of the apparatus and methods to be used by the contractor for the tests required by Section 2.01, Materials.

7. Details of ducts including length, placement of carrier reinforcement for aligning ducts within the forms and alignment mark.

1.05 FIELD DEMONSTRATION

A. Grouting Operation Plan:

1. Hold a joint meeting with the Contractor, Grouting Crew, Authority's Representative to discuss and understand the Grouting Operation Plan, required testing and corrective procedures before grouting operations commence.

2. After the Contractor's Grouting Plan is given preliminary acceptance by the Representative and two weeks before grouting commences, perform a Mockup Test at the project site. The purpose of this test is to verify that the materials, equipment, methods, and procedures proposed will result in grout meeting the requirements of this special provision and properly grouted tendons. The test will also serve as training for the grouting personnel on site.

B. Mockup Test:

1. The Mock-Up Test will consist of grouting a tendon in a clear duct with a horizontal duct profile, and performing field trial tests on the grout as specified in Section 2.01. The Contractor must use the same equipment, materials (except the use of a clear duct is required), methods, connections, and procedures that are in the accepted Grouting Operation Plan.

2. The Test Specimen shall be between 20' in length. The tendon will be transversely sectioned into four specimens of equal length.

3. The duct material is to be transparent and 5" max diameter. Inside the duct, there is to be a tendon consistent with that described for a Type 1 Retrofit in the Contract Drawings. It is not necessary that the post-tensioning strand be stressed. Place a minimum of two (2) grout inlets/outlets, one at each end.

C. Grouting Plan Approval:

Voids in excess of 2% of the cross sectional area of the grouted duct constitutes a failure. The mockup procedure shall be repeated with modification to the grouting plan and/or grout mix design until satisfactory results are achieved.

1.06 DELIVERY, STORAGE AND HANDLING

A. Post-Tensioning Steel

1. Protect all post-tensioning steel against physical damage at all times from manufacture to grouting or encasing in concrete. Post-tensioning steel that has sustained physical damage at any time will be rejected. Any reel that is found to contain broken wires will be rejected and the reel replaced.

Post-tensioning steel is to be packaged in containers or shipping forms for protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor, which prevents corrosion or rust, is to be placed in the package or form, or be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the engineer, a corrosion inhibitor may be applied directly to the steel. The corrosion inhibitor may have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Inhibitor carrier type packaging material will conform to the provisions of Federal Specifications MIL-P-3420. Packaging or forms damaged from any cause is to be immediately replaced or restored to original condition.

2. The post-tensioning steel is to be stored in a manner which will at all times prevent the packing material from becoming saturated with water and allow a free flow of air around the packages. If the useful life of the corrosion inhibitor in the package expires, immediately rejuvenate or replace it.

3. At the time the post-tensioning steel is installed in the work, it must be free of loose rust, loose mill scale, dirt, paint, oil, grease or other deleterious material. Removal of tightly adhering rust or mill scale will not be required. Post-tensioning steel that has experienced rusting to the extent it exhibits pits visible to the naked eye may not be used in the work.

4. The shipping package or form is to be clearly marked with the heat number and with a statement that the package contains high-strength post-tensioning steel, and care is to be used in handling. The type and amount of corrosion inhibitor used, the date when placed, safety orders and instructions for use are also to be marked on the package or form.

B. Grout

1. Delivery Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
2. Storage and Handling Requirements:
    a. Store and handle materials in accordance with manufacturer's instructions.
    b. Keep materials in manufacturer's original, unopened containers and packaging until application.
    c. Store materials in clean, dry area indoors.
    d. Do not store materials directly on floor.
    e. Protect materials during storage, handling, and application to prevent contamination or damage.
    f. All manufacturer's recommendations are to be strictly followed and no grout is to be stored on site for longer than 30-days.

PART 2 - PRODUCTS

2.01 MATERIALS

The materials to be incorporated into work covered by this section must conform to the requirements herein. References to ASTM and AASHTO specifications indicate the latest revisions of the document referenced.

A. Strands:
    1. All post-tensioning strands are to be uncoated, Grade 270, low-relaxation, 7-wire strand conforming to requirements of AASHTO M 203 (ASTM A-416).
    2. No coupling or splicing of strands is permitted.

B. Threaded-Bar:
    1. All post-tensioning bars are to be uncoated, Grade 150, high strength deformed thread bars conforming to the requirements of AASHTO M 275, Type II (ASTM A-722, Type II).
    2. No coupling or splicing of thread-bar is permitted.

C. Wires:

Post-tensioning wire is to be uncoated, low-relaxation wire conforming to the requirements of AASHTO M 204 (ASTM A-421).

D. Post-tension Anchorages
    1. Secure all post-tensioning steel at the ends by means of permanent type metallic anchoring devices. Anchors manufactured from composite materials will not be allowed. Post-tension anchorages must develop at least 95 percent of the minimum specified ultimate tensile strength of the post-tensioning steel. Wedges are to be three-part (two part wedges are not to be used).

2. For tendon anchorages, the design and furnishing of any reinforcement (in addition to the reinforcement shown on the Contract Plans) which is needed to resist bursting and splitting stresses imposed on the concrete by the proposed anchorage system will be the responsibility of the post tensioning supplier and the Contractor, at no expense to the Authority.

3. Post-tension anchorage devices are to effectively distribute post-tensioning loads to the concrete and must conform to the requirements of AASHTO Standard Specifications for Highway Bridges, 17th Edition – 2002.

4. Bending stresses in the plates or assemblies induced by the pull of the post-tensioning steel may not exceed the yield point of the material in the anchorage plate when 95 percent of the ultimate strength of the tendon is applied. Nor may it cause visual distortion of the anchor plate as determined by the Representative.

5. Non-metallic grout caps are to be furnished at the anchor heads. The grout caps are to be grouted with the same grout used for tendon grouting.

6. The Contractor will furnish for testing by the Representative a complete anchorage of each type used, with a post-tensioning tendon having a minimum length of 5 feet, for strength tests only. If strength tests indicate the need for additional verification tests, the Contractor shall furnish additional samples at no cost to the Authority.

E. Ducts

1. All duct material is to be sufficiently rigid to withstand loads imposed during placing of concrete and internal pressure during grouting while maintaining its shape, remaining in proper alignment and remaining watertight.

2. The duct system, including splices and joints are required to effectively prevent entrance of cement paste or water into the system and effectively contain pressurized grout during grouting of the tendon. The duct system must also be capable of withstanding water pressure during flushing of a duct in the event the grouting operation is aborted.

3. The interior diameter of ducts for single strand, bar or wire tendons is to be at least ¼-inch greater than the nominal diameter of the tendon. The interior diameter of ducts for tendons consisting of more than one strand, bar or wire is to be such that the interior area of the empty duct is not less than 2.25 times the net area of the post-tensioning steel.

4. Ducts shall be Corrugated Plastic

   a. Plastic duct will be made of high-density polyethylene (HDPE) or polypropylene (PE). HDPE is to conform to ASTM D3350, cell classification range 424432C to 335534C. PE is to conform to ASTM D4101.

   b. Plastic duct is to be corrugated with a pitch not less than 1/10 of the radius of the duct. Material thickness of 0.08 inches as manufactured, and 0.06 inches after tensioning is required.

   c. Corrugated plastic duct is to be designed so that a force equal to 40 percent of the ultimate tensile strength of the tendon will be transferred through the duct into the surrounding concrete in a length of 2.5 feet. Twelve static pull out tests

will be conducted to determine compliance of a duct with the force transfer requirement. If ten (10) of these tests exceed the specified force transfer, the duct is acceptable. Provide to the Representative, certified test reports verifying that the duct meets specification requirements in regard to force transfer.

To satisfy the intent of these tests, the results for static pullout tests from previous projects utilizing identical duct and post-tensioning steel with similar concrete and grout material may be submitted to the Representative in lieu of executing new pullout tests. However, if the previous results are unacceptable or if there is a significant difference in the materials used, then the Contractor must provide results from new tests for this project.

F. Inlets and Outlets (Ports or Vents) for Grout

1. Inlets (Grout Injection Ports) are to be provided for injecting grout into the duct.
2. Outlets (Grout Exit Vents) are to allow the escape of air, water, grout, and bleed water.
3. The inner diameter of inlets and outlets must be at least ¾ inch for strand tendons, and ½ inch for single bar tendons and 4-strand transverse deck tendons.
4. Inlets and Outlets are to be of flexible HDPE pipe.
5. Plastic Components, if selected and approved, may not react with concrete or enhance corrosion of the post-tensioning steel, and be free of water-soluble chlorides
6. Inlets and outlets are to be located and attached as specified herein, and in accordance with details provided in the Contract Plans.

G. Position and Straightness

Install ducts as per the Contract Drawings with position and straightness tolerance of ¼".

H Sampling and Testing of Post-tensioning Elements

1. Samples must be furnished at least 30 days in advance of the time they are to be incorporated into the work.
2. The Representative reserves the right to reject for use any material or device which is obviously defective or was damaged subsequent to testing.
3. All testing is to be performed by the Representative in accordance with applicable ASTM Standards.
4. The Contractor will furnish at his expense the following samples of materials and devices upon written request from the Representative:
   a. Three (3) samples of seven (7) foot long post-tensioning wire or bar for each size from each heat number or production lot.
   b. Three (3) samples of five (5) foot long post-tensioning strand for each size from each heat number or production lot.
   c. Three (3) samples with two specimens each coupler from the materials to be used on the project.consisting of four (4) foot lengths of the specific post-tensioning bar coupled with a bar.

d. One (1) unit of each post-tension anchorage to be used on the project. If strength tests indicate the need for additional verification tests, furnish additional samples at no cost.

e. For each type of duct material intended for the project, one (1) sample, four (4) feet long, from each production lot or per 10,000 linear feet, whichever is greater.

I. Manufacturer's Lots (Contractor's Quality Control)

1. The manufacturer of post-tensioning steel, post-tension anchorages and bar couplers is to assign an individual number to each Lot of strand, wire, bar or devices at the time of manufacture. Each reel, coil, bundle or package shipped to the project is to be identified by tag or other acceptable means as to Manufacturer's Lot number. Establishing and maintaining a procedure by which all post-tensioning materials and devices can be continuously identified with the manufacturer's Lot number is the Contractor’s responsibility. Items, which at any time cannot be positively identified by Lot number, may not be incorporated into the work.

2. Low-relaxation strand must be clearly identified as required by AASHTO M 203 (ASTM A-416). Any strand not so identified will not be accepted.

3. Furnish manufacturer's certified reports covering the tests required by this special provision. A certified test report stating the guaranteed minimum ultimate tensile, yield strength, elongation, and composition is to be furnished for each lot of post-tensioning steel. When requested, typical stress-strain curves for post-tensioning steel are to be furnished. A certified test report stating strength when tested using the type of post-tensioning steel to be used in the work is to be furnished for each Lot of post-tension anchorage devices.

J. Testing of Post-tensioning Tendons by the Contractor

1. General

Perform certain testing of post-tensioning tendons as specified herein.

2. In-Place Friction Test of Tendons

If the measured elongations in the field for the draped tendons are consistently different from the theoretical elongations by more than 7% (+ or -), then a friction test will be performed as follows:

The test procedure will consist of stressing a tendon at an anchor assembly with the dead end anchor incorporating a calibrated load cell or calibrated stressing jack/ram for the specified tendon size. The results of the tests (loss due to friction and modulus of elasticity) are to be submitted to the Representative. Apparatus and methods used to perform the tests will be proposed by the contractor and be subject to the acceptance by the Representative. Notify the Representative at least two weeks in advance of performing an in-place friction test.

K. Grout Materials and Properties

All grout used for the post-tensioning system on this project will be Commercial Prepackaged Enhanced Grout exhibiting thixotropic properties, as described herein.

1. General

a. Grout for tendons will consist of Portland cement, potable water, mineral admixtures for partial cement replacement, and other specified or approved admixtures which impart low water content, good flow, fluidity, minimal bleed, non-shrink, non-metallic, thixotropic, and where necessary, set retarding properties to the grout, all in accordance with this special provision. Grout is to have enhanced corrosion-resisting properties such as increased resistance to chloride penetration. Grout shall have a minimum compressive strength of 5000 psi at 28 days. There may not be any deliberate addition of materials containing chlorides.

b. Commercially available, prepackaged, cement-based grout mixtures meeting the requirements of this special provision are to be used and to be submitted to the Representative for review and acceptance.

2. Grout Classification:

Commercial Prepackaged Enhanced Grout is to be used and to exhibit thixotropic properties, contain both mineral admixtures for partial cement replacement and chemical admixtures for improved corrosion protection and resistance to bleed.

3. Grout Ingredients

a. Cement:

Portland cement is to conform to the requirements of AASHTO M-85 Type I or Type II. Cement is to be fresh and not contain lumps or other indications of hydration or "pack set". Furnish, prior to initial use, a manufacturer's report stating results of tests made on samples of the material taken during production or transfer and certifying compliance with the applicable requirements of AASHTO M-85.

b. Cement Replacement

Silica fume and fly ash (Class F) may be used for cement replacement to enhance the corrosion resistance and durability enhancing characteristics of the grout.

Water content will be calculated for the total weight of cementitious material (cement + replacement material) and be expressed as water/cementitious ratio.

c. Water

(1) Water is to be potable, clean, and free of injurious quantities or substances known to be harmful to Portland cement and/or post-tensioning steel, such as chlorides, sulfides, sulfates and nitrates.

(2) Water will have chloride, sulfide, sulfate, and nitrate contents not greater than 500, 100, 650 and 13 ppm respectively.

d. Admixtures

Admixtures consist of chemicals that impart the following properties when incorporated into the grout mixture: low water content, good flow, fluidity, minimal bleed (sedimentation of cement), non-shrink, non-metallic, thixotropic, and where necessary, set retarding. Any admixture containing chlorides, sulfites, fluorides or nitrates may not be used in the grout. The date of

manufacture and shelf life is to be clearly stamped on each container. No admixture may be used for which the shelf life recommended by the manufacturer has expired.

(1) Non-Shrink Properties and Expansion Agents

Grout is to have non-shrink properties. Gas evolving expansion agents and/or additives containing free aluminum are not to be used.

(2) Corrosion Inhibitors

Corrosion inhibiting chemical admixtures may not be used.

(3) Chloride Ion Content

All constituent materials are to be such that the acid-soluble chloride ion content of the grout not exceed 0.08% by weight of Portland cement as measured by ASTM C1152 “Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete.”

4. Grout Properties

a. The proposed commercial prepackaged grout must meet the requirements of this specification through testing as independently certified by an approved Cement Concrete Research Laboratory (CCRL). Personnel experienced in the testing of grouts and mortars are to perform all grout testing.

The Representative may waive laboratory trial test requirements if:

(1) The prepackaged grout has previously met the necessary qualifying performance tests as independently certified by an approved CCRL (unless the material source has changed); or

(2) Results of earlier tests (not exceeding 12 months from notice to proceed) on grouts with the same design, procedures, equipment, and source of materials are satisfactory and within the acceptance requirements.

b. Prior to beginning grouting operations, furnish the Representative with a report for the proposed grout detailing the types and number of tests performed, test procedures, results, and comparison of results with specified values.

c. Qualifying Commercial Prepackaged Enhanced Grout is to have the physical properties listed in Table 1 when mixed, prepared and tested in an approved CCRL.

Table 1 - Physical Property Requirements for Enhanced Grout

Physical Property	Requirement	Test Method
Water-Cementitious Material Ratio, w/c	Maximum 0.45	N/A
Setting Time	Minimum 3 hours Maximum 12 hours	ASTM C953
Grout Cube Strength	Min. 3,000 psi at 7 days Min. 5,000 psi at 28 days	ASTM C942
Permeability	≤ 2,500 Coulombs after 6 hours*	ASTM C1202*
Volume Change	Vertical height change of cylinder: 0.0% to +0.1% at 24 hours Less than +0.2% at 28 days	ASTM C1090
Pumpability and Fluidity for Thixotropic Grouts (Modified Flow Cone Efflux Time for 1 Liter Discharge**)	Immediately after mixing: Min. 9 sec., Max. 20 sec. After letting stand for 30 min. and remixing for 30 sec.: Max. 30 sec.	Modified ASTM C939**
Control of Bleed (Wick Induced Bleed Test)	Max. 0% bleed after 3 hours at 70°F	Modified ASTM C940***
Wet Density	Establish Value for Field Monitoring per ASTM C185	ASTM C185

* When evaluating grouts, the ASTM C1202 procedure is to be modified to perform the test at 30 volts rather than 60 volts. Testing will be performed on grout samples at 28 days of age. For grouts containing pozzolanic mineral admixtures, testing may be performed on grout samples at 90 days of age.

** For Enhanced Grouts with thixotropic properties, the modified flow cone efflux time will be measured, and the pumpability and fluidity requirements of Table 1 will apply. The modified version of C939 involves filling the flow cone to the top instead of the standard level, and the efflux time is measured as the time to fill a 1-liter container placed directly under the flow cone.

*** The modified version of ASTM C940 is described in the PTI “Guide Specifications for Grouting of Post-Tensioned Structures.”

5. Grout Testing During Grouting Operations

Acceptance testing for grout physical properties is to be performed during grouting operations as specified below:

a. Production Tests

Perform as specified herein, the testing of production grout. To qualify, Commercial Prepackaged Enhanced Grout that has previously met the requirements of this Special Provision as independently certified by a Representative approved CCRL, will have the physical properties listed in Table 2 when mixed, prepared and tested on-site during production grouting operations.

The frequency of testing listed in Table 3 may be reduced at the discretion of the Representative based on the contractor's proven ability to provide consistent quality grout meeting the requirements of these special provisions.

Table 2 – Acceptance Testing Requirements for Production Grouting

Approved Commercial Prepackaged Enhanced Thixotropic Grout

Physical Property	Frequency of Testing*	Requirement	Test Method
Pumpability and Fluidity	For each 2 cubic yards of grout or every 2 hours of grouting: One (1) test after mixing and before injection, and One (1) test on grout collected at duct outlet	Thixotropic Grouts** Modified Flow Cone Efflux Time: 1) Immediately after mixing: Min. 9 sec., Max. 20 sec. 2) After collection at duct outlet: Max. 30 sec.	Modified ASTM C939**
Wet Density	Two (2) Mud Balance tests per day or when there is visual or apparent change in grout characteristics	Established Laboratory Value Using ASTM C185	API 13B-1

* Perform each test at least once per grouting operation.

** The modified version of ASTM C939 involves filling the flow cone to the top instead of the standard level, and the efflux time is measured as the time to fill a 1-liter container placed directly under the flow cone.

2.02 MANUFACTURERS

The following companies, and systems, in alphabetical order, are pre-approved to provide post tensioning systems for this project:

A. Dywidag Systems International {Multi-Strand Post Tensioning}
320 Marmon Drive
Bolingbrook, EL 60440
630-739-1100
www.dsiamerica.com 8/27/2009 3 SP (01-002-FCXM-C)

B. Schwager Davis, Inc. (SDI)
198 Hillsdale Avenue
San Jose, CA 95136
408-281-9300
www.schwagerdavis.com

C. VSL {ES/ESI and EC/ECI Systems}
8006 Haute Court
Springfield, VA 22150
703-451-4300
www.vsl.net

PART 3 – EXECUTION

3.01 PROTECTION OF POST-TENSIONING STEEL AFTER INSTALLATION OF TENDONS IN DUCTS

A. The post-tensioning steel is to be protected from corrosion and the duct system be sealed to prevent moisture intrusion from the time of tendon installation to the time of grouting, as provided below.

B. The ends of ducts and anchorages and all duct connections are to be sealed at all times following installation in the forms to prevent entry of moisture and debris. In addition, all grout ports and vents are to be closed or plugged at all times during the period prior to grouting.

C. Proceed with grouting as soon as possible after installation and stressing of the tendons. The time from installing the tendons in an unstressed condition to grouting after stressing must not exceed 7 days without approval of the Representative. It is understood that in most instances, cold weather grouting will not be possible. The Contractor is to protect the tendons and wait until the cast concrete, which the tendons travel through, has reached a sustainable temperature in accordance with the manufacture's recommendations.

D. Tendon Protection Between Installation and Stressing

Take measure to protect the post-tensioning steel when there is a period of more than 24 hours between installation of the tendons in ducts and stressing. Wrap continuously in plastic sheeting and seal using waterproof tape, bare strand projecting out of the duct. Extend the plastic wrap to the tendon anchorage. Seal the anchorage opening with plastic and waterproof tape sufficient to prevent moisture intrusion. All grout ports and vents are to be closed or plugged, and all duct connections sealed.

E. Tendon Protection Between Stressing and Grouting

Cap or otherwise seal anchorages immediately following stressing and the cutting of strand tails. Where permanent end anchorages protection caps are required, the time period between stressing and installation of the permanent end caps may not exceed 12 hours without approval of the Representative.

Where permanent end anchorage protection caps are not required, the end anchorage region of the tendon is to be sealed against moisture intrusion using plastic sheeting and waterproof tape within 24 hours of stressing.

F. In all cases, tendons and ducts are to be thoroughly blown dry with oil-free compressed air immediately prior to sealing or capping of the anchorages. In addition, all grout ports and vents are to remain plugged, sealed or otherwise capped, and all duct connections sealed.

G. The use of corrosion inhibitors such as water-soluble oils for temporary corrosion protection is not permitted without prior approval of the Representative.

3.02 INSTALLATION OF DUCTS

A. Securely tie, carefully inspect, and repair ducts before starting concrete placement. Exercise care during placement of the concrete to avoid displacing or damaging the ducts.

B. Support internal ducts from carrier reinforcement at intervals necessary to prevent deflection and/or displacement of the ducts, spacing not exceed four (4) feet.

Any additional mild reinforcing required to support post-tensioning ducts will be supplied by the contractor at no expense to the Authority.

C. The tolerance on the location of the tendons is to be plus or minus 1/4-inch at any point, in any direction. After installation in the forms, ends of ducts are to at all times be sealed to prevent entry of water, debris, or other deleterious substances.

3.03 INSTALLATION OF GROUT INLETS AND OUTLETS

A. Install grout inlet and outlet tubes on each duct to serve as injection or vent ports during grouting. Place these inlet and outlet tubes at locations shown on the Contract Plans or accepted Shop Drawings and in accordance with the following:

1. Provide Inlets (Grout Injection Ports) for injecting grout into the duct.

2. Outlets (Grout Exit Vents) are to allow the escape of air, water, grout, and bleed water.

3. The inner diameter of inlets and outlets are to be at least ¾ inch for strand tendons, and ½ inch for single bar tendons and 4-strand transverse deck tendons.

4. Inlets and Outlets are to be of flexible HDPE pipe.

5. Extend inlet ports or outlet vents sufficiently out of the concrete to allow for proper closing. At all high points, the outlet is to connect at the uppermost part of the duct profile except do not exit vents to any finished top deck slab surface. In the latter case, gradually turn down vents with no kinks to exit on the underside of the top slab or to an internal face unless specifically shown on Contract Plans.

6. Place Inlets and Outlets at locations shown on the Contract Plans, on the accepted Shop Drawings, and on the accepted Grouting Operation Plan described below.

7. Make all connections to ducts witH plastic structural fasteners. Use waterproof tape or sealant at all connections including vent and injection tubes, except where otherwise specified herein. Vents are to be mortar tight, taped or sealed as necessary, and provide means for injection of grout through the vents and for sealing the vents.

8. Permanently seal all inlets and outlets to prevent water infiltration to the grouted tendon. Sealing details are to be submitted to the Representative for acceptance.

9. Fit all grout injection and vent tubes with positive mechanical shut-off valves. Fit vents and injection tubes with valves, caps or other devices capable of withstanding the pumping pressures.

3.04 CARE AND PROTECTION OF DUCTS, VENTS, ANCHORAGES, AND BLOCKOUTS

A. Take care to ensure that all ducts, anchorages, blockouts, openings and vents are kept clean and free of water, debris, fuel, oils, site trash, and other contaminants at all times prior to and after installation of the tendons. Use temporary plugs, seals and covers.

B. Minor duct damage may be repaired through the removal of locally damaged areas, and the splicing of new duct or couplers onto the remaining intact section (prior to the placing of concrete).

C. Repair of major duct damage requires the removal and replacement of the entire duct section.

D. Grout hose connections to inlet ports, ejection ports, and vents are to be kept airtight and free from dirt, debris, and other deleterious substances.

3.05 PRE-GROUTING AIR PRESSURE TEST OF DUCT SYSTEM

A. Following assembly of the complete duct system, including installation of all ducts, grout inlets and outlets, couplers and connections, and immediately after stressing of the tendon, an air pressure test is to be performed on each complete duct system.

B. The air pressure test will involve pressurizing the complete duct system to 10 psi with dry, oil-free air, and monitoring the pressure in the system for a period of 5 minutes. If the pressure loss during this 5-minute period exceeds 10%, all sources of leakage must be identified, and measures taken to reduce or eliminate the identified leaks.

C. The operation of each vent is to be tested by blowing dry, oil free air into the duct system and opening and closing each vent in turn.

3.06 POST-TENSIONING OPERATIONS

A. General

1. Concrete Strength: post-tensioning may only be applied when the concrete has attained the required compressive strength as determined from test cylinders cured under the same conditions as the structural concrete.

2. The design of the structure is based on the assumed friction and wobble coefficient shown in the Contract Plans.

3. The post-tensioning forces shown are theoretical and do not include losses in the system or thermal effects.

4. Stressing Tendons: All post-tensioning is to be tensioned by means of hydraulic jacks so that the force of the post-tensioning steel not be less than the value shown on the Contract Plans or accepted Shop Drawings, or as otherwise approved by the Representative. Monostrand stressing may not be used. Maximum Stress at Jacking: The maximum temporary tensile stress (jacking stress) in post-tensioning steel may not exceed 80 percent of the specific minimum ultimate tensile strength of the post-tensioning steel. Tendons may not be overstressed to achieve elongation.

5. Initial and Permanent Stress: The post-tensioning steel is to be anchored at initial stresses in a way that will result in the ultimate retention of permanent forces of not less than those shown on the Contract Plans or the accepted Shop Drawings, but in no case may the initial stress, after anchor set, exceed the limits set forth in the Contract Plans. The anchor set shown in the Contract Plans may not be exceeded.

6. Permanent force and permanent stress are the force and stress remaining in the post-tensioning steel after all losses, including creep, shrinkage, and elastic shortening of concrete, steel relaxation, thermal affects, losses in post-tensioning steel due to the sequence of stressing, friction, take-up of anchorages, and all other losses peculiar to the method or system of post-tensioning, have taken place or have been provided for in an accepted stressing plan.

7. Excessive Friction: When friction must be reduced, water-soluble oil or graphite with no corrosive agents may be used as a lubricant, subject to approval of the Representative. Flush lubricants from the duct by use of water pressure as soon as possible after stressing is completed. Flush these ducts again just prior to the grouting operations. Immediately and thoroughly blow dry with oil-free air each duct each time that the duct has been flushed.

B. Stressing Jacks

1. Stressing Equipment: Each jack is to be equipped with a pressure gauge having an accurate reading dial at least six inches in diameter for determining the jack pressure.

2. Prior to use for stressing on the project, each jack and its gauge is to be calibrated as a unit. Initial calibration will be done, using a proven load cell, at an independent testing laboratory approved by the Representative.

   Calibration is to be done with the cylinder extension in approximately the same position that it will be in when applying the final jacking force, and with the jacking assembly in an identical configuration to that which will be used at the job site (i.e. same length hydraulic lines). Furnish certified calibration calculations and a calibration chart, both in English units of measure, to the Representative for each jack and gauge unit.

   Recalibrate each jack at six month intervals and at other times when requested by the Representative. At the option of the Contractor, calibrations subsequent to the initial laboratory calibration may be accomplished by the use of a master gauge. The master gauge must be calibrated at the same time as the initial calibration of the jacks, and be part of the unit for each jack. Furnish the data recorded during the initial calibrations to the Representative for use in the field. Supply the master gauge in a protective waterproof container capable of protecting the calibration of the master gauge during shipment. Provide a quick-attach coupler next to the permanent gauge in the hydraulic lines, which enables the quick and easy installation of the master gauge to verify the permanent gauge readings. The master gauge will remain in the possession of the Representative for the duration of the project.

3. If a jack is repaired or modified, including seal replacement, the jack is to be recalibrated by the approved testing laboratory. No extra compensation will be allowed for the initial or subsequent jack calibrations or for the use and required calibration of a master gauge.

C. Tendon Stressing

1. Do not apply Post-tensioning forces until the concrete has attained the specified compressive strength as evidenced by tests on representative samples of the concrete. Store these samples under the same conditions as the concrete so that the curing condition of the concrete in place is accurately represented.

2. Post-tension stressing shall be done from one end of each tendon. Jacks shall be located such that results in the condition that has the least impact on motorists and/or pedestrians. If Contractor elects to stress using 4 multi-strand jacks simultaneously, jacks may have to be positioned on either side of the pier cap retrofit to provide sufficient space between jacks.

3. Conduct the tensioning process so that tension being applied and the elongation of the post-tensioning steel may be measured at all times. Keep a permanent record of gauge pressures and elongations at all times and submit the record to the Representative.

4. Tendon stressing shall be performed using one of the following two options at each retrofit.

   a. Option 1:

      Stress all 4 tendons to 100% of the jacking force simultaneously using 4 multi-strand jacks. All 4 hydraulic jacks shall be plumbed together and powered by a single hydraulic pump.

   b. Option 2:

      The wedge blocks shall be clocked and the strands shall be installed in a parallel lay configuration.

      Stress tendons incrementally using the sequence shown in the Contract Drawings. 25% stressing increments shall be achieved by stressing 25% of the primary strands to the final jacking force in each strand, i.e. a 16 primary strand tendon shall be stressed 4 strands at a time to the final jacking force in each strand.

      Each strand shall be marked after it has been stressed to prevent accidental restressing and wearing of the wedges.

      Example Primary Stressing Sequence:

         Assume a 16 (4) strand tendon (16 primary strands, 4 reserve strands), Specified Jacking Force = 600kips applied in 25% increments

            1st Stressing Increment: Stress 4 strands to 25% (600kips) = 150kips or 37.5kips / strand

            2nd Stressing Increment: Stress 4 strands to 25% (600kips) = 150kips or 37.5kips / strand

            3rd Stressing Increment: Stress 4 strands to 25% (600kips) = 150kips or 37.5kips / strand

            4th Stressing Increment: Stress 4 strands to 25% (600kips) = 150kips or 37.5kips / strand

      Stressing of reserve strands shall only be performed if the specified total jacking force is not achieved after stressing of the primary strands is performed. The jacking force applied to the reserve strands shall be limited to the force necessary to achieve the total specified jacking force.

      Example Reserve Stressing Sequence:

Assume a 16 (4) strand tendon (16 primary strands, 4 reserve strands), Specified Jacking Force = 600kips applied in 25% increments, Applied Jacking Force after stressing of Primary Tendons = 540kips

Reserve Strand Stressing: Stress 4 strands to 600kips - 540kips = 60kips or 15kips / strand

In the event that the required stress in the reserve strands exceeds the maximum allowable stress contact the Authority Representative for instruction.

5. Wedges shall be seated a maximum of twice to prevent unnecessary wear on the PT strands and wedges. In the event that a wedge requires seating more than twice, contact the Authority Representative for direction.

6. For all tendons, excluding post-tensioning bars, when the tendon force measured by gauge pressure is applied to the tendon, measured elongations must agree within seven percent (7%) of the theoretical elongation, or the entire operation is to be checked and the source of error determined and remedied to the satisfaction of the Representative before proceeding with the work. Measure elongations to the nearest 1/16". In determining why the measured tendon force and the theoretical elongation do not agree within seven percent (7%), the Contractor may elect to establish that the apparent modulus of elasticity of the post-tensioning steel varies from the value shown in the general notes to the Contract Plans by conducting a bench test on a full size tendon in accordance with a procedure furnished by the Representative. This test may be performed at a site remote from the project provided that the Contractor pays the cost to the representative to witness the test. Equipment for tensioning the tendons must be furnished by the manufacturer of the system. Should agreement between pressure gauge readings and measured elongations fall outside the acceptable tolerances, the Representative may require additional in-place friction tests, without additional compensation to the Contractor, in accordance with Section 2.01 Materials.

7. Verify with a lift-off after initial stressing operations the anchor force for all permanent post-tensioning bars. The resulting lift-off must be within 7% of the expected final anchor force as specified in the Contract Plans or shop drawings. Permanent post-tensioning bars longer than 20 feet will require checking elongations in addition to performing lift-offs.

8. Multi-strand post-tensioning tendons having wires that have failed by breakage or slippage during stressing may be accepted providing that:

   a. The completed structure must have a final post-tensioning force of at least 98% of the design total post-tensioning force at the affected sections.

   b. At any stage of erection, the post-tensioning force across a mating surface must be at least 98% of the force required for that stage.

   c. Any single tendon must have no more than 2% reduction in cross-sectional area of the post-tensioned steel.

   If these conditions cannot be met, then the affected tendon(s) must be removed and replaced. Previously tensioned strands may not be re-used unless approved by the Representative. Any of these conditions may be waived by the

Representative when the Contractor is able to propose an acceptable means of restoring the post-tensioning force lost due to wire failure or slippage.

9. Post-tensioning bars used to apply temporary post-tensioning may be reused as temporary bars if they are undamaged.

10. Cut post-tensioning steel by an abrasive saw to within ¾-inches to 1-1/2 inches of the anchoring device. Flame cutting of post-tensioning steel is not allowed.

11. Tendon Stressing Personnel Qualifications

    a. Carry out all tendon stressing operations by workers trained for the tasks required, and under the direct supervision, at the location of tendon stressing, of personnel having at least 5 years of experience on previously successful projects of similar type and magnitude.

    b. Tendon stressing must be performed under the immediate control of a Supervisor skilled in the various aspects of tendon stressing and having experience on at least four previous and satisfactorily completed projects of a similar size and scope. Name and furnish proof of experience and certification of this person as required by the Representative.

    c. Tendon Stressing Supervisors must hold a current PTI Level 2 Certification applicable to the post-tensioning system being used.

3.07 GROUTING

A. Grout the annular space between the post-tensioning steel and the duct, after post-tensioning and anchoring of a tendon has been completed and accepted. The interval between post-tensioning and grouting is limited as specified herein. Temporarily seal all grout vents, anchorages, and duct connections of each tendon immediately after post-tensioning to prevent the entrance of air, water, and other deleterious substances. These are to remain sealed until just prior to tendon grouting.

B. Grouting Operation Plan

The Grouting Operation Plan must address the following:

1. Names of grouting crew and Supervisor.

2. Experience of crewmembers and Supervisor.

3. Training to be provided or undertaken prior to operations.

4. Type of equipment to be used, including capacity in relation to demand.

5. Working condition of equipment, back-up and spare parts.

6. Types, brands and certifications of materials.

7. Identity of independent testing laboratory for certification of materials.

8. Production of grout fluidity, on-site flow testing, adjustments and controls.

9. Estimate of grout required per tendon or group of tendons.

10. Method of controlling rate of flow and filling of ducts.

11. Locations, types and sizes of inlet and outlet vents.

12. Means of sealing and protecting tendons and ducts prior to grouting.
13. Grout mixing and pumping procedures.
14. Tendon or groups of tendons to be grouted in one operation.
15. Direction of grouting and sequence of using inlets and closing vents.
16. Procedures for handling blockages, including flushing of ducts.
17. Procedures for possible re-grouting to detect and fill voids.
18. Procedure for controlling water/cement ratio, and for ensuring that the water used is acceptable.
19. Contractor's QC forms that are to be signed daily by Grout Supervisor.

C. Grouting Personnel Qualifications

d. Carry out all grouting operations by workers trained for the tasks required, and under the direct supervision, at the location of grouting, of personnel having at least 5 years of experience on previously successful projects of similar type and magnitude.

e. Grouting must be performed under the immediate control of a Supervisor skilled in the various aspects of grouting and having experience on at least four previous and satisfactorily completed projects of a similar size and scope. Name and furnish proof of experience and certification of this person as required by the Representative.

f. Grouting Supervisors must hold a current ASBI Grouting certification and a current PTI Level 2 Certification applicable to the post-tensioning system being used.

D. Equipment

1. Grouting equipment consists of measuring devices for water and admixtures, a mixer, a storage hopper, and a pump with all the necessary connecting hoses, valve, pressure gauges, and test equipment. Provide accessory equipment for accurate solid and liquid measures of all materials to be batched.

2. Grouting equipment is to have sufficient capacity to ensure that the post-tensioning duct or group of ducts to be grouted can be filled and vented without interruption at the required rate of injection. Under normal conditions, the equipment must be capable of continuously grouting the longest tendon (or group of tendons) on the project in 30 minutes.

3. The grout mixer is to be a high-shear (colloidal) mixer capable of continuous mechanical mixing in accordance with grout manufacturer’s recommendations. It s to produce a homogeneous and stable grout that is free of lumps and undispersed solids and be capable of delivering a continuous supply of grout to the pumping equipment.

4. Grouting equipment is to have two identical charging/holding tank units. Each unit alternates duties between blending and holding. Tank units are to have a high-shear (colloidal) mixer and pump. The placing pump is to have exact pressure control capabilities and be fed from the holding tank. Grouting equipment is to utilize a gravity feed to the pump inlet from the agitator attached to and directly over it, and includes a pressure filter grout test kit.

5. Grouting equipment will include a screen with maximum opening size of 3/16-inches to screen the grout prior to its introduction into the grout pump. This screen will be easily accessible for inspection and cleaning, and be periodically inspected during grouting operations for signs of improper grout mixture, such as cement lumps remaining on the screen.

6. Grout injection equipment (pumps) must be capable of pumping the grout in a continuous operation with little variation of pressure and include a system for re-circulating grout when injection is not in progress. The equipment must be capable of maintaining a pressure on completely grouted ducts and be fitted with a valve that can be locked-off without loss of pressure in the duct. The use of compressed air for pumping grout will not be allowed.

7. Positive displacement variable output pumps are to be used for grouting, and be capable of producing an outlet pressure of not less than 145 PSI. Pumps will have seals adequate to prevent the intrusion of oil, air or other foreign substances into the grout and to prevent the loss of grout or water.

8. A pressure gauge having a full-scale reading from 0 PSI to a maximum between 290 PSI and 320 PSI is to be placed at some point in the grout line between the pumping outlet and the duct inlet, generally near the grout inlet port for long lengths of hose.

9. Incorporate a sampling tee into the piping to the grout pump in the most direct manner, minimizing the number of bends, valves, and changes in diameter. The diameter and rated pressure capacity of the grout hoses must be compatible with pump output, the assumed maximum pressure, and the length of hoses needed. Connect grout hoses firmly to pump outlets, grout injection tubes, and any intermediate connections along the length of the grout hose(s).

10. Make oil and water free compressed air available to check the free passage of the ducts, to blow out any excess water from the ducts, and to check the ducts for leaks.

11. Make immediately available during grouting operations, adequate flushing equipment and a potable water supply to facilitate complete removal of the grout from the duct in the event of equipment failure, breakdown, or other disruption that may occur prior to completion of the grouting operation. Stand-by equipment must be kept in working order at all times. The condition of stand-by equipment is to be verified prior to each grouting operation. The contractor shall use lined tanks for potable water where a potable water supply is not available. Non-potable water may not be used.

E. Mixing Grout

1. Charging of the mixer and the mixing of grout is to be in accordance with the grout manufacturer’s written procedures.

2. Mix the grout until a uniformly blended mixture is obtained and continuously agitate until it is introduced into the grout pump. Batches of grout are to be placed within 30 minutes of mixing. No water may be added to the grout to modify its consistency after the initial mixing operation is completed.

F. Field Quality Control

1. General:

a. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for the first 48 hours or for additional time as may be required before transporting samples to the test lab.

b. Provide concrete for testing of density (unit weight) and temperature and, for making cylinders.

2. Consult with the manufacturer in developing quality control operations appropriate to the project.

3. Field testing and inspection shall be performed in accordance with ACI 301.

4. Concrete tests shall be conducted by an ACI Concrete field Testing Technician Grade I, or equivalent, knowledgeable in testing self-consolidating concrete.

5. Tests shall be conducted on each lot of concrete mixture placed.

6. The testing agency shall provide the following services:

a. Inspect grout placement.

b. Sample the grout in accordance with ASTM C 172.

c. Determine the density (unity weight) of concrete sample for each strength test in accordance with ASTM C 138, except that the concrete shall be filled in one lift and not consolidated.

d. Record the temperature of concrete for each strength test in accordance with ASTM C 1064.

e. Cast concrete specimens for compressive strength test as follows:

Cast and cure at least four 2-inch by 2-inch cubes per lot of grout. One lot of grout is considered to be an adequate quantity to complete the grouting process for one retrofit (4 tendons) or mock-up. Cast and cure cubes in accordance with ASTM C 31, except that the grout shall be placed in one lift and not consolidated. However, light tapping of the sides of the cylinders with an open hand is permitted.

f. Record the fresh concrete data for each set. The datasheet shall include the following:

(1) Mixture number

(2) Specified 28-day strength

(3) Date and time of batching

(4) Time of testing

(5) Location of placement

(6) Ambient temperature

(7) Names and quantities of admixtures added on site, and, name and title of the person who authorized the addition

(8) Set number, if more than one set of cylinders are cast on a single day

(9) Name of the testing agency

(10) Name and signature of the inspector who conducted the test, and

(11) Any additional observations or comments.

g. Mark the cubes and write the date of casting on each cube.

h. Store and protect the cubes from job site to the laboratory in accordance with ASTM C 31.

i. Transport the cubes and write the date of casting on each cube.

j. Cure the cubes in the laboratory in accordance with ASTM C 31.

k. Test cubes for compressive strength in accordance with ASTM C 109.

(1) Test two cylinders at 7 days and two cylinders at 28 days for acceptance.

l. Base strength value on the average of at least two 2-inch by 2-inch cubes tested at 28 days.

j. Test report shall include all the information in Item 10 above and compressive strength data, and shall be signed by the laboratory manager.

k. Strength of concrete shall be deemed satisfactory if both of the following requirements are met (ACI 318):

(1) Every arithmetic average of any two consecutive compressive strength test equals or exceeds the specified compressive strength, and

(2) No compressive strength test falls below the specified compressive strength by more than 500 psi (3.5 MPa).

If any strength test of laboratory-cured cylinders falls below the specified compressive strength by more than the values specified above, remedial measures shall be taken as recommended by the Architect/Engineer.

G. Cleaning and Flushing Tendons

1. Tendons are not to be flushed with water except when otherwise specifically directed by the Representative. If necessary, the Representative may permit flushing with water where an unexpected interruption to grouting requires the flushing of grout from the duct, or where a water-soluble lubricant has been applied to the pre-stressing strands at the approval and permission of the Representative.

2. If flushing is to be performed as directed by the Representative, flush the inside of the duct system with water under pressure meeting the quality requirements herein to remove all traces of the lubricant or other contaminant. Following flushing operations, completely drain water from the duct system and thoroughly blow out the system with compressed oil-free air to the extent necessary to dry the post-tensioning steel and inside surfaces of the ducts to the satisfaction of the Representative as demonstrated by the contractor. Capture and properly dispose of the waste fluid flushed from the duct system .

H. Injecting Grout

1. Perform the injection of grout using qualified individuals meeting the certification requirements of the Project Specifications, previously approved and successfully demonstrated materials, equipment, methods, and operations. Grout injection is to

follow the requirements of the PTI Guide Specifications for Grouting of Post-Tensioned Structures and the recommendations below:

2. General Grouting Procedures:

   a. Start grouting at the lowest injection port with all vent holes open. A continuous one-way flow of grout is to be maintained at all times.

   b. Grout injection rates of 16 ft per minute for vertical ducts and 50 ft per minute for horizontal ducts are the maximum allowed.

   c. Pump grout through the duct and allow it to flow continuously at the first vent hole after the injection port until no visible slugs or other evidence of air or water are ejected and the grout being ejected has the same consistency as the grout being injected. At this time, at least one gallon of grout for tendon sizes 7-0.6" and smaller and 3 gallons of grout for tendon sizes 9-0.6" and larger are to be vented from the first vent hole into a suitable receptacle and discarded properly. The first vent valve may then be closed. Continue grout injection until all vents have been closed one after another in the direction of flow following the same process. At intermediate crests where vents have been provided both at the crest and immediately downstream from the crest, close the vent downstream of the crest before the associated crest vent.

   d. Close the injection port immediately following stoppage of the grout pump after the tendon duct has been completely filled with grout and after the last outlet vent has been closed.

   e. When a one-way flow of grout cannot be maintained, or when grouting is interrupted, the grout is to be immediately flushed out of the duct with water. Make a water pump available on-site for this purpose as part of the standard flushing equipment. The flushing pressure may not exceed the grouting pressures listed herein.

3. Grouting Pressure

   a. Normal grouting operations will be performed at a pumping pressure of approximately 75 psi, with due consideration of grouting recommendations stated in the PTI Guide Specification for the Grouting of Post-tensioned structures, 2001. Additionally, pumping pressure at the tendon inlet may not exceed the following 245 psi.

   b. If the actual grouting pressure exceeds the maximum permitted pumping pressure, the inlet is to be closed and grouting may continue at any vent hole that has been or is ready to be closed, provided that a one-way flow of grout is maintained. Any such outlet used for injection must be fitted with a positive shut-off.

   c. Grout may not be injected into a succeeding outlet from which grout has not yet flowed.

4. Temperature Considerations

   a. No grouting may be done when the temperature of the grout is below 45°F. Maintain the temperature of the concrete and air surrounding the tendon at 35°F

or above from the time grout is placed until the compressive strength of the grout, as determined from tests on two-inch cubes cured under the same conditions as the in-place grout, exceeds 800 PSI.

b. Grout early in the morning under hot weather conditions, when daily temperatures are lowest. No grouting may be done when the temperature of the grout exceeds 90°F. It may be necessary to chill mixing water or take special measures to lower the grout temperature.

5. Post-Grouting Measures at Injection and Vent Ports

Not less than 48 hours after the completion of grouting, the level of grout at all injection port and outlet vent locations are to be inspected and topped off as necessary with freshly mixed grout. This process will continue until the Representative is assured that there are no bleed water or subsidence voids. Subsequent spot inspections may be conducted on one or more selected anchorages per span as long as no voids are found. If voids are found, all tendons will be checked for voids until the Representative is assured that voids are no longer occurring.

6. Post-Grouting Measures at Injection and Vent Ports

a. Reopen grouting vents at high points 10 minutes after completion of grouting and record any escape of air, water or grout.

b. Within approximately 30 minutes of grouting and before the grout has hardened, all opened vents are to be checked for voids. At locations where voids are observed, top off grout through the outlet, or perform a re-grouting operation using an injection port and outlet vent, and the vents re-closed.

7. Post-Grouting Inspection of Anchorages by Contractor

a. Inspect all end anchorages for the presence of voids behind the anchorage not less than 48 hours after the completion of grouting.

b. Drill out or otherwise clean out the grout injection port on the anchorages to allow the inspection of potential voids immediately behind the anchorage or within the trumpet region of the tendon. Take care during the drilling process to ensure that the drilling operation does not come into contact with the strands or bar(s) of the tendon.

c. Assessment of the potential void space will involve physical probing through the grout injection port with a suitable wire or probe, or by visual inspection using a flexible fiberscope or videoscope. The presence of a void and an estimation of its extent or length is to be recorded.

d. If after the first 12 anchorages have been inspected, no voids have been found, the frequency of post-tensioning anchorage inspections may be reduced solely at the discretion of the Representative. The Representative reserves the right to reinstate inspection of all anchorages at any time.

e. All voids identified behind anchorages are to be re-grouted as follows:

(1) Re-grouting will involve insertion of a grout tube through the grout injection port into the void space, and filling the void with freshly mixed grout meeting the requirements stated herein.

(2) Grout tube is to be a flexible plastic of sufficient rigidity to allow grouting under pressure without excessive bulging or rupture. The maximum allowable size of the grout tube will be ½-inch outside diameter.

(3) Grout material is to be injected into the void at a low pressure (<100 psi). Pressure must be sufficiently low to prevent segregation and bleeding of the grout.

(4) Insert the grout tube into the trumpet as far as possible. The tube must remain within the trumpet, immersed within the grout at all times during the grouting operation, until specified.

(5) Continuously grout the tendon anchorages. No interruptions in grouting will be allowed.

(6) Continue grouting until all air, water, or other foreign material is completely purged from the trumpet and duct. Further continue grouting until an uninterrupted stream of sound, uncontaminated grout flows from the port for a minimum of ten (10) seconds. At this time, the grout tube may be slowly and continuously removed from the port while grout is still flowing out of the tube under pressure.

(7) Upon completion of grouting, all ports are to be sealed to prevent grout leakage until final set of the grout.

8. Post-Grouting Finishing Operations

a. Following the post-grouting measures shut off valves may not be opened on injection ports or vent ports, nor may grout tubes or caps at port locations be removed until the grout has set.

b. After the grout has set, grout tubes used as injection or vent ports that penetrate a finished concrete surface are to be cut off at least one inch below the surface of the concrete. Uniformly coat the resulting recess with an approved bonding compound meeting the requirements of AASHTO Specification M-235, Class III. Apply the epoxy in a manner and thickness as recommended by the manufacturer. Completely fill the recess immediately following application of the bonding compound with an approved non-metallic, non-shrink, cement-based mortar. The mortar filler is to be placed within the time limits specified by the epoxy bonding compound manufacturer. The filler may exhibit no shrinkage, and contain no aluminum powder, iron particles, chlorides, sulfites, fluorides or nitrates.

c. Vent ports on external tendons, saddles, vent hoses and all other hardware are to be removed and the holes in the ducts sealed using a heat shrink repair sleeve. Extend the heat shrink repair sleeve a minimum of six inches beyond the vent opening in the duct in both directions. All heat shrink repair materials and procedures must be approved by the Representative prior to use.

d. Remove all miscellaneous material (tie wire, duct tape, etc.) used for sealing grout inlet or vent connections prior to carrying out further work to protect end anchorages. Install end anchorage protection as described below.

3.08 PROTECTION OF POST-TENSION ANCHORAGES

Anchorage protection shall consist of the installation of a non-metallic anchor head cap. The cap is to be fully grouted during the tendon grouting procedure with the same grout used for tendon grouting.

3.09 RECORD OF STRESSING OPERATIONS

A. Keep a record of all post-tensioning operations for each tendon installed and stressed. This includes, but is not necessarily limited to the following:

1. Project name, number
2. Contractor and/or Sub-Contractor
3. Tendon location, size and type
4. Date tendon was first installed in ducts
5. Coil/reel number for strands or wires and heat number for bars and wire
6. Assumed and actual cross-sectional area
7. Assumed and actual modulus of elasticity
8. Date stressed
9. Jack and gauge numbers per end of tendon
10. Required jacking force
11. Gauge pressures
12. Elongations (anticipated and actual)
13. Anchor sets (anticipated and actual)
14. Wire breakages for strand tendons
15. Stressing sequence (i.e. tendons before and after this)
16. Stressing mode (1 end only, 2 ends in sequence, or 2 ends simultaneous)
17. Witnesses to stressing operation (Contractor and Inspector)
18. Record of any other relevant information

B. Provide the Representative with a complete copy of the corresponding Record of Stressing Operations.

3.10 RECORD OF GROUTING OPERATIONS

A. Keep a record of all grouting operations for each tendon or group of tendons installed, stressed and grouted. This record includes, but not necessarily be limited to the following:

1. Tendon or group of tendons grouted in one continuous operation.
2. Date grouted.
3. Number of days from stressing to grouting, per tendon.
4. Commercial Prepackaged Enhanced Grout used.

5. Fluidity test results of the grout (flow-cone) for both newly mixed and 30 minute rested grout as per these specifications.
6. Wet density results from API Mud Balance testing, as specified.
7. Location of injection port and direction of grout flow.
8. Applied grouting pressure during normal pumping, and maximum pressure at any time with description of events.
9. Theoretical volume of grout anticipated for filling of the duct or ducts.
10. Actual quantity of grout in place in the duct(s) after grouting (For one grout mixing and injection operation, this is the quantity mixed less the quantity wasted at the vents, less the quantity remaining in the mixer and injection equipment).
11. Summarize any difficulties encountered and corrective actions taken.
12. Names of witnesses to the grouting operation (Contractor and Inspector) with title and company identified.

B. Provide the Representative with a complete copy of the corresponding Record of Grouting Operations.

END OF SECTION

SECTION 03410

PRECAST LIGHTWEIGHT STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 SUMMARY:

A. Section Includes:
1. Requirements for designing, furnishing, and installing precast lightweight concrete components as indicated on the Contract Drawings and in the Specifications.

B. Related Sections:
1. Section 03300: Cast-in-Place Structural Concrete.
2. Section 03621: Non-Metallic Non-Shrink Grouting
3. Section 07130: Waterproofing.
4. Section 07900: Seals and Sealants.

1.02 REFERENCES:

A. American Concrete Institute (ACI):
1. ACI Manual of Concrete Inspection
2. ACI 211.2; Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
3. ACI 213; Guide for Structural Lightweight Aggregate Concrete.
4. ACI304.5R; Batching, Mixing, and Job Control of Lightweight Concrete.
5. ACI 318; Building Code Requirements for Structural Concrete and Commentary.

B. ASTM International (ASTM):
1. ASTM A615; Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
2. ASTM A1064; Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
3. ASTM C31; Standard Practice for Making and Curing Concrete Test Specimens in the Field.
4. ASTM C33; Standard Specification for Concrete Aggregates.
5. ASTM C39; Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
6. ASTM C42; Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
7. ASTM C150; Standard Specification for Portland Cement.
8. ASTM C260; Standard Specification for Air-Entraining Admixtures for Concrete.
9. ASTM C330; Standard Specification for Lightweight Aggregates for Structural Concrete.
10. ASTM C494; Standard Specification for Chemical Admixtures for Concrete.
11. ASTM C567, Standard Specification for Determining Density of Structural Lightweight Concrete.
12. ASTM C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
13. ASTM C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

C. American Welding Society (AWS):
1. AWS D1.1; Structural Welding Code - Steel.
2. AWS D1.4; Structural Welding Code - Reinforcing Steel.

3. AWS D1.6; Structural Welding Code - Stainless Steel.

D. International Code Council (ICC):
   1. International Building Code (IBC).

E. Precast/Prestressed Concrete Institute (PCI):
   1. PCI MNL-116, Manual for Quality Control.
   2. PCI MNL-120, PCI Design Handbook – Precast and Prestressed Handbook.

1.03 DESIGN REQUIREMENTS:

A. Design the precast concrete sections in accordance with the design criteria and requirements of ACI 318.

B. Design the precast concrete sections for the following:
   1. Initial handling and erection.
   2. All dead and live loads as specified on the Contract Drawings.
   3. All other loads specified for the member, where applicable.

C. 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.

1.04 SUBMITTALS:

A. Submit the following information to the Engineer for approval in accordance with the requirements of Division 1, Submittal Requirements:
   1. Product Data:
      a. Portland cement.
      b. Aggregates.
      c. Air-Entraining Admixture.
      d. Water-Reducing, Retarding, Accelerating, and High-Range Water-Reducing Admixtures.
      e. Corrosion Inhibitor Admixture.
      f. Mild Steel Reinforcing.
      g. Wire.
      h. Grout.
      i. Sealant.
      j. Bearing Material.
      k. Structural Precast Concrete.
      l. Structural Steel Plates and Shapes.
   2. Shop Drawings:
      a. Submit Shop Drawings and Product Data for the precast structural concrete sections that include at a minimum the following information:
      b. Dimensions of all precast sections.
      c. The design camber.
      d. Details of inserts, anchors, connections, accessories, joints, and openings.
      e. The chamfer and radius of corners.
      f. The location and type of reinforcing steel.
      g. Welds.
      h. The size and type of bearings.
      i. Lifting positions and devices.
      j. Storage locations.
      k. Erection sequence and phasing consistent with overall station staging.
   3. Submit shop drawings for sections used for mock-up. See requirements above.

4. Submit installation drawings showing the installation layout of the precast concrete sections using the same identification marks used to fabricate the sections and showing lifting positions and devices. Show all inserts and field welds.
5. Submit the precast structural concrete unit manufacturer's instructions for handling, transporting, and erecting their units.
6. Spare sections: Precaster shall produce additional spare sections to keep on hand in case of damage to precast panels during shipping or erection. Produce extra 2 precast wall panels for each wall type, 1 additional precast beam for each location, 1 precast column, 2 precast arch panels for each side and 1 end precast arch panel for each side at North end.
7. Quality Assurance/Control Submittals:
   a. Design Data:
      1) Design calculations per Subparagraph 1.05.B.1.a.1, sealed by a Professional Engineer Registered in the State of Maryland.
   b. Test Reports:
      1) Concrete test reports per Subparagraph 2.04.A.3.
   c. Certifications:
      1) Design compliance certification per Subparagraph 1.05.B.1.
      2) Material compliance certification per Subparagraph 1.05.B.2.
   d. Qualifications Statements:
      1) Manufacturer experience per Subparagraph 1.05.A.1.a.
      2) Manufacturer plant certification per Subparagraph 1.05.A.1.b.
      3) Field erection supervisor’s resume per Subparagraph 1.05.A.2.b.3.

1.05 QUALITY ASSURANCE:

A. Qualifications:
   1. Manufacturer Qualifications:
      a. Experience: Submit documentation that the precast structural concrete manufacturer has been regularly engaged in manufacturing structural precast concrete for at least ten years.
      b. Plant Certification Requirements: Submit documentation that the manufacturer’s plant is certified under the Precast/Prestressed Concrete Institute’s Plant Certification Program.
   2. Erector Qualifications:
      a. Erector Crew Qualifications:
         1) Either provide an erection crew completely familiar with the erection practices of the manufacturer of the precast structural concrete units, or use the manufacturer's erection crew.
      b. Field Erector Supervisor’s Qualifications:
         1) Regardless of the choice of erector crew, employ a representative of the manufacturer of the precast structural concrete units as a field erection supervisor to provide full-time supervision of the erection of the precast structural concrete units.
         2) Employ a field erection supervisor who can demonstrate a minimum of five years continuous experience erecting precast structural concrete units.
         3) Submit the field erection supervisor’s resume.
   3. Welder Qualifications:
      a. Only employ welders for erecting the precast structural concrete units who can demonstrate they are qualified to perform the types of work required by having passed the qualification tests prescribed in AWS D1.1 for the procedures.
         1) Submit certified copies of qualification test records that indicate each welder employed to perform the Work has satisfactorily passed the AWS qualification tests for the required welding procedures.

B. Certifications:
1. Design Compliance Certification:
a. Submit evidence from the manufacturer certifying that the precast structural concrete units have been designed to meet the lifting, transportation, storage and installation loads. Precast sections were designed to meet loading requirements after being installed.
1) Submit design calculations stamped by a registered Professional Engineer in the state of Maryland for all members and connections.
2. Submit calculations for all lifting and erection inserts. Limits where the inserts are allowed to be installed are shown on Contract drawings. Coordinate with contractor and erection equipment supplier on lifting and erection inserts. Insets must be capable carrying all loads during transportation, lifting and installation. Verify that the reinforcing steel in the precast members is adequate. If needed provide additional reinforcing. Material Compliance Certification:
a. Submit evidence from the manufacturer certifying that the material complies with the requirements of the Specifications, and submit evidence to support the certification.

C. Allowable casting tolerances
1. Members shall be manufactured with a tolerance of + 0", -1/4".

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Packing, Shipping, Handling, and Unloading:
1. Follow the manufacturer's instructions for handling and transporting the products specified in this Section.
2. Handle members to protect them from dirt and damage.
a. Lift members at designated points only, and use lifting inserts if provided.
b. Use lifting slings or spreader bars to keep the angle between the lifted member and the cable greater than 45 degrees.
3. Comply with the requirements of PCI MNL-116 and PCI MNL-120.

B. Storage and Protection:
1. Do not place precast structural concrete units in positions which will cause overstress, warp, or twist in the members.
2. Place stored precast structural concrete units so that identification marks are discernible.
3. Stack precast structural concrete units so that lifting devices are accessible and undamaged.
4. Separate stacked precast structural concrete units by battens across the full width of each bearing point.

C. Fall Protection:
1. Fall protection installed overhead at crossover is available for installers to use during precast arch section installation.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Portland Cement:
1. Provide Portland cement that complies with the requirements of ASTM C150, for Type I or III.

B. Aggregates:

1. Expanded shale, clay or slate produced by the rotary kiln method and shall conform to ASTM C330. A durability report shall be available showing that concrete made from the aggregate has a minimum durability factor of 90% when tested in accordance with ASTM C666. Natural or manufactured sand shall conform to ASTM C33.

C. Water:
   1. Provide potable water or water free from foreign materials in amounts harmful to concrete and embedded steel.

D. Air-Entraining Admixture:
   1. Provide a product conforming to the requirements of ASTM C260.

E. Water-Reducing, Retarding, Accelerating, and High-Range Water-Reducing Admixtures:
   1. Provide water-reducing, retarding, accelerating, and high-range water-reducing admixture products conforming to the requirements of ASTM C494.
   2. Do not provide admixtures containing chlorides.

F. Corrosion Inhibitor Admixture:
   1. Provide corrosion inhibitor admixture products conforming to the requirements of ASTM C494, Type C; calcium nitrite.

G. Steel Reinforcing:
   1. Provide reinforcing steel conforming to the requirements of ASTM A615, Grade 60.

H. Wire:
   1. Provide wire for concrete reinforcement conforming to the requirements of ASTM A1064.

I. Clear Curing and Sealing Compound:
   1. Provide a liquid clear curing and sealing compound conforming to the requirements for Type I, Class A, specified in ASTM C1315.
   2. Provide liquid clear curing and sealing compounds which complies with low volatile organic compound (VOC) requirements. Do not coat top surface of arch panels where waterproofing coating will be applied in the field.
   3. Acceptable manufacturers:
      a. Lumiseal WB Plus™, L&M Construction Chemical, Inc.
      b. Kure-N-Seal® 25LV, BASF The Chemical Company.
      c. Superior Diamond Clear VOX, Euclid Chemical Co.
      d. Approved equal.

J. Grout:
   1. Provide a grout mixture of not less than one part Portland cement to three parts fine sand with a consistency such that joints can be substantially filled without seepage over adjacent surfaces.
   2. Provide grout having a 28-day compressive strength of 3,500 psi, minimum.

K. Sealant:
   1. Provide gun-grade caulking as specified in Section 07900.

L. Structural Steel Plates and Shapes:
   1. Provide structural stainless steel plates and shapes conforming to the requirements of ASTM Type 304. See contract drawings for embedded stainless steel plates.

2.02 FABRICATION

A. Comply with the manufacturing procedures and tolerances in PCI MNL-116.

B. Precast Structural Concrete Members:
   1. Fabricate the precast structural concrete members by casting concrete in smooth rigid forms on long production lines.
   2. Fabricate units in widths shown on contract drawings.

C. Compressive Strength:
   1. Cure the units at the manufacturer's plant by steam curing or other suitable method to secure a 5,000 psi minimum compressive strength after 28 days.

D. Unit Weight:
   1. Materials shall be proportioned to produce concrete with a maximum equilibrium density of 120 pcf at 28 days age, as determined by ASTM C567.

E. Corrosion Inhibitor Admixture:
   1. Add corrosion inhibitor admixture at the rate recommended by the product manufacturer.
   2. Decrease water in mix to account for addition of admixture.

F. Provide a concrete cover over reinforcing in accordance with ACI 318/318R unless noted otherwise on the Contract Drawings.

2.03 FINISHES

A. Finish the precast structural concrete in conformance to the requirements of PCI MNL-116.

B. For surfaces to be painted, provide the finish required by paint manufacturer.

2.04 SOURCE QUALITY CONTROL

A. Concrete Compression Tests.
   1. Test Method:
      a. Direct the precast arch manufacturer to test the concrete compressive strength of the concrete used to fabricate the arches in accordance with the requirements of ASTM C39.
      b. Mold and cure four test specimens for each concrete compression test in accordance with ASTM C31.
      c. Perform at least one concrete compression test for each 75 cubic yards of concrete, but not less than one concrete compression test for each day's production of concrete arches.
   2. Acceptance Criteria:
      a. Test two specimens to verify stress transfer strength, and test two additional specimens after 28 days for acceptance.
      b. The strength level of the concrete is satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual test result is below the specified strength by more than 500 psi.
   3. Test Reports:
      a. Submit reports that document the results of all concrete tests and inspections performed immediately after the work is performed.
      b. In the reports, state whether the tested and inspected items comply with specified requirements or deviate from them.

B. Non-Conforming Test Results:
   1. If the strength of the tested cylinders falls below the specified compressive strengths, the Engineer has the authority to order a change in the mix proportions for the remaining concrete being poured.
   2. If required by the Engineer, obtain and test core specimens from the hardened concrete arches in accordance with ASTM C42.

PART 3 EXECUTION

3.01 PREPARATION

A. Anchor Bolts for Precast Wall Panels:
   1. Install anchor bolts for precast wall panels accurately in the positions shown on contract drawings.
   2. Ensure that the anchor bolts are firmly held in their correct position and elevation by using suitable templates.

3.02 ERECTION

A. Do not install warped, cracked, or broken sections.
   1. Remove warped, cracked, or broken sections from the site, and replace them with new undamaged sections at no increase in Contract Price.
   2. All members must be inspected and dimensions verified before shipped.

B. Erect sections in accordance with manufacturer's instructions using equipment recommended or supplied by the manufacturer.

C. Perform field welding according to AWS D1.1, AWS D1.4 and AWS D1.6.

D. Align and level sections before grouting the keys.
   1. Mix, place, and cure grout as specified in Section 03621.
   2. Finish the underside of joints between precast members using joint backing, i.e. backer-rod and gun-grade sealant.
      a. Apply sealant as specified in Section 07900.

E. Furnish headers for openings where additional structural support is required.
   1. As the Work of this Specification Section, provide openings through the precast structural concrete sections to accommodate the Work of other Specification Sections.
   2. Make these openings in accordance with the manufacturer's recommendations and opening size limitations.

F. Apply waterproofing membrane to the top side of the arch members as specified in Section 07130 - Waterproofing.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 03621

NON-METALLIC NON-SHRINK GROUTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies furnishing and placement of non-metallic non-shrink grouting capable of delivery under pressure.

B. Related Work Specified Elsewhere:

1. Concrete Formwork: Section 03110.
2. Concrete Reinforcement: Section 03210.
3 Self-Consolidating Concrete: Section 03312.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. American Society for Testing and Materials (ASTM):

a. ASTM C 78 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
b. ASTM C 191 – Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle.
c. ASTM C 469 – Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
d. ASTM C 496 – Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
e. ASTM C 531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
f. ASTM C 666 – Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
g. ASTM C 939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
h. ASTM C 942 – Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
i. ASTM C 1090 – Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout.
j. ASTM C 1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
k. ASTM C 1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
l. ASTM E 488 – Standard Test Methods for Strength of Anchors in Concrete Elements.

2. COE CRD-C621 – Specification for Non-Shrink Grout.
3. ICRI 310.2 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
4. ISO 9001:2008 – Quality Management Systems – Requirements.
5. NSF/ANSI 61 – Drinking Water System Components - Health Effects.

B. Manufacturer's Qualifications:

1. Manufacturer regularly engaged, for past 15 years, in manufacture of non-shrink grout of similar type to that specified.
2. ISO 9001:2008 certified.

C. Applicator's Qualifications:

1. Applicator regularly engaged, for past 5 years, in application of non-shrink grout of similar type to that specified.
2. Employ persons trained for application of non-shrink grout.

1.03 SUBMITTALS

A. Submit the following for approval by the Authority:

1. Product Data: Submit manufacturer's product data, including surface preparation, forming, mixing, placing, and curing instructions.
2. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
3. Manufacturer's Project References: Submit manufacturer's list of successfully completed non-shrink grout projects, including project name and location, name of architect or engineer, and type and quantity of non-shrink grout furnished.
4. Applicator's Project References: Submit applicator's list of successfully completed non-shrink grout projects that required installation similar to the installation described in the Contract Drawings and these specifications. Include the project name and location, project description, name of architect or engineer, and type and quantity of non-shrink grout placed.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage and Handling Requirements:

1. Store and handle materials in accordance with manufacturer's instructions.
2. Keep materials in manufacturer's original, unopened containers and packaging until application.
3. Store materials in clean, dry area indoors.
4. Do not store materials directly on floor.

5. Protect materials during storage, handling, and application to prevent contamination or damage.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Non-Shrink Grout:

1. Description: 1-component, high-precision, non-shrink, hydraulic cement-based, graded mineral-aggregate grout with extended working time.
2. Compliance:
   a. ASTM C 1107.
   b. CRD-C621, Grades B and C.
   c. NSF/ANSI 61 approved. Suitable for use with potable water.
3. VOC Content: 0 lbs per gal (g/L).

B. Physical Properties Test Data:

1. Compressive Strength, Fluid Consistency, ASTM C 942, according to ASTM C 1107:
   a. 1 Day: 3,500 psi (24 MPa).
   b. 3 Days: 4,500 psi (31 MPa).
   c. 7 Days: 6,500 psi (45 MPa).
   d. 28 Days: 7,500 psi (52 MPa).
2. Volume Change, Fluid Consistency, ASTM C 1090:
   a. 1 Day: Greater than 0 percent change.
   b. 3 Days: 0.04 percent change.
   c. 14 Days: 0.05 percent change.
   d. 28 Days: 0.06 percent change.
3. Setting Time, Fluid Consistency, ASTM C 191:
   a. Initial Set: 4.5 hrs.
   b. Final Set: 6.0 hrs.
4. Flexural Strength, Fluid Consistency, ASTM C 78:
   a. 3 Days: 1,000 psi (6.9 MPa).
   b. 7 Days: 1,050 psi (7.2 MPa).
   c. 28 Days: 1,150 psi (7.9 MPa).
5. Modulus of Elasticity, Fluid Consistency, ASTM C 469 Modified:
   a. 3 Days: 2.82 x 106 psi (1.94 x 104 MPa).
   b. 7 Days: 3.02 x 106 psi (2.08 x 104 MPa).

c. 28 Days: 3.24 x 106 psi (2.23 x 104 MPa).

6. Coefficient of Thermal Expansion, Fluid Consistency, ASTM C 531: 6.5 x 10-6 in/in/degree F (11.7 x 10-6 mm/mm/degree C).

7. Punching Shear Strength, Fluid Consistency, BASF Method:

   a. 3 Days: 2,200 psi (15.2 MPa).

   b. 7 Days: 2,260 psi (15.6 MPa).

   c. 28 Days: 2,650 psi (18.3 MPa).

8. Splitting Tensile Strength, Fluid Consistency, ASTM C 496:

   a. 3 Days: 575 psi (4.0 MPa).

   b. 7 Days: 630 psi (4.3 MPa).

   c. 28 Days: 675 psi (4.7 MPa).

9. Tensile Strength, Fluid Consistency, ASTM C 190:

   a. 3 Days: 490 psi (3.4 MPa).

   b. 7 Days: 500 psi (3.4 MPa).

   c. 28 Days: 500 psi (3.4 MPa).

10. Ultimate Tensile Strength, Fluid Consistency, ASTM E 488:

    a. 5/8-inch (16-mm) diameter by 4-inch (102-mm) depth: 23,500 lbs (10,575 kg).

    b. 3/4-inch (19-mm) diameter by 5-inch (127-mm) depth: 30,900 lbs (13,905 kg).

    c. 1-inch (25-mm) diameter by 6.75-inch (171-mm) depth: 65,500 lbs (29,475 kg).

11. Bond Stress, Fluid Consistency, ASTM E 488:

    a. 5/8-inch (16-mm) diameter by 4-inch (102-mm) depth: 2,991 psi (20.3 MPa).

    b. 3/4-inch (19-mm) diameter by 5-inch (127-mm) depth: 2,623 psi (18.1 MPa).

    c. 1-inch (25-mm) diameter by 6.75-inch (171-mm) depth: 3,090 psi (21.3 MPa).

12. Resistance to Rapid Freezing and Thawing, 300 Cycles, ASTM C 666, Procedure A: RDM 99 percent.

C. Mixing Water: Potable water.

D. Membrane Curing Compound: ASTM C 1315.

E. Epoxy Resin System: Provide a system conforming to the strength requirements of ASTM C 881 for epoxy injection.

F. Epoxy Resin Concrete Sealer:

1. General. An epoxy-type base polymer, thermosetting resin as follows:

   a. Composed of 100% reactive constituents (condensation products of the reaction of epichlorohydrin with bisphenol A).

   b. Essentially pure, diglycidyl-ether of bisphenol A, containing no more than trace amounts of hydrolyzable chlorine.

c. Epoxide equivalent between 465 and 530.

d. Reacting system consisting of a blend of condensation polymers of dimerized and trimerized unsaturated, fatty-acids and an aliphatic polyamine.

e. Pigmentation added so the cured coating conforms to the Federal Color Standard 595, Color – Grey (16473 to 16492). Care shall be taken to ensure color consistency between retrofits.

2. Physical Requirements of the Mixed Epoxy System.

a. Viscosity - 300 centipoises to 700 centipoises at 72°F

b. Pot Life - a minimum of 7 hours at 75°F

c. Minimum solids content - 48%

d. A cured system that does not exhibit amine blushing or sweating.

e. When the pigmented finished coats are tested for abrasion, according to ASTM D 968, a minimum of 25 L of sand is required to abrade a 1-mil thickness of coating. A 2 ½-mil dry film thickness of the coating, tested by ASTM D 522, is required to pass a ⅛-inch diameter mandrel test, without splitting the film or causing loss of bond.

3. Packaging and Marking:

a. Furnish the two components in separate containers that are nonreactive with the contained materials. If directed, provide a container size so the recommended final mixture proportions can be obtained by combining one container of a component with one or more containers of the other component. Have containers marked as base polymer and reacting system, showing the mixing directions and usable temperature range. Have each container marked with the name of the manufacturer, the lot or batch number, the date of packaging, pigmentation, if any, and the quantity in pounds and gallons.

Indicate the potential hazards on the package, according to the Federal Hazardous Products Labeling Act.

4. Certification:

a. Provide either a copy of the manufacturer's dated test report or a statement, accompanied by a copy of the dated test results, showing the system has been sampled and tested.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive non-shrink grout.

B. Notify Authority Representative of conditions that would adversely affect surface preparation or application.

C. Do not begin surface preparation or application until unacceptable conditions are corrected.

3.02 SURFACE PREPARATION

A. Prepare surfaces in accordance with manufacturer's instructions.

B. Clean steel surfaces to be free of dirt, dust, oil, grease, and other contaminants.

C. Concrete Surfaces to be Grouted:

1. Cured Concrete: Clean, saturated surface-dry (SSD), sound, and roughened to CSP of 5 to 9 in accordance with ICRI 310.2 to permit proper bond.

2. Freshly Placed Concrete: Achieve required surface profile in accordance with manufacturer's instructions.

3. When Dynamic, Shear, or Tensile Forces are Anticipated:

a. Roughness of plus or minus 3/8 inch (10 mm) in accordance with manufacturer's instructions.

b. Verify absence of bruising in accordance with ICRI 310.2.

D. Saturate concrete surfaces with clean water for 24 hours just before grouting.

E. Remove freestanding water from foundation and bolt holes immediately before grouting.

F. Grout anchor-bolt holes and allow to sufficiently set before major portion of non-shrink grout is placed.

G. Shade surface from sunlight for 24 hours before grouting.

3.03 FORMING

A. Build forms for non-shrink grout in accordance with manufacturer's instructions.

B. Build forms to be liquid tight and nonabsorbent.

3.04 MIXING

A. Add water to non-shrink grout and mix in accordance with manufacturer's instructions.

B. Use minimum amount of water required to achieve necessary placement consistency.

C. Do not use more water than necessary to achieve 25 to 30 second flow in accordance with ASTM C 939.

D. Do not retemper non-shrink grout by adding water.

E. Do not add plasticizers, accelerators, retarders, or other additives to non-shrink grout, unless approved by manufacturer.

F. Store and mix non-shrink grout to produce mixed-grout temperature in accordance with manufacturer's instructions.

3.05 FIELD QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for the first 48 hours or for additional time as may be required before transporting samples to the test lab.

2. Provide concrete for testing of density (unit weight) and temperature and, for making cylinders.

B. Consult with the manufacturer in developing quality control operations appropriate to the project.

C. Field testing and inspection shall be performed in accordance with ACI 301.

D. Concrete tests shall be conducted by an ACI Concrete field Testing Technician Grade I, or equivalent, knowledgeable in testing self-consolidating concrete.

E. Tests shall be conducted on each lot of concrete mixture placed.

F. The testing agency shall provide the following services:

1. Inspect grout placement.

2. Sample the grout in accordance with ASTM C 172.

3. Determine the density (unity weight) of concrete sample for each strength test in accordance with ASTM C 138, except that the concrete shall be filled in one lift and not consolidated.

4. Record the temperature of concrete for each strength test in accordance with ASTM C 1064.

5. Cast concrete specimens for compressive strength test as follows:

   Cast and cure at least four 6-inch by 12-inch cylinders per lot of grout. One lot of grout is considered to be an adequate quantity to complete one grout pad or mock-up. Cast and cure cylinders in accordance with ASTM C 31, except that the concrete shall be placed in one lift and not consolidated. However, light tapping of the sides of the cylinders with an open hand is permitted.

6. Record the fresh concrete data for each set. The datasheet shall include the following:

   a. Mixture number

   b. Specified 28-day strength

   c. Date and time of batching

   d. Time of testing

   e. Location of placement

   f. Ambient temperature

   g. Names and quantities of admixtures added on site, and, name and title of the person who authorized the addition

   h. Set number, if more than one set of cylinders are cast on a single day

   i. Name of the testing agency

   j. Name and signature of the inspector who conducted the test, and

   k. Any additional observations or comments.

11. Mark the cylinders and write the date of casting on each cylinder.

12. Store and protect the cylinders from job site to the laboratory in accordance with ASTM C 31.
13. Transport the cylinders and write the date of casting on each cylinder.
14. Cure the cylinders in the laboratory in accordance with ASTM C 31.
15. Test cylinders for compressive strength in accordance with ASTM C 109 or ASTM C 39 as applicable.
    a. Test two cylinders at 7 days and two cylinders at 28 days for acceptance.
16. Base strength value on the average of at least two 6-inch by 12-inch cylinders tested at 28 days.
17. Test report shall include all the information in Item 10 above and compressive strength data, and shall be signed by the laboratory manager.
18. Strength of concrete shall be deemed satisfactory if both of the following requirements are met (ACI 318):
    a. Every arithmetic average of any two consecutive compressive strength test equals or exceeds the specified compressive strength, and
    b. No compressive strength test falls below the specified compressive strength by more than 500 psi (3.5 MPa).

    If any strength test of laboratory-cured cylinders falls below the specified compressive strength by more than the values specified above, remedial measures shall be taken as recommended by the Authority Representative.

G. Damaged or Defective Grout Pads

1. Each grout pad cast will be jointly inspected by the Authority Representative and Contractor after casting and form removal. Identify and categorize all defects during these inspections. Examine the defects and furnish to the Authority Representative a solution in writing that proposes:
    a. Measures that the Contractor will take to prevent recurring defects in future grout pads.
    b. The repair method for all defects discovered as a result of the inspection as required herein. If recurring defects continue, following implementation of the Contractor's preventive measures, or as detected at any time during the construction, the Contractor will cease operations producing such defective grout pads. The Contractor will then examine the defects and propose to the Authority Representative, in writing:
        (1) The measures the Contractor will take to prevent recurring defects in future grout pads.
        (2) The method of repair of all defects discovered as a result of the inspection as required herein. The Authority Representative will determine what constitutes damage or defect, whether the damage or defect is isolated or recurring, and will categorize the damage or defects. Two categories of defects are recognized by the Authority Representative for this purpose:

i. Cosmetic: Cosmetic defects or damages are those which do not affect the ability of the grout pad to resist construction or service loads or reduce its life expectancy. This category of defect includes a superficial discontinuity such as non-structural cracks, generally less than or equal to 0.012-inches wide, small spalls or honeycombed areas, or any defect that does not extend beyond the centerline of any reinforcing steel.

Cosmetic defects of other types and causes may also be designated by the Authority Representative.

Repair of cosmetic defects are to be made in such a manner that the aesthetics and the structural integrity of the grout pads are restored.

ii. Structural: This category of defect includes any defect that will impair the ability of the grout pad to adequately resist construction or service loads or reduce its life expectancy. Any defect or damage that extends beyond the centerline of any reinforcing steel is considered a structural defect. Examples of such defects include cracks wider than 0.012-inches, large spalls and honeycombed areas, and major segregation or breakage of concrete. Structural defects of other types and causes may be designated by the Authority Representative.

Repair of structural defects must be such that the aesthetics and structural integrity of the grout pad be completely restored to an expected condition had the defect or damage not occurred.

H. Repairs

1. Cosmetic repairs are only to be made as per this specification.

Structural repairs are to be made by the following procedures prepared by the Contractor. The repair procedure must be signed and sealed by a Registered Professional Engineer representing the Contractor, be submitted in writing to the Authority Representative, and include the following minimum information:

a. A detailed description and sketch of the defect.

b. The magnitude and type of the most critical construction and service loading condition to which the defective area will be subjected.

c. Detailed reinforcement requirements, material types, surface treatments, curing methods, and general repair procedures proposed.

d. The specific nondestructive testing method and procedure by which the Contractor is to demonstrate to the Authority Representative that the defect no longer exists and the retrofit has been restored to a condition to be expected had the defect or damage not occurred.

2. Repair Procedures

a. Deep Voids: Voids extending beyond the centerline of a reinforcing bar, into a post-tensioning element, and/or with a depth greater than 2" and with a surface area greater than 6 square inches will be considered “Structural Repairs” requiring repair in accordance with the following:

(1) Saw cut the perimeter of the affected area to a depth of at least ½". Chip away all partially consolidated material until sound concrete is encountered. If reinforcing steel passes through the void, expose the full diameter plus ½". Clean the exposed portions of reinforcing steel of any misplaced concrete. Remove any remaining dirt, oil, paint, or other deleterious substances by 3,000 psi water blasting. Remove all other debris with compressed air. Prior to patching concrete, prepare parent concrete to a saturated surface dry condition without any standing water or per the recommendations of the patch material manufacturer. Attach wood or steel forms as necessary to contain the patching concrete.

(2) Coat all surfaces of the void with an Authority Representative approved bonding agent (or other suitable material as approved by the Authority Representative). Fill the void with concrete of the same mix design and strength as the retrofit; cover and allow to cure properly using the curing procedures discussed in these specifications. To ensure proper bond, place concrete within the time limit specified by the bonding agent manufacturer.

(3) Finish the patched area to match the surrounding concrete. Use similar constituent materials, such that color differences between the repaired area and existing concrete are minimized.

(4) Commercially available concrete patching systems may be used if submitted to, and approved by, the Authority Representative.

b. Shallow Voids (less than the specified cover). Voids shallower than cover depth and smaller than 6 square inches in surface area will be considered “Cosmetic Repairs” requiring repair in accordance with the following:

(1) Saw cut the perimeter of the void to a depth of ½". Chip away all partially consolidated material until sound concrete is encountered. Remove any dirt, oil, paint, or other deleterious substances by 3,000 psi water blasting. Remove all other debris with compressed air.

(2) Prior to patching concrete, prepare parent concrete to a saturated surface dry condition without any standing water or per the recommendations of the patch material manufacturer.

(3) Fill the void per the recommendations of the manufacturer, using an approved non-sag mortar or other suitable material approved by the Authority Representative.

(4) Finish the patched area to match the existing concrete. Minimize color differences between the repaired area and existing concrete.

c. Cracks - Cracks are classified as Structural or Non-Structural. Structural cracks are those induced by external forces that produce internal stresses exceeding the tensile strength of the concrete. Nonstructural cracks are those that appear as a result of component material characteristics, environmental effects, and local constraints or shrinkage. Notify the Authority Representative of any cracks. The Authority Representative will determine the crack classification. Do not seal or repair structural cracks without approval from the Authority Representative.

(1) Treat non-structural cracks as follows:

i. Seal cracks 0.007 to 0.012 inches wide with an epoxy sealer. Seal cracks from 0.012 inches to 0.024 inches wide by injecting with epoxy according to the procedure outlined below. Cracks wider than 0.024 inches will require further investigation.

(a) Procedure for Epoxy Injection:

(i) Drill holes and install plastic injection ports at approximately 8 inches on center.

(ii) Seal crack between ports with an epoxy (or other similar material) approved by the Authority Representative.

(iii) Inject crack with epoxy (or other similar material) approved by the Authority Representative using a hand pump. Begin injection from the lowest port and continue until epoxy runs out of the next highest port. Move to the next port and repeat the process until the entire crack is filled.

d. Entrapped Air Pockets (Bug Holes). Entrapped air pockets are considered “Cosmetic”. Fill entrapped air pockets in the exterior surface of the concrete and sack the surface with burlap. Use a non-shrink, non-sag mortar approved by the Authority Representative, and follow the recommendations of the manufacturer. Cure properly using curing procedures discussed in this specification.

e. This work may not be the basis for any request for extension of time or additional compensation.

3.06 PLACING

A. Place non-shrink grout in accordance with manufacturer’s instructions at locations indicated on the Drawings.

B. Place non-shrink grout in one continuous pumping procedure per pad. The grout inlet shall be located as low as possible into the area to be grouted. A vent hole shall be located as high as possible into the area to be grouted. The pumping procedure shall continue until grout flows from the vent hole. A minimum of 3 gallons of grout shall be evacuated through the vent hole or a suitable amount to ensure no entrapment of air or water within the area to be grouted.

C. Place non-shrink grout to prevent entrapment of air or water within the area to be grouted.

D. Ensure non-shrink grout fills entire space being grouted and remains in contact with all surfaces.

E. Discard grout that becomes unworkable.

F. Do not vibrate grout.

G. Trim non-shrink grout surfaces immediately after placement and cover exposed grout with clean wet rags, not burlap. Maintain this moisture until grout surface is ready for finishing or until final set.

H. Placement Depth:

Full depth as indicated in the Contract Drawings. Lifts over 6 Inches in depth shall be placed in accordance with the manufacturer's instructions.

I. Coordinate placement with WMATA for a time window to complete activities in accordance with construction sequencing.

3.07 FINISHING

A. Grout finish shall be smooth in all exposed areas.

B. After the forms are removed, correct irregularities in the exposed concrete surfaces. Exposed surfaces are surfaces above normal ground level or water level, when applicable, and surfaces that will not be concealed by other construction. Irregularities include fins, protrusions, individual holes larger than 1 inch in any dimension, and clusters of smaller holes.

3.08 CURING

A. Cure non-shrink grout in accordance with manufacturer's instructions.

B. Cure exposed non-shrink grout with membrane curing compound immediately after wet rags are removed, to minimize potential moisture loss within grout.

C. Shade grout from sunlight for 24 hours after completed placement.

D. Ensure contact surfaces and grout temperatures do not fall below 40 degrees F (4 degrees C) until after final set, when grouting at minimum temperatures.

E. Protect non-shrink grout from freezing until it has attained compressive strength of 3,000 psi (21 MPa).

3.09 PROTECTION

Protect placed non-shrink grout from damage during construction.

3.10 EPOXY INJECTION

After grout is fully cured, inspect for voids between the grout pad(s) and contact surfaces. If voids are present epoxy inject the voids with a two part, high solids crack injection epoxy designed to repair cracks in concrete that is suitable to achieve full contact between the grout pad(s) and the contact surface.

3.11 SEALING

A. Apply epoxy resin protective coating for concrete surfaces to all exposed concrete surfaces of the retrofits as follows:

1. Do not apply epoxy to any given retrofit until 28 days after the final placement of concrete or grout at that retrofit or before any portion of the retrofit has achieve its 28 day strength. Do not use membrane-forming curing compounds where epoxy treatment is to be applied.

2. Protect surrounding areas, landscaping features, plantings and surfaces not to be sealed from possible spatters, spills, and drips during application of the sealer. In the event that sealer spatters, spills, or drips onto a surface not to be sealed, clean the sealer from the surface immediately in accordance with the manufacturer's instructions.

3. Restrict public access to areas below surfaces being sealed and an appropriate safety margin during the sealer application.

4. Measure and mix, as recommended by the manufacturer of the epoxy, in a clean mixing container. Thoroughly mix the epoxy using a 400 rpm to 600 rpm (low speed, ± 2-inch) electric drill, and paddle-type mixer. After mixing, let the material stand for an induction period of one hour before application.

5. Apply the mix by brush or roller. If applied by roller, use a first-quality, long-nap roller for rough surfaces and a short-nap roller for smooth surfaces. Spray application is not permitted.

   Apply two thin, uniform coats of the mixed material, each approximately 2 mils to 3 mils dry film thickness (4 mils to 5 mils wet thickness). Apply the second coat 24 hours after the application of the first coat. Use a rate of coverage as recommended by the manufacturer of the epoxy resin sealer. Apply at temperatures between 60°F and 90°F.

END OF SECTION

THE PAGE LEFT BLANK INTENTIONALLY

SECTION 03720

REPAIR OF EXISTING CONCRETE

PART 1 GENERAL

1.01 SUMMARY:

A. Section Includes: The work specified in this section consists of repairs to portions of the existing concrete. Types of repair to be made include but are not limited to:
1. Repair of surface spalls and cracks in existing concrete.
2. Installation of drainage hose at locations of severe water infiltration.

1.02 REFERENCES:

A. ASTM International (ASTM):
1. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
2. ASTM C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
3. ASTM C267, Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
4. ASTM C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
5. ASTM C496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
6. ASTM C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
7. ASTM D1042, Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.

B. Army Corps of Engineers (USACE):
1. CRD C48, Standard Test Method for Water Permeability of Concrete

1.03 SUBMITTALS:

A. Product Data: Submit manufacturer's descriptive product data and current specifications for materials proposed for the work of this section. Provide a certification stating that the repair materials meet the specified requirements.

1.04 QUALITY ASSURANCE:

A. Concrete Repair Product Manufacturer Qualifications: The manufacturer of the specified product shall have in existence, for a minimum of 10 years, a program of training, certifying, and technically supporting a nationally organized Approved Contractor Program with annual re-certification of its participants.

B. Contractor Qualifications: Contractor shall have at least five years of experience in concrete repair services. The Contractor shall also be an Approved Contractor of the manufacturer of the specified product, who has completed a program of instruction in the use of the specified material, and shall provide a notarized certification from the manufacturer attesting to their Approved Contractor status.
1. Contractors shall provide the Engineer with two job references where they have successfully repaired existing concrete with the specified product.

C. Manufacturer's Representative Services: The Contractor shall arrange for and provide the services of the product manufacturer's technical representative to be on-site during the startup repair operation.
1. Services shall include detailed instructions to the Contractor's personnel on the use of the concrete repair material.

D. 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.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Delivery and Handling: Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.

B. Storage: Store the specified product as recommended by the manufacturer.

1.06 PROJECT CONDITIONS:

A. The Contractor shall inspect the existing concrete surfaces and confirm the location, limits, and type of repair required. Repairs of deteriorated concrete specified by quantities listed on the Contract Drawings. The Contractor shall not perform any repair work without prior approval of the Authority Representative.

B. Reinforcement may be encountered within the repair region.

PART 2 PRODUCTS

2.01 CEMENTITIOUS POLYMER MORTARS:

A. Crack Injection: (Type 1 Crack): Low viscosity, expanding, polyurethane chemical grout to stop water infiltration
1. NSF/ANSI 61 approved for potable water content
2. Tensile Properties, ASTM D 638
3. Tensile Strength: 29 psi
4. Elongation Properties,
5. Elongation 44%
6. Shrinkage Properties, ASTM D1042
7. Less than 1%
8. Acceptable Manufacturer:
a. Sika Corporation: SikaFix HH LV
b. Euclid Chemical Corp.: Dural Aqua-Dam LV

B. Cementitious Crystalline Waterproofing: (Type 2 Concrete Repair): Blend of portland cement, fine treated silica sand and active chemicals that react with water to form a non-soluble crystalline formation of dendritic fibers within the pores and capillary tracts of concrete.
1. Crystalline Penetration: Crystallizing capability of waterproofing material shall be evidenced by independent SEM (Scanning Electron Microscope) photographs documenting penetration of crystal-forming waterproofing material to a depth of 2 inches (50 mm).
2. Permeability: Independent testing shall be performed according to U.S. Army Corps of Engineers CRD C48 "Permeability of Concrete."
a. Concrete samples (treated and untreated) to have design strength of 2000 psi (13.8 MPa) and thickness of 2 inches (50 mm). No admixtures permitted.

b. Coatings to have maximum thickness of 0.05 inches (1 mm) per coat with up to two coats permitted.
c. Samples to be pressure tested to 175 psi (405 foot head of water) or 1.2 MPa (123.4 m head of water).
d. Treated samples, after crystalline growth has occurred, shall exhibit no measurable leakage.

3. Chemical Resistance: Independent testing shall be performed according to ASTM C267 “Chemical Resistance of Mortars” and ASTM C39 “Compressive Strength of Cylindrical Concrete Specimens.”
   a. Concrete samples (treated and untreated) to have design strength of 4000 psi (27.6 MPa). No admixtures permitted.
   b. Coatings to have maximum thickness of 0.05 inches (1 mm) per coat with up to two coats permitted.
   c. Untreated and treated specimens to be immersed for a minimum of 84 days in following chemical solutions: hydrochloric acid (3.5pH), brake fluid, transformer oil, ethylene glycol, toluene, caustic soda.
   d. Treated specimens shall exhibit no detrimental effects after exposure, and shall have a minimum of 14% increase in compressive strength versus untreated control specimens.
4. Acceptable Manufacturer:
   a. Xypex Chemical Corporation

C. Polymer Repair Mortar:
1. Repair of Horizontal Surfaces (Type 3 & 4 Concrete Repair):
   a. Polymer-modified, cementitious, 2-component, free-flow self-leveling mortar such as SikaTop 111 Plus as manufactured by Sika Corporation.
   b. Polymer-modified, cementitious, 2-component, trowel-grade patching mortar such as SikaTop 122 Plus as manufactured by Sika Corporation.
2. Repair of Vertical and Overhead Surfaces (Type 3 & 4 Concrete Repair):
   a. Polymer-modified, cementitious, 2-component, fast-setting mortar such as SikaTop 123 Plus, Gel Mortar, as manufactured by Sika Corporation.

D. Bonding Compound
1. Provide Bonding Compound on excavated surfaces (Type 3, 4, & 9 Concrete Repair)
2. Acceptable Manufacturer:
   a. Sika Corporation: Sika Armatec 110 EpoCem

E. Crack Injection, Structural Repair: (Type 7 Concrete Repair): A two-component, super low-viscosity, crack healing, epoxy resin for both dry and damp cracks that structurally improves concrete surface.
1. Tensile Properties, ASTM D-638
   a. Tensile Strength at 7 days: 7,100 psi
2. Bond Strength, ASTM C-882
   a. Hardened Concrete to Hardened Concrete at 2 days: 2,500 psi
   b. Hardened Concrete to Steel at 2 days: 1,500 psi
3. Flexural Properties, ASTM D-790
   a. Flexural Strength at 7 days: 8,500 psi
4. Shear Strength, ASTM D-732
   a. Shear Strength at 7 days: 5,800 psi
5. Compressive Strength
   a. Compressive Strength at 28 days at 90°F: 10,000 psi

6. Acceptable Manufacturer:
   a. Sika Corporation: Sikadur 55 SLV

F. Gravity Crack Repair: (Type 8 Concrete Repair): Low viscosity, high strength epoxies resin.
1. Tensile Properties, ASTM D-638
   a. Tensile Strength at 7 days: neat 8,900 psi
2. Bond Strength, ASTM C-882
   a. Bond Strength at 2 days 4,000 psi
3. Compressive Strength, ASTM D-695
   a. Compressive Strength at 28 days: neat at 90 degrees 10,500 psi
4. Acceptable Manufacturer:
   a. Sika Corporation: Sikadur 35, Hi-Mod LV

2.02 DRAINAGE HOSE INSTALLATION

A. Modular Seal Assembly
1. Seal shall be modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   a. Elastomeric element shall be sized and selected per manufacturer's sizing procedure.
2. Modular seal pressure plates shall be a uniform pressure plate design molded of glass reinforced Nylon Polymer.
3. Modular seal hardware shall be sized according to the manufacturer's technical data. Bolts, allen head/flange hex nuts shall be either:
   a. Mild Steel with a 60,000 psi minimum tensile strength and 2-part Zinc Dichromate coating.
   b. 316 Stainless Steel with a 85,000 psi average tensile strength.
4. Acceptable Manufacturer:
   a. PSI-Thunderline/Link-Seal

B. Thick-Wall PVC Pipe and Pipe Fittings
1. Threaded (NPT) Schedule 80 Pipe Nipple
   a. Threaded on one end
   b. 1 ½" Pipe Size
2. 90° Elbow
   a. Female NPT Threaded Ends
   b. 1 ½" Pipe Size
3. By McMaster-Carr or equal.

C. Nylon Extra-Grip Barbed Tube Fittings
1. Straight Adapter
   a. Tube-to-Male Threaded Pipe
   b. 1 ½" Pipe Size
2. 90° Elbow
   a. Tube-Tube
   b. 1 ½" Pipe Size
3. By McMaster-Carr or equal.

D. Flexible Tubing: High-Pressure PVC Tubing
1. Walls of tubing to be embedded with polyester braid
2. Clear walled tubing

3. By McMaster-Carr or equal.

2.03 MATERIAL SUBSTITUTIONS:

A. The use of other than the specified products will be considered providing the contractor requests their use in writing to the Engineer. This request shall also be accompanied by (a) A certificate of compliance from an approved independent testing laboratory that the proposed substitute products meet or exceed the specified performance criteria, tested in accordance with the specified test standards; and (b) Documented proof that the proposed substitute products have a five year proven record of performance, confirmed by actual field tests and five successful installations that the Engineer can investigate.

PART 3 EXECUTION

3.01 PREPARATION:

A. Type 1 through Type 4 and Type 7 through Type 8 repair procedures are defined in this section with additional guidelines given on the Contract Drawings.

B. Contractor to perform inspection of tunnel lining by sounding of the concrete.

3.02 TYPE 1 REPAIR- INJECTION REPAIR CONCRETE CRACKS/JOINTS:

A. Repair Procedure:
1. Crack must be clean and sound. All efflorescence shall be removed prior to injecting.
2. Drill 5/8” diameter holes along the side of the crack/joint at a 45° angle.
3. Follow manufacturer’s recommendations for installation.
4. Once ports are used and crack/joint is completely injected, knock off outside of port, and cover the hole with polymer repair mortar.

3.03 TYPE 2 REPAIR – CEMENTITIOUS CRYSTALLINE WATERPROOFING:

A. General: This work consists of repair of cracks as indicated on the drawings.
1. Rout out crack in a “U” shaped slot 1” wide and at least 1.5” deep. A “V” shaped slot is not acceptable.
2. Remove all loose material and saturate with water. Allow water to soak into concrete and then remove all surface water.
3. Apply one slurry coat at a coverage of 1.5 lb./sq. yd. to slot and to 6” strip on either side of slot. Application may be performed by brush or gloved hand.
4. While slurry coat is still tacky, fill slot to surface. Compress it tightly using a pneumatic packing device or a hammer and block.
5. Wet surface lightly with water, then apply a slurry coat at a coverage of 1.5 lb./sq. yd. over the repaired area and to 6” strip on either side of slot.
6. Cure by fog spraying periodically with water for two days.

3.04 TYPE 3 REPAIR – SHALLOW CONCRETE SPALL:

A. General: This work consists of the removal of unsound concrete and the repair of spalled and delaminated concrete surfaces for an area of five square feet or less, and one inch or less in depth, unless otherwise indicated on the drawings.

B. Repair Procedure:

1. Inspection: Inspect concrete surfaces to be repaired under work of this section to determine the exact limits and locations of those areas to be repaired.
2. Make a one-inch-deep saw cut around the perimeter of the repair area. Remove spalled, scaled, loose, and deteriorated concrete to sound concrete. Use maximum 30 pound size pneumatic hammer or other approved method to remove deteriorated concrete. Thoroughly blast and vacuum the newly exposed area prior to installing repair mortar. Remove all debris from the site.

C. Minimum ambient and substrate temperature at time of application: 45º F and rising.

3.05 TYPE 4 REPAIR – DEEP CONCRETE SPALL:

A. General Requirements: This consists of the removal of unsound concrete and the repair of spalled and delaminated concrete surfaces in areas greater than five (5) square feet and greater than one inch (1") deep, using repair mortar with pea gravel. Contact manufacturer for recommended amount of pea gravel.

B. Mixing:
1. Follow manufacturers' recommendations.

C. Repair Procedure:
1. Inspection: Inspect concrete surfaces intended to be repaired under work of this section to determine the exact limits and locations of those areas.
2. Make a one-inch deep saw cut around the perimeter of the repair area. Remove spalled, scaled, loose, and deteriorated concrete to sound concrete. Minimum depth of concrete removal shall be 4 inches. Thoroughly blast and vacuum the newly exposed area prior to forming. Remove all resulting debris from the site.
3. Remove unsound concrete material in a manner to facilitate uniform placement of fresh concrete; slope upper area of excavated voids evenly to within one inch (1") of the face of the concrete to preclude entrapping air and forming hollow spots in the freshly placed concrete. Within one inch (1") of the surface, the upper outline shall be essentially normal (perpendicular) to the surface.
4. Render all surfaces of exposed concrete and reinforcing steel free of oil, solvent, grease, dirt, dust, bitumen, rust, loose particles, and foreign matter.
5. If reinforcing steel is encountered, use caution where reinforcing steel is uncovered so as not to damage the steel or its bond in the surrounding concrete. Do not use pneumatic tools in direct contact with reinforcing steel. Use maximum 30 pound size hammer for chipping behind reinforcing steel. Exposed reinforcing shall remain in place except where otherwise indicated for removal by direction of the Engineer or the Contract Drawings. Blast reinforcing steel in accordance with SSPC-SP-6, Commercial Blast Cleaning, to remove all contaminants, rust and rust scale.
   a. In areas where reinforcing steel is found to be surrounded by deteriorated concrete or has at least one-half its surface area exposed or has less than 1" cover, the depth of removal shall be such as to include all deteriorated concrete but not less than 3/4" below or behind the reinforcing steel.
   b. Where the existing reinforcing steel is severely corroded or damaged, cut out reinforcing steel and replace with new reinforcing steel of the same size and spacing. Where existing steel is determined by the Engineer to have insufficient cover, either replace reinforcing or adjust as directed. Attach new steel behind existing steel with a minimum lap of 16". Remove concrete to a minimum depth of 3/4" behind the new steel.
6. Provide Bonding compound on excavated surfaces.

3.06 TYPE 7 REPAIR – INJECTION STRUCTURAL REPAIR CONCRETE CRACKS/JOINTS

A. General Requirements: This consists of the structural repair of cracked concrete including interior slabs, exterior above-grade slabs, and structures exposed to foot and pneumatic tire traffic.

1. Crack must be clean, sound, less than 1/4" wide, and free of surface moisture. Remove all disintegrated and loose materials by mechanical means including shotblasting, sandblasting, low pressure water cleaning, or high pressure water jetting. Areas cleaned with water methods must be allowed to dry for a minimum of 24 hours at room temperature (about 73°F).
2. Mixing and Injection:

a. Follow manufacturer's recommendations for installation.

3.07 TYPE 8 REPAIR – GRAVITY REPAIR CONCRETE CRACKS

A. General: This work consists of gravity repair of horizontal cracks as indicated on the drawings.

1. Crack must be clean.
2. Seal underside of slab surface prior to filling if cracks reflect through structural slab.
3. Provide temporary dam each side of crack and fill the crack with epoxy. Remove temporary dam when epoxy hardens and remove any harden epoxy on top surface.
4. Follow manufacturer's recommendations for application.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 04415

GRANITE

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies providing granite for architectural work as shown on the Drawings.

B. Related Work Specified Elsewhere:
1. Seals and Sealants: Section 07900.
2. Replacement of Quarry Tile with Concrete Paver: Section 03214

1.02 PERFORMANCE REQUIREMENTS

A. Stone Abrasion Resistance: Minimum abrasive-hardness value of 12, as determined per ASTM C241.

B. Static Coefficient of Friction: ASTM C1028, values as follows:
1. Level Surfaces: A minimum of 0.6.

1.03 SUBMITTALS

A. 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.

B. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Shop Drawings:
a. Show the following:
1) Bedding, bonding and jointing of granite, including typical and special anchoring, expansion-joint details and interface with other work.
2) Dimensions and setting numbers of each stone in plan and elevation, including grading data for drainage.
2. Samples:
a. Submit three sets of samples of each type of granite used in the work, showing full range of color, texture, veining, fissures and finish of each type; each sample 12 inches square by one-inch thick. Include a minimum of two pieces in each set with maximum number of pieces in each set as necessary to demonstrate full range and variations. Material delivered or erected not within approved range of samples will be rejected.
b. Epoxy for mortar dams and epoxy fill and for setting dowels: Manufacturer's standard container.
c. Non-staining wedge.
d. Stainless steel dowel.
3. Documentation:
a. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of

completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

b. Quality-Assurance Program.

4. Certifications as required above.

1.04 REFERENCE STANDARDS

A. Reference Standards:

1. U.S. Government:

a. Federal Transit Administration (FTA):

1) 49 CFR 661 Buy America Requirements.

1.05 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards and Specifications.

1. Comply with codes and regulations of the jurisdictional authorities.

2. NBGQA: Specifications for Architectural Granite. 3. ASTM: C241, C615, C1028.

B. Qualifications of Granite Quarries:

1. Obtain granite from approved quarries having capacity and facilities for furnishing the quantity, size and quality of granite required.

2. Provide the product of one quarry matching approved samples.

3. Source Limitations for Stone: Obtain each variety of stone, regardless of finish, from a single quarry with resources to provide materials of consistent quality in appearance and physical properties.

4. Installer Qualifications: An experienced installer who has completed dimension stone cladding systems similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Quality Assurance Program: Before installing granite stairs, construct mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for completed work.

1. Platform Edge Slabs:

a. Prior to erection at site, test each stair tread and stair landing to withstand live load of 300 psf, placed at midspan, for duration of not less than 15 minutes. Test only components which perform a structural function and are not supported over their entire length by cast-in-place concrete.

D. Regulatory Agency 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 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Pack granite so as to prevent damage in transit, and deliver in accordance with Contract schedule and setting sequence.

B. Deliver each piece of granite with code mark on unexposed face, corresponding to shop drawings using non-staining paint. Deliver and unload granite. Prevent damage and soiling during delivery and unloading of granite.

C. Protect from disfiguring elements.

D. Separate granite from wood skids with polyethylene or other non-staining material. Store under waterproof covering, and keep dry.

E. Remove rejected stones from jobsite immediately.

1.07 JOB CONDITIONS

A. Environmental Requirements:
1. Do not use frozen materials or materials mixed or coated with ice or frost. Remove and replace dimension stone cladding damaged by frost or freezing conditions.
2. Erection and pointing of granite when ambient temperature is below 50F and or tending to fall below 50F is prohibited.

B. Cold-Weather Protection: When night-time temperature is forecasted within 50 to 25 Deg F: Cover dimension stone cladding with a weather-resistant membrane for 48 hours after construction. Do not install granite when night time temperature is forecasted below 25 Deg.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Granite:
1. Granite Building Stone Standard: ASTM C615.
2. NBGQA Specifications for Architectural Granite, free from starts, cracks or seams which might impair its structural integrity or appearance.
3. Color classification: Granite matching grain, color and variegation of all white, fine-to-medium-grain granite as listed in referenced NBGQA standard.
4. Exposed surfaces finished in accordance with the following and as shown:
   a. Type 1: Thermal finish or four-cut, slip-resistant.
5. Where stone thickness permits, provide lewis holes for lifting stones weighing over 100 pounds. Make lewis holes not closer than two inches from finished face of stone not in exposed portions of stone.
6. For alteration and restoration work, use granite salvaged from existing work as indicated on the drawings.

B. Mortar Materials and Granite Accessories: Section 04 05 00.

C. Portland Cement Paste: Section 03 30 00.

D. Dowels: Stainless Steel, minimum 1/2-inch diameter by 4 ½" long to extend into stone 1/2 thickness of stone and to extend two inches into precast structural concrete

E. Non-staining shim wedges to support granite slabs during curing of epoxy mortar dams: As approved.

2.02 ACCESSORIES

A. Accessories for Granite:

1. Stainless steel, ASTM A276 or A666, Type 304, for anchors, cramps, angles, dowels, plates, bolts or other accessories in contact with stone.
2. Anchor sizes:
   a. Anchors with dowels: 3/16 inch by one inch in cross section.
   b. Two-way anchors: 1/8 inch by two inches in cross section.
   c. One-way anchors: 1/8 inch by one inch in cross section.
   d. Anchors to stone: Anchors of necessary length and of type that turn into stone minimum of 1/2 inch.
   e. Anchors to concrete: Heavy-duty sleeve style or wedge-type anchors with 3,000-pound hold-fast strength or anchors suitable for use with dovetail slots.
   f. Lewis anchors for lifting stones: 3/4 inch in diameter.
   g. Other anchors: Sizes as shown on approved shop drawings.
   h. Fasteners for Stainless-Steel Anchors: Annealed stainless-steel bolts, nuts, and washers; ASTM F593 for bolts and ASTM F594 for nuts.
   i. Setting Shims: Strips of vulcanized neoprene, 50 to 70 Shore A durometer, non-staining to stone, sized to suit joint thicknesses and depths of stone supports without intruding into required depths of joint sealants or causing third-side adhesion between sealant and setting shims.
   j. Weep and Vent Tubes: Medium-density polyethylene tubing, 1/4- inch OD and of length required to extend from exterior face of stone to cavity behind.
3. Sizes for other accessories:
   a. Dowels: Minimum of 1/2 inch in diameter, designed to extend two inches into stone and two inches into concrete.
   b. Cramps: 1/8-inch by one-inch plate with 3/8-inch dowels at each end designed to extend into stone and concrete a minimum of one inch.
   c. Angles, plates, and bolts: Sizes as shown on approved shop drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive dimension stone cladding and conditions under which dimension stone cladding will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of dimension stone cladding.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Runways, Scaffolds and Hoists: Provide and move scaffolding, temporary runways, temporary floors, staging and hoists in accordance with specified safety requirements.

B. Substrate: Remove foreign substances that would affect bond of mortar from surfaces to receive granite.

C. Advise installers of other work about specific requirements for placement of inserts and similar items to be used by dimension stone cladding Installer for anchoring, supporting, and flashing of dimension stone cladding system. Furnish installers of other work with Drawings or templates showing locations of these items.

D. Remove granite edge stone from platform in accordance with applicable section of 04415. Salvage all granite edge stone where possible. Relocate all granite edge stone from inbound and outbound side of the platform to a storage yard designated by AR. Order new granite edge stone identical to those that were not salvageable and as per Section 04415 and the Contract Drawings.

3.03 FABRICATION AND ERECTION

A. General:

1. Fabricate granite in sizes and with joint patterns shown on Contract Drawings and approved shop drawings.
2. Installation of granite which is not within the approved range of color, texture, finish, veining and fissures; is mismatched; shows flaws or imperfection in cutting; or has other defects is prohibited.
3. Provide 1/4-inch joints, unless otherwise shown on Contract Drawings and approved shop drawings.
4. Unless otherwise shown, completely fill joints in granite work and rake out to depth of 3/4 inch, except paving joints showing grout.
5. Set stones accurately in alignment with other stones and adjacent work. Set stones in full mortar beds. Level and plumb stones as work progresses.
6. Set finish surfaces in true and even planes, with uniform jointing. Take up and reset loose, hollow sounding slabs. Leave surface free of mortar stain and other defacements.
7. Where epoxy materials are used, follow manufacturer's recommendations.

B. Tolerances: Meet NBGQA Specifications for Architectural Granite.

3.04 POINTING AND CLEANING

A. Pointing:

1. After setting mortar has cured, point voids in joints of exposed granite with preshrunk mortar. Remove excess mortar.
2. Seal joints in granite work with sealants in accordance with Section 07900.

B. Cleaning:

1. Clean joint surfaces and remove dirt, coatings, moisture and other foreign substances which could interfere with bond. Re-caulk granite edge slabs' transverse joints both vertically and horizontally with grout and let cure.
2. Thoroughly and carefully clean work by approved means and leave in first class condition, free from mortar or other defacement. Clean all exposed granite surfaces, including joints, with water and washing compound soap powder solution in accordance with recommendations of manufacturer. Sponge and wash thoroughly. Use of acid or acid cleaners is prohibited. Remove stains by approved means. Clean granite masonry surfaces, including those grouted or sealed, with

soap- powder solution and fiber brushes to remove stains. Thoroughly and carefully clean work and leave in first-class condition, free from mortar stains or other defacement. Immediately after cleaning, rinse surfaces with clear water. Polish with clean dry cloths.

C. Protection:

1. Protect granite work from damage after erection. Provide protective boards or boxing or other suitable means whenever necessary in the absence of specific instructions from the A.R. Do not use materials that will stain or deface granite. Use galvanized nails in protective boxing.
2. Continuously protect granite work from water during construction and until installation is complete and is approved.
3. Protect granite work from traffic of any kind immediately after setting. Remove protection when notified by the Engineer.

3.05 FIELD QUALITY ASSURANCE:

A. Perform work in accordance with approved quality-assurance program.

B. Change of procedures and personnel without approval is prohibited.

END OF SECTION

SECTION 05120

FABRICATED STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This Section specifies furnishing and constructing structural steel plates, shims, and shear studs in accordance with the details indicated on the Contract Drawings.

B. Related Work Specified Elsewhere:

1. Post-Tensioned Concrete: Section 03380.

1.02 QUALITY ASSURANCE:

A. Reference Standards

1. American Institute of Steel Construction (AISC):

a. AISC Code of Standard Practice for Steel Buildings and Bridges.

b. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

2. American National Standards Institute (ANSI):

a. ANSI B 18.2.1, Square and Hex Bolts and Screws (Inch Series).

b. ANSI/ASME B 18.2.2, Square and Hex Nuts (Inch Series).

c. ANSI B 18.22.1, Plain Washers.

3. Federal Specifications (FS):

a. FF-W-92B, Washer, Flat (Plain).

4. American Society for Testing and Materials (ASTM):

a. ATSM A6, Specification for General Requirements for rolled Steel Bars, Plates, Shapes, and Sheet Piling.

b. ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

c. ATSM A123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

d. ATSM A153, Specification for Zinc coating (Hot-Dip) on Iron and Steel Hardware.

e. ASTM A234, Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

f. ASTM A338, Specification for Malleable Iron Flanges, Pipe Fittings, and Valve Parts for Railroad, Marine, and Other Heavy Duty Service at Temperatures Up to 650°F (345°C).

g. ASTM A563, Specification for Carbon and Alloy Steel Nuts.

h. ASTM A709, Specification for Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges.

i. ASTM B695, Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

j. ASTM F436, Specification for Hardened Steel Washers.

5. American Welding Society (AWS): ANSI/AWS D1.1 except as follows:

a. For welding of structural steel, AWS D1.5.

6. American Railway Engineering and Maintenance-of-Way Association.

B. All welds shall be pre-qualified welds.

C. Source Quality Control:

1. Testing and Inspection

a. Nondestructive test requirements for welded members

Perform the following:

(1) Butt welds: 40 percent of welds inspected by ultrasonic examination.

(2) Fillet welds: 25 percent of welds inspected by magnetic particle inspection.

b. Mill Testing:

(1) For identified stock materials provide three specimens from each heat number, one for tension test, one for bend test and one for Charpy V-notch impact test.

(2) Cut, machine and test specimens in accordance with ASTM A370.

c. Bolts:

(1) The Engineer will randomly select at least five bolts for test purposes from each bin of bolts furnished.

d. Shear Studs:

(1) The Engineer will randomly select at least five shear studs for test purposes from each bin of shear studs furnished.

e. Visually inspect all welds for full length.

f. Nondestructive testing of welded members shall be provided by an independent testing laboratory, approved by the Engineer and paid by the Contractor.

g. Use procedure and acceptability of test in accordance with the requirements of ANSI/AWS D1.1 and AASHTO.

h. Provide AWS certified welding inspector to interpret the results.

i. Submit results of test to the Engineer.

D. Qualifications of Fabricator: Fabricator shall submit evidence of qualification for the fabrication of structural steel members as per Category III of the AISC Quality Certification Program.

E. Qualification of Welding Personnel and Procedures:

1. Prior to qualifying welding personnel and welding procedures submit and obtain approval from the Engineer for procedural details, sequence of welding, handling of materials to be inspected, and approval of electrodes, wire, flux and other welding materials and equipment.

2. Employ welding personnel whose qualification is certified in accordance with AWS Standard D1.1. Such certification is to remain in force for the duration of the welding operations under this Contract.

3. Do not start fabrication until qualification has been successfully completed and procedures approved.

F. Qualification of Nondestructive Testing Personnel:

1. Conduct nondestructive testing of fracture-critical members, by personnel qualified as NDT Level II or Level III in accordance with ASNT SNT-TC-1A.

2. Supervise Level II technicians with Level III personnel.

G. Stock Material:

1. For qualification of welding personnel and procedures and for quality assurance testing, use only stock materials which can be identified as having been rolled from a given heat and for which certified mill tests can be produced.

2. When stock materials is proposed, inform the Engineer of such intention at least 10 days in advance of commencing fabrication to permit sampling and testing. Select identified materials from as few heats as possible.

H. Welder’s Identification Mark:

1. Assign each welder and welding operator an identification mar to stamp on pieces he has welded.

2. Have welder or welding operator place his identification mark by metal die stamp in letters 3/8 inch high in position that identification of welder or operator will appear adjacent to each of his welds in finally assembled members for ready reference to radiographic film and for identification by the Engineer.

1.03 SUBMITTALS:

A. Submit the following:

1. Shop Drawings:

a. Show all shop and erection details including welding techniques and sequence, cuts, gussets and all other members, holes, fasteners, camber, fabrication and erection tolerances, type of coating, weights of members, length of member, length of span, elevations and critical clearances. Indicate all surface finishes and welds, both shop and field, by symbols conforming to ANSI/AWS Standards.

2. Furnish setting diagrams, templates, and directions for the installation of embedded items.

3. Provide diagram showing matchmarks for connecting structural parts assembled in shop for purpose of drilling or reaming holes in field connections.

4. Furnish details of methods of erection to be used.

5. Welding Records and Data:

   a. Prior to commending any work requiring welding, submit for approval the procedure that will be used for prequalifying welders and welding procedures. For all procedures submit a copy of procedure qualification test records.

   b. Submit certified copy of qualification test record for each welder, welding operator, and tacker who will be employed in the work.

   c. Submit descriptive data for field welding equipment, including type and electrical power requirements.

   d. Submit data reports of the results of nondestructive inspection tests of shop welds to the Engineer within 24 hours after the welds are made.

      (1) Indicate the type and location of shop welds tested, type and location of defects noted, measures taken to correct the defects, and the test results of corrected welds.

      (2) Report any defective welds that are not corrected.

   e. Do not start fabrication until qualification has been successfully completed and procedures approved.

6. 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 and shear connectors.

7. Structural computations for all designed work shall be signed and sealed by a Maryland registered Professional Engineer.

8. Certifications:

   a. Certified mill test reports of structural steel at least 14 days prior to start of fabrication.

   b. Manufacturer’s certification that bolts meet approved testing.

   c. Certified quality assurance testing and inspection reports.

   d. Certification verifying that welding personnel have been qualified in accordance with AWS D1.1 and D1.5.

1.04 PRODUCT DELIVERY, HANDLING AND STORAGE:

A. Exercise care to avoid bending, scraping, and overstressing the steel work. Block with wood, or otherwise protect, projecting parts likely to be bent or injured.

B. Mark weight on all members. Match-mark all shop pre-fitted members.

C. Ship small parts, such as bolts, nuts, washers, 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 in itemized list and description of the contents on the outside of each container.

D. Load, transport, unload, and store structural materials in such a manner that the metal is kept clean and free from injury. Store material above ground on platforms, skids, or other supports, and cover and protect it from corrosion. Use fabric slings or chokers to lift coated steel to prevent damage to coating.

E. Identify all materials by heat and lot, if applicable.

F. Replace pieces bent or damaged unless repairs are authorized by the Engineer.

1.05 SHOP CONDITIONS:

A. Welding:

1. When welding during cold weather, avoid chilling weld metal within zone of welding influence and avoid restraining manual functions of welder or welding operator.

2. When temperature where steel is stored is more than 20°F below that of welding shop, move steel to be welded into shop sufficiently in advance of welding to allow it to attain shop temperature prior to welding.

3. Steel to be free of moisture. Dry as necessary by application of heat not exceeding 100°F.

4. Do not weld when shop temperature is below 40°F.

PART 2 - PRODUCTS

2.01 PLATES, SHAPES, AND BARS:

A. General Requirements for Rolled Steel Plates, Shapes and Bars: ASTM A6.

B. Structural Quality Carbon Steel: ASTM A709, Grade 36.

C. High Strength Steel: ASTM A709, Grade 50

2.02 FASTENERS:

A. General:

1. Provide fasteners of type, grade, and class required for the particular use.

B. Miscellaneous Screws and Bolts:

1. Standard Steel Bolts:

a. Hexagon head type, ASTM A307, Grade A, unless otherwise indicated or specified.

2. Carbon Steel Nuts: ASTM A563, Grade A.

3. Washers: ASTM F436.

4. Stainless Steel Bolts, Nuts and Washers: ASTM A320, Grade B8, AISC Type 304.

C. High Strength Structural Steel Bolts, Nuts and Washers:

1. High Strength Bolts: ASTM A325.
2. Carbon and Alloy Steel Nuts: ASTM A563.
3. Hardened Steel Washers: ASTM F436

D. Lubricant for Bolts: Molybdenum disulfide base.

2.03 PROTECTIVE COATINGS:

Galvanizing: Steel products specified as galvanized. Hot-dip galvanized after fabrication, in accordance with the following:

A. Zinc coating on products fabricated from rolled, dressed and forged steel shapes, plates and strips: ASTM A123.

B. Zinc coating on iron and steel hardware: ASTM A153.

C. Zinc coating on assembled steel products: ASTM A386.

D. Zinc coating weight: Two ounces per square foot minimum.

E. Cold Galvanizing Compound, zinc-oxide primer conforming to SSPC 5-82 applied in two coats for repairs to damaged surfaces after removal of loose or cracked zinc coating.

2.04 ELECTRODES:

A. Use low-hydrogen electrodes for field welding.

B. Electrodes for Structural Plate, Shapes, Pipe, Tubes, and Bars: Conform with ANSI/AWS A5 Series Standards and be coated rods or wire of size and classification number as recommended by their manufacturers for the positions and other conditions of actual use. Matching filler metal requirements shall conform to ANSI/AWS D1.1, Table 3.1.

PART 3 - EXECUTION

3.01 FABRICATION:

A. General: Fabricate and shop-assemble work in accordance with AISC Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design; AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts; AISC Code of Standard Practice for Steel Buildings and Bridges; and AISC Manual of Steel Construction – Allowable Stress Design.

B. Straighten rolled material, if necessary, before it is laid out for fabrication, in a manner conforming to the mill tolerances provided in ASTM A6, and by a process and in a manner that will not injure the material. Sharp kinks and bends will be cause for rejection of the material. Straighten, plane, and otherwise correct portions of members in bearing assemblies and in direct bearing after those member have been fabricated.

C. Perform shearing, flame cutting, and chipping carefully and accurately so as not to induce residual stress in the metal being cut. Cut flame-cut edges of members subjected to dynamic loading by a mechanically guided torch or by hand, and remove all nicks by grinding to a depth not exceeding ¼ inch. The radii of re-entrant gas-cut fillets shall be not less than ¾ inch and as much larger as practicable. Perform flame cuttings in such

manner that metal being cut is not carrying stress. Exposed edged, flame-cut by hand, shall be finished by grinding.

D. Bend load-carrying cold-rolled steel plates cold, at right angles to the direction of rolling. The radius of bend, measured to the concave face of the metal, shall conform to AISC Manual of Steel Construction, Part 4.

F. Machine finish all bearing surfaces to meet the ANSI Surface requirements specified in ANSI Manual of Steel Construction, Part 4.

G. Except where welded or ASTM A307 bolted connections are shown, use ASTM A325 bolts for shop connections.

I. Bolt Holes: Punch, drill, sub-punch, sub-drill and ream holes for bolts as required in accordance with AISC Specifications. Flaming cutting is prohibited.

J. Plates:

1. Bent plates: For load carrying cold-bent plates, use identified stock and arrange direction of bending at right angles to direction of rolling. Ensure radius of bend, measured on concave face of metal, is not less and preferably more than the following.

Angle of Plate Bend	Minimum Radius
61° – 90°	1.0T
92° – 120°	1.5T
121° – 150°	2.0T
T = Plate Thickness	

2. Sheared plates: For gusset plates or connection plates, use sheared plates designed to resist applied loads in more than one direction in plane of plate.

K. Welding: Perform all welding in accordance with ANSI/AWS D1.1 except as modified herein.

1. Field installation of shear studs shall utilize Electric Arc Stud Welding only.

2. Perform procedure and sequence of welding so as to avoid needless distortion and minimize stresses. Straighten transverse warpage of flanges if necessary by controlled heating along outside face.

3. Make allowance in shop for expected weld shrinkage when laying out and assembling members. Trim members to size only when most or all of welding has been completed.

4. Complete butt welds in flange joints before flanges are assembled on web. Use extension blocks on such joints when mating ends of butt welds removing extension blocks only upon completion and cooling of weld. Ensure ends of welds are finished smooth and flush with edges of abutting parts. Use double-V-flange butt welds, unless otherwise shown.

5. Make welds in web plates where shown on approved Shop Drawings.

6. Prior to ultrasonic or radiographic testing of butt welds, grind or machine weld reinforcement of joint to remove irregularities of weld surface so that it merges smoothly with base surface; one side for ultrasonic testing and both sides for radiographic testing.

7. Ensure that welded joints which are to be radiographed are free of paint, scale and grease. Grind off welded ripples and surface irregularities on both sides of joint. Grind perpendicular to length of weld and to such a degree that resulting radiographic contract due to remaining irregularities cannot mask or be confused with that of objectionable defect and so that weld surface will merge smoothly into adjoining surface.

8. Repair defective welds by chipping or melting out such defects from one or both sides of joint removing no more weld metal than necessary to correct defect. Reweld and have weld retested radiographically.

9. Inspection of Welds as specified in Article 1.02.C above:

    a. Correct all deficiencies in accordance with ANSI/AWS D1.1 and have weld tested at no additional cost to the Administration.

L. Bolting:

1. For connections using high strength steel bolts, conform to requirements of ASTM Specifications.

2. Assemble high strength bolted parts so that they fit solidly together when assembled. Do not use gaskets or any other interposed compressible materials unless shown on the plans.

3. Remove scale, dirt, butts and other defects liable to prevent proper seating when assembling joint surfaces, including those adjacent to washers.

4. Clean off oil, paint or lacquer from contact surfaces of slip-critical joints.

5. For slip critical connections, tighten the A325 bolts, nuts and direct tension indicators as indicated in ASTM F959.

    a. A representative from the direct tension indicator supplier shall be on site during initial tightening to witness and approve degree of tightening to ensure proper tensioning is achieved.

    b. Place direct tension indicators under either the bolt head or the hardened washer.

    c. If direct tension indicators are placed under the turned element, a hardened round steel washer shall be used between the direct tension indicator and the turned element.

6. Tightening bolts in non-slip-critical connections:

    a. Tighten A325 bolts to bolt tension not less than proof load given in AISC specifications for bolts.

    b. Tighten by means of properly calibrated torque wrenches.

c. When tightening, place hardened washer under turned element (nut or bolt head), depending on which element is turned in tightening operation.

d. Calibrate torque wrenches by tightening bolt assembly in device capable of indicating actual bolt tension.

e. Test three bolts minimum from each lot.

f. Measure torque when nuts or bolts are in tightening motion.

g. Adjust power wrenches to cut out or stall at required tension.

7. Arrange bolts so that heads show in areas exposed to view.

M. Painting:

1. Surface Preparation: Power Tool Cleaning - SSPC SP 3.

2. Apply paint to structural steel in accordance with manufacturer's recommended procedures at minimum coating thickness specified in Section 05950.

3. Apply only a primer coat onto faying surfaces.

4. Do not paint areas of connection plates or members where a slip critical connection is noted on the Contract Drawings.

N. Galvanizing:

1. Hot dip products indicated on the drawings or specified to be galvanized, after fabrication in accordance with the following:

a. ASTM A153 for galvanizing of iron and steel hardware.

b. ASTM A123 for galvanizing rolled, pressed and forged steel shapes, plates, bars and strip 1/8 inch thick and heavier.

2. Mechanically galvanize A325 high strength bolts and nuts, prior to painting, in accordance with ASTM B695.

3.02 SHOP ASSEMBLY:

A. Undertake complete or progressive shop assembly of plate girders. Obtain approval of the Engineer for progressive shop assembly procedure.

B. Clean surfaces of metals in contact with each other before assembling.

C. Assemble parts to line and fit; drill or ream bolt holes while assembled. Hand reaming is prohibited unless approved.

3.03 ERECTION:

A. Erect steel members true and plumb following the match marks and in accordance with the Contract Drawings, pertinent regulations and referenced AISC standards.

B. Report immediately to the Engineer, errors in shop fabrication or deformation resulting from handling or transportation, which prevent the proper erection and fitting of parts.

C. Thoroughly clean surfaces to be joined.

D. Install anchor bolts accurately in position shown.

1. Install anchor bolts in preformed holes or in drilled holes in concrete, use approved non shrink, non metallic grout for securing them in place.

E. Use temporary bracing to resist loads to which the structures may be subjected including erection equipment or the operations of same. Leave bracing in place as long as may be required for safety, and until the diaphragms are constructed.

G. Field Assembly:

1. Align and adjust members forming parts of a complete assembly after assembly and before fastening.

H. As erection progresses, perform sufficient bolting of the work to support dead load, and wind and erection loads. Perform permanent bolting when enough alignment has been done to ensure as much of the structure as possible will be supported by such fastening work.

1. Ensure that holes are not enlarged and that the drifting occurring during assembly does not disturb the metal in the vicinity of the holes.

2. Enlarge holes to admit bolts for connections only if approved by the Engineer. Make the enlargement by reaming and not by burning. Avoid hand reaming.

3. Erection bolts used in welded construction shall be tightened securely and left in place.

I. Do not weld members in the field except as indicated on the Contract Drawings.

3.04 FIELD QUALITY CONTROL:

A. Provide an Independent Testing Agency, proposed and paid for by the Contractor, and approved by the Engineer to inspect field assembled bolted construction in accordance with AISC Specification for Structural Joints Using ASTM A325 Bolts, Section 9.

B. The Independent Testing Agency shall inspect field welds by method selected from ANSI/AWS D1.1, AASHTO and specified in Article 1.02.C. above.

3.05 FIELD TOUCH UP PAINTING:

A. General: Paint bolt heads and nuts, field welds and areas within 2 inches of welds and touch up abrasions in the shop coat.

B. Surface Preparation: Use methods at least as effective as those specified for the structure itself but in no case less than SSPC SP 3 for removal of handling marks and SSPC SP 6 for areas showing rust.

C. Paint: Use those individual products as specified for Shop Paint.

END OF SECTION

SECTION 05121

STAINLESS STEEL

PART 1 GENERAL

1.01 DESCRIPTION:

A. Section Includes
1. This Section covers the design, manufacture, and installation of structural metal framing and stainless steel elements.

B. Related Sections
1. Section 03621: Non-Metallic Non-Shrink Grouting.

C. References
1. American Iron and Steel Institute (AISI):
   a. AISI 303; Stainless Steel Bar and Rod
2. American Institute of Steel Construction (AISC):
   a. Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design.
   b. Code of Standard Practice for Steel Buildings and Bridges.
   c. Specification for Structural Joints Using ASTM A325 or A490 Bolts (approved by Research Council on Structural Connections, June 2000).
3. American National Standards Institute (ANSI):
   a. ANSI B18.22.1, Plain Washers.
4. ASTM International (ASTM):
   a. ASTM A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
   b. ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. ASTM A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   d. ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   e. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   f. ASTM A480, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   g. ASTM A484, Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings.
   h. ASTM A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
   i. ASTM A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
   j. ASTM A666, Standard Specification for Annealed or Cold-Worked Austenitic-Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   k. ASTM A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
   l. ASTM E164, Standard Practice for Contact Ultrasonic Testing of Weldments.
   m. ASTM F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   n. ASTM F594, Standard Specification for Stainless Steel Nuts.

o. ASTM E709, Standard Guide for Magnetic Particle Testing.

5. American Welding Society (AWS):
   a. AWS D1.1 Structural Welding Code – Steel.
   b. AWS D1.6 Structural Welding Code – Stainless Steel

1.02 SUBMITTALS:

A. Shop Drawings and Product Data:
   1. For shop assemblies which require markings for erection identification, provide easy-to-read markings on shop and erection drawings.
   2. Note on shop drawings variations in tolerances or clearances between various products.
   3. Use standard welding symbols of the American Welding Society on shop drawings; show size, length, and type of each weld.

B. Welding Records and Data:
   1. Prior to commencing work requiring welding, submit the procedure which will be used for prequalifying welders and welding procedures. For all procedures other than those set forth in AWS D1.1 and AWS D1.6, submit a copy of procedure qualification test records.
   2. Submit certified copy of qualification test record that each welder, welding operator, and tacker who will be employed in the work has satisfactorily passed AWS qualification tests for welding procedures.
   3. Submit certified copy of reports for all analyses and tests required by referenced ASTM Specifications, including test reports for filler metals for welding, and mechanical tests for high-strength threaded fasteners.

C. Mill Test Results:
   1. Submit reports signed by the manufacturer certifying their products comply with requirements specified.
   2. Submit test reports certifying material conforms to ASTM specification.
   3. Certification test or heat lot markings shall correlate with the actual material identification markings prior to material usage.
   4. Certified Type 304 Stainless Steel shall have a maximum carbon content of 0.080% ladle analysis for each heat of material used in fabrication and construction.

1.03 QUALITY CONTROL:

A. Qualifications:
   1. 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 and AWS D1.6 of the American Welding Society, to perform type of work required.

B. Comply with applicable provisions listed in those references stated in Article 1.02 of this specification unless otherwise indicated.

C. Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field by a qualified inspection agency. Such inspections and tests will not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.
   1. Promptly remove and replace materials or fabricated components that do not comply.

D. 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.

1.04 DELIVERY, STORAGE, AND HANDLING:

A. Store steel on platforms, skids, blocking or other supports in a sheltered area to prevent dirt and debris contact. Protect from exposure to conditions that produce contamination or damage.

B. 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.

C. Mark weight on all members. Match-mark all shop pre-fitted members.

D. 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.

E. Replace pieces bent or damaged unless repairs are authorized by the Professional.

F. Certified Type 304 Stainless Steel shall be segregated from carbon steel and other stainless material.

G. Products and tools used for the fabrication of carbon steel products shall not be used for the fabrication and production of stainless steel elements.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Stainless Steel plate, sheet, and strip shall conform to ASTM A240, Type 304L, of thickness as indicated on the Drawings and shall be furnished hot-rolled, annealed, and pickled with the following finishes. Minimum yield strength shall be 25 ksi. Material shall be marked in accordance with ASTM A480.
1. Plate finish shall be No. 1 finish.

B. Stainless Steel bars and shapes shall conform to ASTM A276 or A484, Type 304L, of designation indicated on the Drawings and shall be hot rolled or extruded, cold finished, annealed and descaled. Minimum yield strength shall be 25 ksi. Material shall be marked in accordance with ASTM A484.
1. Finish shall be at least No. 1.

C. Stainless Steel Pipe shall conform to ASTM A312, Type 304L, of designation indicated on the Drawings. Minimum yield strength shall be 25 ksi.

D. Stainless Steel Structural Tubing shall conform to ASTM A554, Type 304L of designation indicated on the Drawings. Minimum yield strength shall be 25 ksi.

E. Stainless Steel Flat Bar shall conform to ASTM A666, Type 304L and shall be cold finished, annealed and descaled. Finish shall be at least No. 1. Material shall be marked in accordance with ASTM A480.

F. Structural shapes indicated on the Drawings not available may be built-up from equal thickness and width plates. Substitution of built-up sections for structural shapes will be subject to written approval of the Professional.

G. Stainless Steel filler material shall be compatible with the specific base metal and shall be in accordance with qualified welding procedures for Stainless Steel.

H. Passivation of Stainless Steel – use an environmentally friendly cleaner that conforms to ASTM A380 and ASTM A967.
   1. Acceptable Manufacturers:
      a. CitriSurf; Stellar Solutions, Algonquin, IL.
      b. Or approved equal.

I. Fasteners
   1. High-Strength Bolted Connections:
      a. Stainless Steel Bolts, Grade 18-8 Stainless (Type 304), ASTM F593.
      b. Stainless Steel Washers, Grade 18-8 Stainless (Type 304) ASTM A240.
      c. Stainless Steel Nuts, ASTM F594.

J. Welding Electrodes:
   1. Stainless Steel – AWS D1.6, Table 3.3, E308-XX.
   2. Use low-hydrogen electrodes for field welding.

2.02 FABRICATION:

A. Fabricate structural steel in accordance with Drawings and referenced AISC standards. Properly mark and match-mark materials for field assembly.
   1. Mill ends of columns and other members transmitting loads in bearing.

B. Perform shearing, flame cutting, and chipping carefully and accurately so as not to induce residual stress in the metal being cut. Cut flame-cut edges of members subjected to dynamic loading by a mechanically guided torch or by hand, and remove all nicks. The radii of re-entrant gas-cut fillets shall be not less than 3/4 inch and as much larger as practicable. Perform flame cuttings in such manner that metal being cut is not carrying stress. Exposed edges, flame-cut by hand, shall be finished by grinding.
   1. Add additional reinforcing as required where members are cut or coped to meet framing conditions.

C. Arrange bolts as indicated on the drawings, or if not indicated, arrange so that heads (not nuts) show in areas exposed to view. Clearly indicate bolt arrangements on shop drawing submittals.
   1. Use special care in handling and shipping members.
   2. Weld tabs for temporary bracing and safety cabling at points concealed from view in the completed structure.

D. Bolt Holes: Punch, drill, subpunch, subdrill, and ream holes for bolts as required in accordance with AISC Specifications and the Drawings.

E. Welding: Perform all welding in accordance with AWS D1.6 for Stainless Steel except as modified herein.
   1. Perform procedure and sequence of welding so as to avoid needless distortion and minimize stresses. Straighten transverse warpage of flanges if necessary by controlled heating along outside face.

2. Make allowance in shop for expected weld shrinkage in laying out and assembling members. Trim members to size only when most or all of welding has been completed.
3. Maintain a welding temperature as low as possible to prevent undue warpage.
4. Use of chill bars is acceptable as long as finished product meets all strength and containment requirements.
5. No preheating of Stainless Steel is required. The based metal shall be at a temperature of at least 65 degrees F before welding is started. The maximum interpass temperature shall not exceed 350 degrees F when welding stainless steel materials.

F. Holes for Other Work: Provide holes required for securing other work to steel (carbon or stainless) framing and for passage of other work through members as shown on final approved shop drawings.
1. Ream, drill, or punch holes perpendicular to metal surface. Do not flame cut holes or enlarge by burning.
2. Additional openings in members not shown on final approved shop drawings shall not be performed; approval of the Professional is required.

PART 3 EXECUTION

3.01 EXAMINATION:

A. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.02 ERECTION:

A. Thoroughly clean surfaces to be joined.

B. Use temporary bracing to resist loads to which the structures may be subjected, including erection equipment or the operations of same. Leave bracing in place as long as may be required for safety.

C. Report immediately errors in shop fabrication or deformation resulting from handling or transportation, which prevent the proper erection and fitting of parts.
1. Do not field cut or alter structural members without the approval of the Engineer.

D. Bolting:
1. For connections using bolts, conform to requirements of AISC Specifications.
2. Assemble bolted parts so that they fit solidly together when assembled. Do not use gaskets or any other interposed compressible materials.
3. Remove scale, dirt, butts, and other defects liable to prevent proper seating when assembling joint surfaces, including those adjacent to washers.
4. Enlarge holes to admit bolts for connections only if approved by the Engineer. Make the enlargement by reaming and not by burning. Avoid hand reaming.
5. For bearing-type connections (snug-tighten), the bolts should be tightened to a snug tight condition achieved by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench to the extent that all plies of the connected material have been brought into snug contact.
6. Arrange bolts so that heads show in areas exposed to view.
7. Ensure that holes are not enlarged and that the metal in the vicinity of the holes is not disturbed by the drifting occurring during assembly.
8. As erection progresses, perform sufficient bolting of the work to resist dead load and wind and erection loads. 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.

9. Erection bolts used in welded construction shall be tightened securely and left in place.

E. Field welding only permitted where approved by the Engineer or as indicated in the drawings.

F. All discoloration of finished surfaces due to welding shall be removed by mechanical cleaning. All weld spatter and welding oxides on finished surfaces shall be removed by a blasting or grinding process. Use of steel wool or other iron containing abrasive is prohibited.

G. Grinding of stainless steel shall be done where indicated on the Drawings and only with new (unused) wheels and compounds, free from exposure. Grinding wheels and other disposable tools to be used for Stainless Steel shall be uniquely marked and controlled so that they are used only on Stainless Steel.

H. After being ground or where subjected to severe forming operation, Stainless Steel surfaces shall be cleaned of all extraneous material, thoroughly rinsed with water and dried. All lubricants and cleaners using the fabrication of stainless steel shall be approved by the Authority Representative.

I. Clean Stainless Steel using standard Stainless Steel Pacification techniques.

3.03 QUALITY ASSURANCE TESTING:

A. Shop Welding: The fabricator will inspect and test during fabrication of structural steel assemblies, as follows:

1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
2. Perform visual inspection of full length of all welds.
3. In addition to visual inspection of shop-welded connections, welds will be inspected and tested according to AWS D1.1, AWS D1.6, and the inspection procedures listed below:
   a. Complete penetration welds: Ultrasonic Inspection; ASTM E164.
   b. Fillet welds: Magnetic Particle Method; ASTM E709.
4. Perform ultrasonic testing of the entire length of full penetration welds for the following:
   a. 10% (minimum) of all other groove and full-penetration welds.
5. Perform magnetic particle testing on the entire length of fillet welds as follows:
   a. 20% (minimum) of fillet welds.

B. Field-Bolted Connections: The Quality Assurance Testing Agency will inspect and test field-bolted connections in accordance with AISC specifications and RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" and the following:

1. Verify proper fastening components were used and the connected elements were fabricated properly.

C. Field Welding: The Quality Assurance Testing Agency will inspect and test during erection of structural steel as follows:

1. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.

2. Perform visual inspection of full length of all welds.

D. Remove and replace work that does not comply with specified requirements.

E. The Contractor shall correct deficiencies in structural steel work that inspections and test reports have indicated to be not in compliance with requirements. The Quality Assurance Testing Agency will perform additional tests, at the Contractor's expense, as necessary to reconfirm any noncompliance of original work and to show compliance of corrected work.

3.04 CLEANING:

A. Upon completion of the installation and with approval of the Authority Representative, all work shall be cleaned of all protective wrappings, soil, discoloration, and disfiguration.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIOANLLY

SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes: This section specifies requirements for providing miscellaneous metal, with the exception of ornamental (architectural) metal and metalwork provided as a part of mechanical, electrical and construction systems.

1.03 SUBMITTALS

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

B. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated.
1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
2. Manufacturer's standard drawings may be submitted in lieu of Contractor-prepared shop drawings if manufacturer's standard drawings show required details.

C. Certification:
1. Certification that welding personnel are currently qualified in accordance with AWS D1.1.
2. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements for corrosion resistance of Type 316 stainless steel.

1.04 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. AGA: The Design and Fabrication of Galvanized Products.
3. AISC: Specification for Structural Steel for Buildings-Allowable Stress Design and Plastic Design (Do not use plastic design).
4. ANSI: A14.3
5. ASME: A 17.1, B18.6.3, B18.21.1, B18.22.1.
6. ASTM: A36, A53, A74, A108, A123, A167, A193, A229, A242, A276, A307, A313, A325, A413,A490, A501, A536, A570, A572, A588, A666, A780, A786/A786M, B 221, B 632, B633, D412, D1187, E488, F 593, F 594, F1554.
7. American Welding Society: AWS D1.1., AWS D1.2 AWS D1.3.
8. FED STD: 595.
9. FS: A-A-462, FF-B-588, FF-H-116, FF-P-395, FF-S-325, RR-T-650, TT-P-86.
10. MS: MIL-P-21035.
11. SSPC: SP 11, Paint 12.

B. Qualifications of Welding Personnel: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.3, "Structural Welding Code--Sheet Steel."
   4. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification. Such certification is to remain in force for the duration of the welding operations under this Contract.

C. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.05 PROJECT CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver products undamaged.

B. Store products so as to prevent rust.

C. Handle products so as to prevent damage.

D. After completion of factory testing, package and ship hatches as directed.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General Requirements:
   1. Insofar as practicable, furnish similar products of a single manufacturer.
   2. Metal Surfaces: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 FERROUS METALS

A. Structural Steel: Plates, shapes, bars and angles, ASTM A36.

B. Rolled-Steel Floor Plate: ASTM A786/A786M; Fabricate raised-pattern floor plates from rolled-steel floor plate, galvanized after fabrication, of thickness and in pattern indicated below:
1. Thickness: Minimum 1/4 inch, unless otherwise shown or calculated.
2. Pattern: No. 2, or as selected from manufacturer's standard patterns; flat back.

C. High-Strength Low-Alloy Structural Steel:
1. ASTM A242.
2. Resistance to atmospheric corrosion: Four times that of carbon steel, minimum.

D. Load-carrier Beams: ASTM A588.

E. Structural Tubing: ASTM A501.

F. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

G. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304. Type 316L for corrosive environments.

H. Stainless-Steel Bars and Shapes: ASTM A276, Type 304. Type 316L for corrosive environments.

I. Hot-rolled Carbon Steel Sheets and Strips: ASTM A570.

J. Pipe, Pipe Sleeves and Pipe Fittings:
1. Cast iron: ASTM A74, service weight.
2. Steel: ASTM A53, galvanized unless otherwise shown or specified.

K. Guard Chain: ASTM A413, Class Grade 28, galvanized steel, 9/32-inch thick, complete with stainless-steel eyes, spring-loaded catches and mounting components.

2.03 ALUMINUM

A. Aluminum Extrusions: ASTM B221, Alloy 6063

B. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B 632M, Alloy 6061.

C. Cast Aluminum.

2.04 COATINGS

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

B. Zinc-rich Paint: MS MIL-P-21035.

C. Electrodeposited zinc coating: ASTM B63.

D. Galvanizing Repair Compound: Stick form, melting point 600F to 650F, GALVABAR or equal.

E. Bituminous Coating: Cold-applied asphalt mastic complying with SSPC Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187.

2.05 FASTENERS

A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

B. Screws: Material, type and size to suit the purpose; steel, except stainless, cadmium-plated.
1. Stainless steel, ASTM A193, Alloy S30400.

C. Machine Bolts: Material, type and size best suited to the purpose. Minimum tensile strength 60,000 psi.
1. Carbon steel: ASTM A307, Grade B, galvanized.
2. Stainless steel: ASTM A193, Class 1A.

D. Toggle Bolt: FS FF-B-588.

E. Drive Stud: FS FF-S-325, Group 6.

F. Expansion Shield: FS FF-S-325 Group I, Type 2, Class 2, Style 1; Group II, Type 3, Class 1; Group IV, Type 1; best suited to the purpose.

G. Screw Anchors: Lead or plastic for wood or metal screws.

H. Anchor-Bolt Sleeve: Corrugated high-density polyethylene plastic.

I. Powder Actuated: FS FF-P-395.

J. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
1. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

K. Internally Threaded Steel Anchor: ASTM A108.

2.06 CONCRETE AND GROUT

A. Nonshrink Grout: Section 03300.

B. Concrete Fill: Normal weight, minimum 3,000 psi structural concrete as required in Section 03300, except limit the max. coarse aggregate size to #8.

1. Non-slip aggregate: Fused aluminum oxide grits or crushed emery, factory graded and packaged, rust-proof, non glazing and unaffected by moisture and cleaning materials.
2. Surface hardener: Water-soluble, inorganic fluosilicate compound for curing, hardening and dustproofing fresh concrete.

2.07 FABRICATION

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Weld corners and seams continuously to comply with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

H. Thermal Movement: Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

I. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

J. Remove sharp or rough areas on exposed traffic surfaces.

K. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.08 MISCELLANEOUS ITEMS

A. Fabricate metal items indicated on the drawings from materials shown or, if not otherwise described, from steel or from galvanized steel wherever exposed to the weather or in contact with concrete or masonry.

B. Make miscellaneous items to the size and configuration indicated, welded or bolted at joints to develop full strength equal to a continuous member, and in every way complete for the intended purpose and finished in appearance.

C. Pylon-Base Ring: Structural steel, galvanized after fabrication.

D. Lifting Eye: ASTM A572, Grade 50, one-inch diameter steel rod, welded, galvanized after fabrication.

2.09 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish metal fabrications after assembly.

B. Galvanizing:
1. Clean ferrous metal thoroughly before applying zinc coating.
2. Apply zinc coating to products after fabrication, by hot-dip method, using coating weighing not less than 2.0 ounces per square foot.

C. Shop Paint:
1. Ferrous metal thoroughly cleaned as recommended by primer manufacturer and in accordance with SSPC SP11 and, except for items to be encased in concrete, given prime coat of paint.
2. Zinc yellow iron-oxide primer or red-lead base primer applied so as to thoroughly cover surfaces without leaving runs or sags.

D. Stainless Steel: Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

E. Aluminum: AA-M10 (Mechanical Finish: As fabricated, unspecified).

F. Non-Slip Abrasive Surfaces: SLIP-NOT as manufactured by the W. S. Molnar Company or approved equal. Fabricate from steel plate or bar with abrasive material metallically bonded to steel by a proprietary process. Provide material with coefficient of friction of 0.6 or higher when tested according to ASTM C1028.

PART 3 - EXECUTION

3.01 PREPARATION

A. Remove foreign substances from surfaces to receive metal items.

B. Protect surrounding surfaces from damage while performing the work of this section.

3.02 INSTALLATION

A. Install metal fabrications in compliance with the applicable manufacturer's printed instructions, accepted Shop Drawings, as indicated, and as specified.

B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

C. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.03 INSTALLING NOSINGS

A. Center nosings on tread widths.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

3.04 INSTALLING BOLLARDS

A. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. After bollards have been inserted into sleeves, fill annular space between bollard and sleeve solidly with nonshrink, nonmetallic grout, mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/4 inch toward bollard.

3.05 PAINTING AND REPAIRING COATED SURFACES

A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finished work, except items encased in concrete.

B. Where shop coat is abraded or burned by welding, clean and touch-up.

C. Touch-up primed surfaces with same material as coating.

D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.

E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
   1. Wire-brush areas to be coated to bright metal.
   2. Apply galvanizing repair compound at rate of two ounces per square foot.

END OF SECTION

SECTION 05501

MISCELLANEOUS METAL

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies providing miscellaneous metal, with the exception of ornamental (architectural) metal and metalwork provided as a part of mechanical, electrical and construction systems.

1.02 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: Detail fabrication and erection of each metal fabrication indicated.
      a. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
      b. Manufacturer's standard drawings may be submitted in lieu of Contractor-prepared shop drawings if manufacturer's standard drawings show required details.
   2. Certification:
      a. Certification that welding personnel are currently qualified in accordance with AWS D1.1.
      b. Mill Certificates: Signed by manufacturers of stainless steel sheet certifying that products furnished comply with requirements for corrosion resistance of Type 316 stainless steel.

1.03 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards, and Specifications:

B. Comply with codes and regulations of the jurisdictional authorities.

C. American Welding Society (AWS):
   1. AWS D1.1.

D. American Institute of Steel Construction (AISC):
   1. Specification for Structural Steel for Buildings-Allowable Stress Design and Plastic Design (Do not use plastic design).

E. FED STD: 595.

F. MS: MIL-P-21035.

G. FS: A-A-462, FF-B-588, FF-H-116, FF-P-395, FF-S-325, RR-T-650, TT-P-86.

H. ASTM: A36, A53, A74, A108, A123, A167, A193, A229, A242, A276, A307, A313, A325, A413, A490, A501, A536, A570, A572, A588, A666, A780, A786, B221, B632, B633, D412, D1187, E488, F593, F594, F1554.

I. American Galvanizers Association (AGA):
1. The Design and Fabrication of Galvanized Products.

J. American National Standards Institute (ANSI):
1. ANSI A14.3

K. American Society of Mechanical Engineers (ASME):
1. ASME: A 17.1, B18.6.3, B18.21.1, B18.22.1.

L. Qualifications of Welding Personnel:
1. Welding: Qualify procedures and personnel according to the following:
   a. AWS D1.1, "Structural Welding Code--Steel."
   b. AWS D1.2, "Structural Welding Code--Aluminum."
   c. AWS D1.3, "Structural Welding Code--Sheet Steel."
   d. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification. Such certification is to remain in force for the duration of the welding operations under this Contract.

M. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project, with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

N. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.04 PROJECT CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver products undamaged.

B. Store products so as to prevent rust.

C. Handle products so as to prevent damage.

D. After completion of factory testing, package and ship hatches as directed.

PART 2 PRODUCTS

2.01 MATERIALS

A. General Requirements
1. Store products so as to prevent rust.
2. Insofar as practicable, furnish similar products of a single manufacturer.
3. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 FERROUS METALS

A. Structural steel: Plates, shapes, bars, and angles – ASTM A36.

2.03 COATINGS

A. Electrodeposited zinc coating: ASTM B63.

B. Galvanizing repair compound: Stick form, melting point 600ºF to 650ºF, GALVABAR or equal.

2.04 FASTENERS

A. General: Provide Type 316 stainless-steel fasteners. Select fasteners for type, grade, and class required.

B. Screws: Material, type and size to suit the purpose; Stainless steel, ASTM A193, Alloy S30400.

C. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E488, conducted by a qualified independent testing agency.
1. Material: Alloy Group 1 or 2 stainless steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

2.05 CONCRETE AND GROUT

A. Nonshrink Grout: Section 03300.

2.06 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Weld corners and seams continuously to comply with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints in a manner to exclude water or provide weep holes where water may accumulate.

2.07 MISCELLANEOUS ITEMS

A. Fabricate metal items indicated on the drawings from materials shown or, if not otherwise described, from steel or from galvanized steel wherever exposed to the weather or in contact with concrete or masonry.

B. Make miscellaneous items to the size and configuration indicated, welded or bolted at joints to develop full strength equal to a continuous member, and in every way complete for the intended purpose and finished in appearance.

2.08 FINISHES

A. Galvanizing:
1. Clean ferrous metal thoroughly before applying zinc coating.
2. Apply zinc coating to products after fabrication, by hot-dip method, using coating weighing not less than 2.0 ounces per square foot.

2.09 ALUMINUM HATCH

A. Interior Aluminum Hatch: Size as indicated on Contract Drawings.
1. Door Leaf(s): ¼-inch aluminum diamond plate reinforced with aluminum stiffeners to withstand a live load of 150 lbs. per square foot.
2. Frame: ¼-inch aluminum with built-in neoprene cushion and with strap anchors bolted to exterior.
3. Door(s): Equip with cast steel hinges bolted to underside. Pivot on torsion bars. Door open to 90 degrees and lock automatically. Provide vinyl grip handle release for closing.
4. Lock: Slam lock on bottom and removable key wrench on top.
5. Hardware: Stainless Steel.
6. Acceptable Manufacturers:
a. Bilco Company - Type "K" or equal.

2.10 ALUMINUM LADDERS (INTERIOR)

A. Provide OSHA-approved design:
1. Railings: Fabricate from extruded aluminum alloy 6063-T6 (6063-T5 not acceptable) schedule 40 railing.
2. Bars: Aluminum alloy 6063-T6 conforming to ASTM B221.
3. Shapes: Aluminum alloy 6063-T6 conforming to ASTM B308.
4. Rungs: Tube or channel shape and of aluminum alloy 6063-T6 conforming to ASTM B308. Rungs to have serrated tread surface. Rungs able to withstand 1,000-pound load without failure.
5. Finish: Mill Aluminum.
6. Ladder Up Safety Post: Telescoping tubular aluminum with stainless steel spring balance mechanism. Acceptable manufacturer: Bilco Company. Provide safety post at all ladder locations.

2.11 MECHANICALLY CONNECTED ALUMINUM PIPE RAILINGS

A. Provide factory prefabricated aluminum pipe railing system of the following components.
1. Railings: 1-1/2 inch (1.90 in. O.D.) Schedule 40 pipe fabricated from extruded aluminum alloy 6061-T6.
2. Posts: 1-1/2 inch (1.90 in. O.D.) Schedule 40 pipe fabricated from extruded aluminum alloy 6061-T6. Post spacing shall be a maximum of 5'-0". The handrail manufacturer shall show that their posts are of adequate strength to meet the loading requirements. If the manufacturer's posts are not of adequate strength, the manufacturer may reduce the post spacing or add reinforcing dowels or may do both in order to meet loading requirements. The midrail at a corner return shall be able to withstand a 200-pound load without loosening. The manufacturer is to provide physical tests from a laboratory to confirm compliance.
3. Fittings: Machine from solid extruded aluminum shapes of aluminum alloy 6061-T6; or aluminum alloy castings conforming to ASTM B26; or if fittings are fabricated from more than one piece, use fabrications that are free from visible weld marks when fittings are installed.
4. Reinforcing Bars: Aluminum alloy 6061-T6 conforming to ASTM B221.
5. Connector Sleeves: Fabricate internal connector sleeves from extruded aluminum alloy 6061-T6.
6. Mounting Flanges: Posts welded to mounting flanges are not acceptable.
   a. Heavy Duty Floor Flanges: Cast aluminum with a solid aluminum reinforcing bar; such as Julius Blum 7571, or equal.
   b. Fascia Flanges (side mount flanges): Extruded aluminum with a solid aluminum alloy 6061-T6 reinforcing bar.
   c. Flange design shall be similar to the flange details shown on the Drawings.
7. Toeboard: Fabricate from extruded aluminum alloy 6061 or 6063. Shall conform to OSHA standards, be a minimum of 4 inches high and be an extrusion that attaches to the posts with clamps that will allow for expansion and contraction between posts.
8. Openings in the railing shall be guarded by a self-closing gate (OSHA 1910.23). Safety chains shall not be used unless specifically shown on the drawings. Where shown, guard chains shall be individually welded straight link AISC Type 316 stainless steel.
9. Finish: Clear satin anodized 215-R1.
10. Fabrication:
    a. Cut material square and remove burrs from exposed edges, with no chamfer.
    b. Make exposed joints butt tight, flush and hairline.

c. Close the exposed open ends of pipe by use of appropriate aluminum end caps.
d. Fabricate toprail continuous over posts without interruptions at corners, bends, and end posts.
e. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.
f. Components that are glued or pop riveted at the joints will not be acceptable. All components must be mechanically fastened with stainless steel hardware.
g. Toe plates shall be set ¼-inch above the walking surface and be provided on handrails as required by OSHA and/or as shown on drawings. Toe plates shall be shipped loose in stock lengths with pre-manufactured corners for field installation.
h. The pipe railing shall be plastic wrapped. The plastic wrap is to be removed after erection.

11. Acceptable Manufacturers:
a. Hollaender Manufacturing Co.; Interna-Rail
b. Reynolds Metal Co.; Reyno-Rail II System.
c. Thompson Fabricating Co.
d. R & B Wagner Inc.: Interna-Rail
e. Architectural Art Mfg. Inc.: "Series 300" Flush-Fit Rail

PART 3 EXECUTION

3.01 PREPARATION

A. Remove foreign substances from surfaces to receive metal items.

B. Protect surrounding surfaces from damage while performing the work of this section.
1. Supervisory wiring at each terminal point. Attach label to a clean, dry section of wire as close as possible to the terminal point.

3.02 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation with edges and surfaces level, plumb, true, and free of rack and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry or similar construction.

D. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint:
1. Test metallic conduit and boxes for electrical continuity.
2. Load Centers: Perform insulation resistance tests of each bust section phase-to-phase and phase-to-ground for one minute using 1,000 volt megger. Insulation resistance not less than manufacturer's recommended value, two megohms minimum. Test enclosure for continuity to substation ground bus. Test circuit connections in accordance with wiring diagrams.
3. Molded case circuit breakers: Perform pole-to-pole and pole-to-ground insulation resistance tests with a 1,000 volt megger.
4. Insulation resistance: 50 megohms minimum.

F. Submit certified test reports within 10 days of completion of tests.

3.03 REPAIRING COATED SURFACES:

A. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating Tenemec 46-465, Carboline or Sherwin Williams.

B. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
1. Wire-brush areas to be coated to bright metal.
2. Apply galvanizing repair compound at rate of two ounces per square foot.

END OF SECTION

THIS PABE LEFT BLANK INTENTIONALLY

SECTION 05810

EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes: This Section specifies requirements for providing expansion joint cover assemblies.

B. Related Requirements:
1. Section 03215 - Replacement of Quarry Tile with Concrete Paver.
2. Section 04415 - Granite.
3. Section 07600 - Flashing and Sheet Metal.
4. Section 07900 - Seals and Sealants.

1.03 SUBMITTALS

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

B. Product data for each type of expansion joint cover assembly specified, including manufacturer's product specifications, installation instructions, details of construction relative to materials, dimensions of individual components, profiles, and finishes.

C. Shop drawings showing fabrication and installation of expansion joint cover assembly including plans, elevations, sections, details of components, joints, splices, and attachments to other units of Work.

D. Samples for initial selection purposes in the form of manufacturer's color charts, actual units, or sections of units showing full range of colors, textures, and patterns available for each exposed metal and elastomeric material of expansion joint cover assembly indicated.

E. Samples for verification purposes in full-size units of each type of expansion joint cover assembly indicated; in sets for each finish, color, texture, and pattern specified, showing full range of variations expected in these characteristics.
1. Install elastomeric material for joints samples to verify color selected.

1.04 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. ADA: Americans with Disabilities Act.
3. UBC Standard 43-1, Fire Tests of Building Construction and Materials.
4. ANSI/UL: 263, Standard for Fire Tests of Building Construction and Materials.
5. ASTM International:
a. ASTM A167-99(2009) Standard Specification for Stainless and

Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip (Withdrawn 2014)

b. ASTM A240 / A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
c. ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
d. ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes,
e. ASTM B455-10 Specification for Copper-Zinc-Lead Alloy (Leaded Brass) Extruded Shapes.
f. ASTM C920, Standard Specification for Elastomeric Joint Sealants.
g. ASTM D2000, Standard Classification System for Rubber Products in Automotive Applications.
h. ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
i. ASTM E1399 / E1399M - 97(2013)e1 Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.

6. National Association of Architectural Metal Manufacturers (NAAMM):
   a. NAAMM Metal Finishes Manual.
7. National Fire Protection Association (NFPA):
   a. NFPA 251: Standard Methods of Tests of Fire Resistance of Building Construction and Materials.

B. Single-Source Responsibility: Where practical, obtain expansion joint cover assemblies specified in this Section from one source from a single manufacturer. Coordinate compatibility with expansion joint cover assemblies specified in other sections.

C. Fire-Test-Response Characteristics: Where indicated, provide expansion joint cover assemblies identical to those assemblies whose fire resistance has been determined according to ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E119, including hose stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Fire-Resistance Ratings: Not less than the rating of adjacent construction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in manufacturer's original, unopened protective packaging, clearly identified with manufacturer's name and type of product.

B. Do not store materials with protective film exposed to sunlight, weather, or extreme temperatures.

C. Store materials under cover in a dry, clean, and protected location.

D. Comply with additional requirements of the manufacturer.

1.06 JOB CONDITIONS

A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and show measurements on final Shop Drawings.

B. Coordination:
1. Coordinate expansion joint cover assemblies with the Work of other trades.
2. Furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in concrete or have recesses formed into edges of concrete slab for later placement and grouting-in of frames.
3. Coordinate installation of fire-rated expansion joint cover assembly materials with related Work so complete assemblies comply with assembly performance requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Aluminum: ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 6061-T6, sheet and plate.
1. Protect aluminum surfaces to be placed in contact with cementitious materials with a protective coating.

B. Bronze: ASTM B455, alloy C38500 for extrusions; alloy C28000 Muntz Metal for plates.

C. Brass: ASTM B36/B36M, UNS alloy C26000 for half hard sheet and coil.

D. Stainless Steel: ASTM A240, Type 304 with 2B finish, unless indicated otherwise, for plates, sheet, and strips.

E. Extruded Preformed Seals: Single or multicellular elastomeric profiles as classified under ASTM D2000, designed with or without continuous, longitudinal, internal baffles. Formed to fit compatible frames, in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors.

F. Preformed Sealant: Manufacturer's standard elastomeric sealant complying with ASTM C920, Use T, factory-formed and -bonded to metal frames or anchor members; in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors.
1. Joints 2 Inches Wide and Less: Withstand plus or minus 35 percent movement of the joint width without failure.
2. Joints Greater Than 2 Inches to 4 Inches Wide: Withstand plus or minus 50 percent movement of the joint width without failure.

G. Seismic Seals: Typically for exterior application, two single-layered elastomeric profiles, one interior and one exterior, as classified under ASTM D2000; retained in a set of compatible frames, in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors. At manufacturer's option, omit interior profile for interior application.

H. Fire Barriers: Designed for indicated or required dynamic structural movement without material degradation or fatigue when tested according to ASTM E1399. Tested in maximum joint width condition with a field splice as a component of an expansion joint cover per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E119, including hose stream test of vertical wall assemblies by a nationally recognized testing and inspecting agency acceptable to authorities having jurisdiction.

I. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesive, and other accessories compatible with material in contact, as indicated or required for complete

installations.

2.02 EXPANSION JOINT COVER ASSEMBLIES

A. General: Provide expansion joint cover assemblies of design, basic profile, materials, and operation indicated on approved shop drawings. Provide units comparable to those indicated or required to accommodate joint size, variations in adjacent surfaces, and dynamic structural movement without material degradation or fatigue when tested according to ASTM E1399. Furnish units in longest practicable lengths to minimize number of end joints. Provide hairline mitered corners where joint changes directions or abuts other materials. Include closure materials and transition pieces, tee-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous joint cover assemblies.

B. Moisture Barrier: Provide manufacturer's continuous, standard, flexible vinyl moisture barrier under covers at locations indicated on approved shop drawings.

C. Fire-Rated Joint Covers: Provide expansion joint cover assemblies with manufacturer's continuous, standard, flexible fire barrier seals under covers at locations indicated on approved shop drawings to provide fire-resistive rating not less than the rating of adjacent construction.

D. Coverless Fire Barrier: Provide manufacturer's continuous standard flexible fire barrier seals at locations indicated on approved shop drawings to provide fire-resistive rating not less than the rating of adjacent construction.

E. Metal Floor-to-Floor Joint Cover Assemblies: Provide continuous extruded metal frames of profile indicated with seating surface and raised floor rim or exposed trim strip to accommodate flooring and concealed bolt and anchors embedded in concrete. Provide assemblies formed to receive cover plates of design indicated and to receive filler materials (if any) between raised rim of frame and edge of plate. Furnish depth and configuration to suit type of construction and to produce a continuous flush wearing surface with adjoining finish floor surface.
   1. Partially Concealed Cover: Provide one frame on each side of joint, designed to accommodate manufacturer's floor cover plate and filler.
   2. Exposed Cover: Provide one frame on each side of joint, designed to support floor plate and filler
   3. Flat Cover Plates: Provide cover plates of profile and wearing surface indicated. Extend flat plates to lap each side of joint.
      a. Filler Insert: Furnish abrasive-resistant flexible gasket filler between edge of cover plate and raised rim of frame to accommodate required movement
   4. Fixed Cover Plates: Attach one side of the cover plate to a frame or finished wearing surface, with other side resting on other frame or finished wearing surface to allow free movement.
   5. Self-Centering Cover Plates: Concealed centering device with the cover plate secured in or on top of frames as to have free movement on both sides.
   6. Floor Cover Plate Wearing Surfaces: Provide cover plates with the following type of wearing surfaces.
      a. Plain.
      b. Fluted.
      c. Recessed to receive full thickness of flooring material.
      d. Abrasive plate.
      e. Adhesive filled plate.

f. Adhesive strip plate.

F. Floor-to-Wall Joints: Provide one frame on floor side of joint only. Provide wall side frame where required by manufacturer's design.
1. Angle Cover Plates: Attach angle cover plates for floor-to-wall joints to wall with countersunk, flat-head exposed fasteners secured to drilled-in-place anchor shields, unless otherwise indicated, at spacing recommended by joint cover manufacturer.

G. Wall, Ceiling, and Soffit Joint Cover Assemblies: Provide interior wall and ceiling expansion joint cover assemblies of same design and appearance. Provide exterior wall and soffit expansion joint cover assemblies of same design and appearance. Provide wall expansion joint cover assemblies compatible with floor expansion joint cover assemblies design and appearance.
1. Fixed Metal Cover Plates: Provide a concealed, continuously anchored frame fastened to wall, ceiling, or soffit only on one side of joint. Extend cover to lap each side of joint and to permit free movement on one side. Attach cover to frame with cover in close contact with adjacent finish surfaces.
2. Floating Metal Cover Plates: Cover plate secured in or on top of frames to permit free movement on both sides.
3. Self-Centering Cover Plates: Concealed centering device with the cover plate secured in or on top of frames to permit free movement on both sides.
4. Flexible Filler: Secure the approved flexible filler between frames to compress and expand with movement.

H. Joint Cover Assemblies with Preformed Seals: Provide joint cover assemblies consisting of continuously anchored aluminum extrusions and continuous extruded preformed seals of profile indicated or required to suit types of installation conditions shown. Furnish extrusions designed to be embedded in or attached to concrete with lugs. Vulcanize or heat-weld splices (if any) to ensure hermetic joint condition.
1. Cover Plate: Include extruded aluminum cover plate fastened to one side of joint and extend plate to lap each side of joint to permit free movement with cover in close contact with adjacent contact surfaces.

I. Joint Cover Assemblies with Elastomeric Sealant: Provide continuous cover joint assemblies consisting of elastomeric sealant factory-bonded to extruded aluminum frames of profile indicated or required to suit types of installation conditions shown. Provide frames for floor joints with means for embedding in or anchoring to concrete without using exposed fasteners and that will result in exposed surfaces of sealant and aluminum frames finishing flush with adjacent finished floor surface without exposing anchors.

J. Compression Seals: Preformed, elastomeric extrusions having internal baffle system in sizes and profiles shown or as recommended by the manufacturer. Provide lubricant and adhesive for installation recommended by the manufacturer.

K. Foam Seal: Nonextruded, low-density, cross-linked, nitrogen-blown ethylene vinyl acetate polyethylene copolymer foam. Provide adhesive for installation recommended by the manufacturer.

2.03 METAL FINISHES

A. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes to products in factory after fabrication. Protect finishes on exposed surfaces before shipment.

B. Aluminum Finishes: Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
1. Mill Finish: AA-M10 (unspecified mill finish).
2. Class II, Clear-Anodized Finish: AA-M12C22A31 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, clear film thicker than 0.4 mil].
3. Class I, Clear-Anodized Finish: AA-M12C22A41 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, clear film thicker than 0.7 mil[complying with AAMA 607.1.
4. Class II, Color-Anodized Finish: AA-M12C22A32/A34 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, film thicker than 0.4 mil with integral color or electrolytically deposited color].
5. Class I, Color-Anodized Finish: AA-M12C22A42/A44 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, film thicker than 0.7 mil with integral color or electrolytically deposited color] complying with AAMA 606.1 or AAMA 608.1.
   a. Color: As selected by the Engineer from within standard industry colors and color density range.
6. Baked Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.
   a. Organic Coating: Thermosetting modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with minimum dry film thickness of 1.5 mils, medium gloss
   b. Color: As selected by the Engineer from manufacturer's standard colors.
7. High-Performance Organic Coating: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.
   a. Fluoropolymer Two-Coat Coating System: Manufacturer's standard two-coat thermocured system, composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.
   b. Fluoropolymer Three-Coat Coating System: Manufacturer's standard three-coat thermocured system composed of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluorocarbon topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.
      1) Resin Manufacturers: Subject to compliance with requirements, provide fluoropolymer coating systems containing resins produced by one of the following manufacturers:
         a) Ausimont USA, Inc. (Hylar 5000).
         b) Elf Atochem North America, Inc. (Kynar 500).
         c) Or equal.

2) Color and Gloss: As selected by the Engineer from manufacturer's standard choices for color and gloss.Retain below for covers in contact with masonry or concrete.

8. Factory-Primed Concealed Surfaces: Protect concealed metal surfaces to be placed in contact with concrete or masonry with a shop coat of manufacturer's standard primer on the contact surfaces.

C. Bronze Finish: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
1. Natural Satin Finish: CDA Designation M32, mechanical finish, directional textured, medium satin.

D. Stainless Steel Finishes: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.
1. Bright, Cold-Rolled Unpolished Finish: AISI No. 2B finish.
2. Bright, Directional Polish: AISI No. 3 finish.

E. Factory Finish: Manufacturer's standard factory finish.

PART 3 - EXECUTION

3.01 PREPARATION

A. Manufacturer's Instructions: In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for phases of Work, including preparing substrate, applying materials, and protecting installed units.

B. Coordinate and furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in or anchored to concrete or to have recesses formed into edges of concrete slab for later placement and grouting in of frames.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary to secure expansion joint cover assemblies to in-place construction, including threaded fasteners with drilled-in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and provide for secure attachment of expansion joint cover assemblies.

3.02 INSTALLATION

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required to install expansion joint covers. Install joint cover assemblies in true alignment and proper relationship to expansion joints and adjoining finished surfaces measured from established lines and levels. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling. Set floor covers at elevations to be flush with adjacent finished floor materials. Locate wall, ceiling, roof, and soffit covers in continuous contact with adjacent surfaces. Securely attach in place with required accessories. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches on center.

B. Continuity: Maintain continuity of expansion joint cover assemblies with a minimum number of end joints and align metal members mechanically using splice joints. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere flexible filler materials (if any) to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

C. Extruded Preformed Seals: Install seals complying with manufacturer's instructions and with minimum number of end joints. For straight sections provide preformed seals in continual lengths. Vulcanize or heat-weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer. Apply adhesive, epoxy, or lubricant-adhesive approved by manufacturer to both frame interfaces before installing preformed seal. Seal transitions according to manufacturer's instructions.

D. Elastomeric Sealant Joint Assemblies: Seal end joints within continuous runs and joints at transitions according to manufacturer's directions to provide a watertight installation.

E. Seismic Seals: Install interior seals in continual lengths; vulcanize or heat-weld field splice joints in interior seal material to provide watertight joints using manufacturer's recommended procedures. Install exterior seal in standard lengths. Seal transitions and end joints according to manufacturer's instructions.

F. Fire Barriers: Install fire barriers, including transitions and end joints, according to manufacturer's instructions so that fire-rated construction is continuous.

3.03 CLEANING AND PROTECTION

G. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's instructions.

END OF SECTION

SECTION 05840

BEARINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies spherical bearings, fixed and sliding types, as shown.

B. Related Work Specified Elsewhere:
1. Structural Steel: Section 05120.
2. Aerial Girder Bearing Replacement: Section 05841.
3. Jacking of Aerial Structure: Section 05842.

1.02 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards and Specifications:
1. Codes and regulations of the jurisdictional authorities.
2. AWS: C-2.2, D 1.5.
3. AASHTO: Standard Specifications for Highway Bridges, including supplement and M235. Where conflict occurs between AWS and AASHTO, AASHTO governs.
4. AISC:
   a. Code of Standard Practice for Steel Buildings and Bridges.
   b. Specifications for Structural Joints using ASTM A325 and A490 Bolts.
5. AISI: C1018, C1020.
6. ANSI: B18.2, B27.2.
7. ASTM: A167, A240, A 709, C287, D621, D1777, D2256.
8. ASNT: Recommended Practice SNT-TC-1A.
9. MS: MIL P23236

B. Source Quality Control:
1. Testing and inspection:
   a. Nondestructive-test requirements for welded members. Perform the following:
      1) For all fillet-weld connections: 10 percent of welds inspected by magnetic particle inspection.
      2) The Engineer may designate additional items to be inspected by radiography.
   b. Bolts: The Engineer will randomly select at least five bolts for test purposes from each bin of bolts furnished.

C. Qualification of Welding Personnel and Procedures:
1. Prior to qualifying welding personnel and welding procedures, confirm an agreement with the Engineer as to procedural details, sequence of welding, handling of materials to be inspected, and approval of electrodes, wire, flux and other welding materials and equipment.
2. Employ welding personnel whose qualification is certified in accordance with AWS Standard D1.5. Such certification is to remain in force for the duration of the welding operations under this Contract.
3. Do not start fabrication until qualification has been successfully completed.

D. Qualification of Nondestructive-Testing Personnel:
1. Nondestructive testing of fracture-critical members to be conducted by personnel qualified as NDT Level II or Level III in accordance with ASNT SNT-TC-1A.
2. Level-II technicians to be supervised by Level III-personnel.

E. Stock Material:
1. For qualification of welding personnel and procedures and for quality-assurance testing, use only stock materials which can be identified as having been rolled from a given heat and for which certified mill tests can be produced.
2. When stock material is proposed, inform the Engineer of such intention at least 10 days in advance of commencing fabrication to permit sampling and testing. Select identified material from as few heats as possible.

F. Welder's Identification Mark:
1. Assign each welder and welding operator an identification mark to stamp on pieces he has welded.
2. Have welder or welding operator place his identification mark by metal-die stamp in letters 3/8-inch high in position that identification of welder or operator will appear adjacent to each of his welds in finally assembled members for ready reference to radiographic films and for identification by the Engineer.

G. Bearing Manufacturer:
1. Qualification of Bearing Manufacturer: The Contractor shall demonstrate that the selected bearing manufacturer has a successful performance record for at least ten (10) years in the design and fabrication of spherical bearings in structures similar to the Work herein. The manufacturer shall also be capable of ensuring a close control over the materials, workmanship and quality within his facilities.
2. Certification of Bearing Quality: The Contractor shall submit the following certification for approval by the Engineer:
   a. Bearing certificate of conformance.
   b. Test reports and certification of all materials included in the construction of all the bearings.
3. Inspection Facilities: The manufacturer shall be required to furnish facilities for the testing and inspection of the complete bearings and/or representative samples in his plant or at an independent test facility.

H. Testing of Bearings:
1. Sampling:
   a. Select at random at least one sample from each "lot" of completed bearings at the manufacturer's plant.
   b. One "lot" consists of one of the following:
      1) No more than 12 fixed or modified fixed bearings of one "load category".
      2) No more than 12 expansion bearings of one "load category".
   c. One "load category" may consist of bearings of differing vertical load capacity but not to exceed a range of capacity differing by more than 300 kips.
2. Friction Test:
   a. Specially made bearings are not to be used; only actual bearings to be used in the project are to be tested. Test in accordance with the requirements of Section 18.8.3 of the current edition of AASHTO "Standard Specifications for Highway Bridges". A

sample from each lot of expansion bearing is to be tested.

3. Proof Load Test:
   a. Test one bearing from each production "lot" of fixed and expansion bearings.
   b. Apply a load to the test bearings equal to 150% of the rated design capacity of the bearing simultaneously rotated 0.02 radians or the design rotation, which is greater, for one hour.
   c. During the test or subsequently upon disassembly, the bearing shall show no sign of deformation or extrusion of the PTFE.
4. Material Tests:
   a. One sample of PTFE is to be taken from each "lot".

1.03 SUBMITTALS

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Structural details: Include the following:
         1) Bills of materials giving complete information for fabrication and erection of component parts of structures including material and finish information.
         2) Details of location, type, sizes of bolts and welds and for welded structures details of welding as specified.
         3) Structural computations for Contractor-designed work certified by a professional engineer registered in the area where the work is to be performed.
      b. Match marks:
         1) Provide diagram showing match marks for connecting structural parts assembled in shop for purpose of drilling or reaming holes in field connections.
      c. Welding:
         1) Complete shop details of qualification test specimens.
         2) Include information on specimen identification, number of pieces and welding procedure specification, type of material, sizes of pieces and welds and other variables affecting detail or tests.
      d. Manufacturer's test procedures for bolts. e. Bearings:
         1) The manufacturer is to submit detailed assembly drawings and any attachments in sufficient detail for proper review of the contract and this specification.
         2) Shop drawings are to include but not be limited to the following information:
            a) Plan view and section elevation including all relative dimensions.
            b) Details of all components and sections showing all materials incorporated into the bearing.
            c) All ASTM, AASHTO and other material designations. d) Vertical, horizontal, rotation and movement capacity.
            e) A schedule of all bearing offsets if required by the project.
            f) Complete design calculations verifying conformance with the provisions of this specification and certified by a professional engineer registered in the

jurisdiction where the work is performed. Do not proceed until approval has been received

B. Certification:
1. Certified mill test reports of structural steel at least 10 days prior to start of fabrication.
2. Certified quality-assurance testing and inspection reports.
3. Certification verifying that welding personnel have been qualified in accordance with AWS D1.1.
4. Manufacturer's certification that bolts meet approved testing.
5. Spherical-type bearings:
a. The certification package is to contain the following:
1) Materials test reports for all steels used except AISI C1018 and C1020 for which a mill conformance certificate is acceptable.
2) Certificate of Compliance for all non-ferrous metals.
3) Certificate of Compliance for PTFE and any adhesives used. A certificate of compliance for the bearings shall be executed by an officer of the manufacturer's company.
4) Certificate of Compliance for any dowels or bolts supplied
5) Test reports for the performance tests.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General:
1. Load, transport, unload and store structural materials so as to keep them clean and free from damage

B. Steelwork: See section 05120.

C. Bolts and Nuts: See section 05120.

D. Bearings:
1. Bearings are to be securely banded together as units so that they may be shipped to the jobsite and stored without relative movement of the bearing parts or disassembly at any time. Bearings are to be wrapped in moisture resistance and dust resistant material to protect against shipping and jobsite conditions.
2. Take care to ensure that bearings at the jobsite are stored in a dry sheltered area free from dirt or dust until installation.
3. When bearings are to be inspected on site, they are to be inspected within one week of arrival and may not be disassembled except under the supervision of the manufacturer or his representative or with the written approval of the manufacturer. Following inspection, the wrapping is to be reapplied and the bearings kept clean until installation.
4. Removal of sole and top plates of bearings for separate attachment to the structure is not permitted except under the direct supervision of the manufacturer.

1.05 JOB CONDITIONS

A. Environmental Requirements:
1. Welding: See section 05120.

B. OSHA Requirements:

1. Contractor shall adhere to Occupational Safety and Health Administration=s (OSHA) Confined Space requirements of Sections 1910.146 and 1926.21(b)(6) when working in the steel box girders of the aerial structure. Conformance to OSHA regulations shall be detailed in the Contractor=s site-specific Safety Program. See section 01000 for additional safety requirements.

PART 2- PRODUCTS

2.01 MATERIALS

A. PTFE sliding surfaces conforming to the material requirements of AASHTO Section 18.8. Reprocessed material shall not be used.

B. Stainless Steel sliding surfaces conforming to ASTM A167 or A240 Type 304 with a surface finish 20 micro-inches rms. or less. Welded stainless steel overlay produced using Type 309L electrodes.

C. Solid Stainless Steel stock for spherical bearings core conforming to ASTM A240, Type 318 or Type 304 or to ASTM A167, Type 304, with a minimum yield strength of F_y equal 30,000 psi.

D. Steel in Bearings: Bearings for Aerial Line Sections

1. Bearing assemblies used in the line sections of the aerial structure with span lengths of 80 feet or more, shall be self-lubricating bearing assemblies to provide rotation and longitudinal movement as needed for expansion joints. The bearing assembly shall be an integral unit composed of:
   a. Spherical bearings plates - A convex solid stainless steel plate with surface of woven PTFE fabric mechanically interlocked to the substrate plate, and a mating concave solid stainless steel plate with finished bearing surface. The spherical interface shall provide rotational movement in any direction.
   b. Flat bearing plates - A flat plate with the PTFE material similarly fixed on the sliding surface, and a solid stainless steel concave mating plate, as described in (a.) above, with a flat finished sliding surface, to provide longitudinal translation movement. The relative movement between these two flat surfaces is to be restricted to the longitudinal direction.
      1) The PTFE fabric shall have a minimum thickness of 1/16" and is to meet the following requirements:
         (a) Hardness at 78□F per ASTM D676 - 50-65 Durometer D Tensile strength per ASTM D638 - 2800 psi (Min. Avg.) Elongation per ASTM D1708 - 200% (Min. Avg.)
         (b) The coefficient of friction between the steel plate and the PTFE surface shall be no greater than .06 at 800 psi compressive loading.
      2) The stainless steel surfaces shall have a finish of 20 RMS.
2. Expansion bearings shall be sized and set at the time of construction to allow for the following:
   a. The maximum temperature movement based on the mean 48 hour prior temperature.
   b. The anticipated rotation and movement due to creep, shrinkage and elastic shortening from time of setting through day 400. These computed rotation and movements shall be increased by a factor of 1.3.
3. Materials and fabrication for all type bearings, shall be in accordance with AASHTO, Section 18, Division II, and with the contract specifications.

E. All steel, except stainless steel, used in fabrication of structural bearings, including

masonry, sole plates, hold-down bolts and plates, etc., to be in accordance with ASTM A709, Grade 50W, unless otherwise shown in the Contract Drawings.

F. Bolts and Nuts: ANSI B18.2.1 and B18.2.2.

G. Round Washers Other Than Those In Contact With High-Strength Bolt Heads And Nuts: ANSI B27.2, Type B.

H. Beveled Washers:
1. Square, smooth and sloped to make contact surfaces of bolt head and nut parallel.
2. Diameter of hole in square beveled washers as follows:
a. For bolts less than one-inch diameter: 1/16-inch larger than bolt size. For bolts larger than one-inch diameter: 1/8-inch larger than bolt size.

I. For all other materials, see section 05120.

2.02 DESIGN OF BEARINGS

A. General:
1. Multi-Rotational bearings are to be designed to accommodate the loads, forces and movements specified in the bearing schedule.
2. Maximum design stresses for all bearing components are not to exceed the allowable design stresses of the applicable issue of the AASHTO "Standard Specifications for Highway Bridges" and the applicable sections of this specification.
3. Minimum "Design Rotation" capacity is 0.015 radians or as specified in the contract plans.
4. Minimum horizontal capacity is 10% of the vertical capacity.
5. Bearings are to be designed for 1 inch additional total movement capacity in each direction specified under "Design Movement" in the "Bearing Schedule". Spacing between the guides of the bearing do not require this additional movement capacity.
6. Bearings are to be designed so that all rotational and sliding elements can be replaced with a minimum of jacking.
7. All dimensions in this specification are in the customary units of the United States.

B. Design of Rotational Elements:
1. Spherical Element-Concave Surface-PTFE/Woven Teflon Fabric Pad:
a. The spherical radius shall be determined such that the resulting geometry of the bearing is capable of withstanding the greatest ratio of horizontal force to vertical load under all loading conditions to prevent unseating the concave element.
b. If required during construction, mechanical safety restraints shall be incorporated to prevent overturning.
c. Maximum design rotation of the structure itself plus 0.03 radians shall be considered in the bearing design to prevent overturning or uplift.
d. Calculations showing the determination of the radius shall be submitted for approval. The projected area of sheet PTFE shall be designed for a maximum working stress of 3500 psi at the full load of the structure.
e. The projected area of woven fiber PTFE shall be designed for a maximum working stress of 6000 psi at the full load of the structure.

f. The concave surface shall face down whenever possible.
g. The minimum edge and center thickness shall be 3/4".
h. For sheet PTFE the minimum thickness shall be 1/8" and recessed for 1/16" in the spherical element.
i. PTFE fabric shall be a minimum of 1/16" thick when measured in accordance with ASTM D1777.
j. PTFE woven fabric shall be mechanically interlocked with the stainless steel substrate in accordance with the requirements of Section 18.8.2.1.3 of AASHTO.

2. Rotational Elements-Spherical Convex Surfaces
a. The convex element shall be designed for the following service rotation in radians:
1) Service rotation = "Design Rotation" +0.03: where Design Rotation refers to the rotation of the structure itself.
b. When convex elements are connected to masonry or distribution plates it shall be by means of a fillet weld around the entire perimeter or set into a cavity and sealed by welding or other acceptable means.
c. The minimum edge thickness shall be 3/4".
d. For PTFE/Stainless and sliding surfaces, the stainless surface shall be one of the following:
1) ASTM A240 Type 304,13 gage thick with a 20 micro-inch RMS finish.
2) Solid stainless steel ASTM A240 Type 304 or 304L shall be equal to or less than a 20 micro-inch RMS finish.
3) Stainless steel weld overlay a minimum of 3/32” thick with a 20 micro-inch RMS finish.
e. If sheet PTFE is used for guided surfaces, it shall be pigmented.

C. Design of Non-Rotational Elements:
1. PTFE Sliding Surfaces:
a. Sheet PTFE sliding surfaces, filled or unfilled, are to be designed for 3500 psi average maximum working stress at the fully factored dead and live load of the structure.
b. Sheet PTFE is to be minimum of 1/8 inch thick, epoxy-bonded into a square-edge recess 1/16 inch deep.
c. Fabric PTFE sliding surfaces are to be designed for 6000 psi average maximum working stress at the fully factored dead and live load of structure.
d. Fabric PTFE is to have a minimum thickness of 1/16 inch and be epoxy-bonded to the substrate using a system that prevents migration of epoxy through the fabric. Any edges, other than the selvedge are to be over sown or recessed so that no cut fabric edges are exposed.
e. PTFE used on guide bars shall be pigmented

2. Stainless Steel Sliding Surfaces:
a. The stainless steel surface is to cover the mating surface in all operating positions plus one inch in each direction of movement. This is to conform with the requirements of Article 2.2.A.5.
b. Sheet stainless steel is to be minimum of 13 gage thick and connected to the substrate by a continuous weld around the entire perimeter. The sheet is to be in full contact with the substrate.
c. Stainless steel sliding surfaces are to be, preferably, face down.
d. Stainless steel welded overlay is to be a minimum of 3/32 inches thick after welding, grinding and polishing and be produced using Type 309L electrodes.

3. Guide Bars:
   a. May be integral by machining from the solid, welded or connected with high strength fasteners. High strength fasteners are to be designed using .25 X Ultimate Strength in shear.
   b. Guide bars are to be designed for the specified horizontal forces, but not for less than 10 percent of the vertical capacity of the bearing.
   c. The total space between the guide bars and guided members (both sides) is to be, preferably, 1/16 inch or as specified.
   d. Guided members must have their contact area within the guide bars in all operating positions.
   e. Guiding off the fixed base or any extensions of it where transverse rotation is anticipated is to be avoided.

2.03 FABRICATION

A. Rotational Elements:
   1. Spherical bearing machined diameters shall be + or - 0.015". Convex radius dimensions shall be + 0.000" - 0.010". Concave radius dimensions shall be +
      0.010" - 0.000"
   2. Mating surfaces shall be as in Design section, external edges may be "as cast" or flame-cut.
      a. Lower surface of convex element shall be Class "C" tolerance.

B. Non-Rational Elements:
   1. Masonry and distribution plate tolerances:
      a. Plan dimensions under 30 inches, minus 0-inch plus 3/16 inch.
      b. Plan dimensions over 30 inches, minus 0-inch plus 1/4 inch.
      c. Thickness tolerance shall be minus 0.030-inch plus 0.060-inch.Masonry plates used with Spherical Bearings, Class "C" for the underside and Class "A" for the upper side.
   2. PTFE sliding surface tolerance:
      a. Plan dimensions "total design area" plus 5 percent minus 0 percent.
      b. Substrate flatness Class "B" Spherical Bearings.
   3. Stainless steel sheet is to be seal-weld around the entire perimeter using techniques which ensure it remains in contact with the backing plate. Finish, 20 micro-inches RMS or better. Flatness to Class "A" tolerance
   4. Sole plates conforming to:
      a. Plan dimensions under 30 inches minus 0-inch plus 3/16-inch.
      b. Plan dimensions over 30 inches minus 0-inch plus 1/4-inch.
      c. Center line Thickness, minus 1/32-inch plus 1/8-inch.
      d. Flatness of surface in contact with poured in place concrete, none, in contact with stainless steel sliding surface, Class "A", in contact with another steel plate, Class "B".
      e. No edge shall be thinner than 3/4-inch.
      f. Bevels shall be machined to an angular tolerance of plus-or-minus 0.002 radians.
      g. Flatness of beveled surfaces shall be Class "A".
   5. Guide bar tolerances:
      a. Length, unless integral with plate plus-or-minus 1/8-inch.
      b. Section dimensions, plus-or-minus 1/16-inch.
      c. Flatness where it bears on another plate Class "A".
      d. Bar-to-bar, nominal dimensions plus-or-minus 1/32-inch.

e. Not more than 1/32-inch out of parallel.

6. Overall bearing height is to be not more than 3/16-inch or less than 1/16-inch under nominal dimension. All edges shall be rounded and not sharp.

C. Determination of Flatness and Tolerances:

1. Flatness of bearings is determined by the following method:

a. A precision straightedge, longer than the nominal dimension to be measured, shall be placed in contact with the surface to be measured or as parallel to it as possible.

b. Select a feeler gage having a tolerance of plus or minus 0.001 inch and attempt to insert it under the straightedge. Since layering of feeler gages tends to degrade accuracy, the least number of blades shall be used.

c. Flatness is acceptable if the feeler does not pass under the straightedge.

d. Flatness tolerances are arranged in the following classes:
Class "A" 0.0005 inch X "Nominal Dimension". Class "B" 0.001 inch X "Nominal Dimension". Class "C" 0.002 inch X "Nominal Dimension".

e. "Nominal Dimension" will be interpreted as an actual dimension of the plate, in inches, under the straightedge.

f. In determining flatness, the straightedge may be located in any position on the surface to be evaluated and not necessarily at 90 degrees to the edges.

g. A 1-inch border around the plate is to be ignored in determining flatness.

PART 3 - EXECUTION

3.01 FABRICATION: See Section 05120.

A. Bearings:

1. The manufacturer of the bearing is also to furnish all details pertaining to the bearing assemblies including the following:
   a. Masonry and sole plates.
   b. Anchor studs and pins.
   c. Guide bars or shear blocks.
   d. High-Strength bolts.
   e. Stainless steel sheets and PTFE sheets.
   f. Shipping straps or retaining clamps.
   g. Miscellaneous details.

2. Sizes, dimensions and details pertaining to the spherical bearing core that are not shown on the Drawings are to be designed and determined by the bearing manufacture for the loading and movements shown on the Drawings and in the Contract Specification.

3. Details shown on the Drawings for the bearings, outside of the actual spherical-bearing core, may have to be adjusted to suit actual dimensions and requirements of the spherical-bearing furnished by the manufacturer. See Bearing Notes on the Drawings.

4. Bolts in guide bars or shear blocks, and sole and masonry plates are to be capable of being removed in the field for bearing replacement. Studs on masonry and sole plates are to be positioned as shown and to clear reinforcement in pier columns, abutment beam seats and box girders.

3.02 WELDING: See Section 05120.

3.03 BOLTING: See Section 05120.

3.04 ERECTION

A. Set bearing assemblies to lines and grades shown and adjust to horizontal position shown.

B. Bearings Installation:

1. Bearings are to be evenly supported over their upper and lower surfaces under all erection and service conditions.
2. Bearings are to be lifted by their undersides only or by specially designed lifting lugs.
3. When installing bearings, care is to be taken to avoid damage to and contamination of bearings surfaces.
4. Align the centerlines of the bearing assembly with those of the substructure and superstructure. On guided bearings, special care must be taken to properly align the guiding mechanism with the designated expansion direction of the structure.
5. Bearings straps or retaining clamps are to be left in place as long as possible to ensure parts of bearings are not inadvertently displaced relative to each other. Care must be taken to remove straps or clamps before any normal structural movement takes place, such as thermal expansion/contraction, traction forces, etc.

END OF SECTION

SECTION 05841

AERIAL GIRDER BEARING REPLACEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish all labor, tools, material, transportation, and other items necessary to satisfactorily complete this Project as written in the Specifications and as indicated on the Contract Drawings.

B. Particulars include, but are not limited to, the following:
1. Contractor shall be responsible for all permits and inspections.
2. Comply with federal and jurisdictional requirements and codes pertaining to this project.
3. Contractor shall comply with all safety requirements and permits required by WMATA.
4. Erection of permanent internal jacking supports.
5. Provision of ventilation and lighting inside box girders.
6. Provision of access towers and work platforms with stairs.
7. Provision of access holes and access hatches.
8. Jacking of steel box girders.
9. Removal of elastomeric bearings and furnishing and installing of spherical bearings.
10. Removal of temporary access facilities and restoration of work.

1.02 QUALITY ASSURANCE

A. Reference Codes and Specifications:
1. Codes and Regulations of the jurisdictional agencies.
2. CFR Title 29, Part 1926.

B. Bearing Replacement Procedure:
1. Sequence of bearing removal and replacement shall be as shown on the Contract Drawings.

1.03 SUBMITTALS

A. Submit the following in accordance with the General Requirements and with the additional requirements as specified for each:
1. Shop and Working Drawings:
a. Site Specific Work Plan for all procedures to be used during performance of the work.
b. Working plans showing locations and complete description and sizes for any proposed access equipment, installation equipment, and methods of protecting adjacent facilities.
c. Complete detailed description of sequence of operations for performance of the work.

d. Installation drawings for each bearing to be replaced, showing reference marks to be used, method of removal of existing bearings, and method of existing surface preparation for new bearing.
e. Installation drawings for new access holes, access hatches and closure plates with bolt locations shown.
f. Installation drawings for new diaphragm showing location of bolts.
g. Proposed jacking procedure for ensuring equal movements to all jacks. Certified calibration charts for each jack and proposed hydraulic configuration.
h. Drawings showing the temporary access platforms.
i. Proposed procedure for replacing jacks in the event of a jack malfunction.
j. Proposed ventilation and lighting provisions inside the box girders.

1.04 JOB CONDITIONS

A. Responsibilities:
1. Maintain safety, stability and integrity of the existing site facilities of whatever nature, regardless of location, which may be affected by the work.
a. Comply with OSHA regulations contained in CFR Title 29, Part 1926.
2. Monitor structure for signs of distress during jacking and cutting of new openings.
3. Repair damage to structures and surface features caused by work of this Contract.
4. Perform construction in accordance with applicable codes and regulations.
5. Perform construction with qualified personnel under continuous supervision of a registered professional engineer experienced in such work and licensed in the State of Maryland.

B. Coordination:
1. Prior to starting work on the aerial structure, coordinate with the AR the proposed construction procedures and sequence of operations, including;
2. Means of access to and from the construction area.
3. Permitted areas of operations.
4. Time restrictions for performance of work.
5. Means of protecting structures, utilities, sidewalks and adjacent construction during all phases of the work.
6. Submit request for Contractor personnel to attend WMATA's Contractor ROW Safety Training.
a. Include list of personnel to attend.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS

A. Materials in accordance with applicable specifications.

B. Hydraulic jacks shall have lock nut cylinders, retraction valves and two inch stroke minimum, four inch stroke maximum. Each jack shall be capable of lifting a minimum of 150 percent of the jacking load (dead load) shown on the Contract Drawings.

C. The Contractor shall provide a minimum of two spare jacks with power packs and two matched spare spherical bearing assemblies, with shims.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Coordinate and verify that all rail has been released from the support blocks and power has been shut off in the zone of influence of the bearing replacement work prior to jacking at the aerial structure.
   1. Coordinate with WMATA OCC and the AR for required power outages (track rights) as cited in the General Requirements.
   2. Comply with all applicable WMATA procedures and regulations.

3.02 SHEAR BLOCK BOLT REPLACEMENT

A. Contractor shall remove and replace shear block bolts in advance of the bearing replacement. The existing bolts are welded to the nuts and must be cut or burned off. Replacement shear block bolts shall be coated with zinc.

B. Bolts shall be replaced one at a time without live load on the aerial structure. Bolts shall not be replaced on the same night as the bearings. Bolts shall be hand tightened.

3.03 GIRDER JACKING

A. See Bearing Replacement Procedure on the Contract Drawings and Section 05842, Jacking of Aerial Structure.

3.04 BEARING REMOVAL

A. Free existing bearing by methods proposed on approved working drawings.

B. Check bearing seat area to ensure that the entire existing bearing and bonding material have been removed.

C. Provide a smooth mating surface free of debris and damage for the new bearing.

3.05 BEARING REPLACEMENT

A. Install bearing as shown on the Contract Drawings.

B. Activate jack and lower aerial girder partially onto bearing pedestal

C. Check to verify proper seating of the bearing.

D. When bearing is properly seated, lower girder fully onto the bearing.

3.06 CLEAN-UP

A. Advise the AR and obtain concurrence to remove jacks.

B. Install new access closure plates as shown.

END OF SECTION

SECTION 05842

JACKING OF AERIAL STRUCTURE

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section specifies the furnishing of all materials, labor, tools, equipment, and incidentals necessary to jack the aerial structure box girders at the end bearings.

1.02 QUALITY ASSURANCE

A. Qualifications of Jack Manufacturer: The Contractor shall demonstrate that the selected jack manufacturer has a successful performance record for at least five (5) years in the design and fabrication of hydraulic jacks used in structures similar to the work herein. The manufacturer shall also be capable of ensuring close control over the materials, workmanship and quality within his facilities.

B. Qualifications of the Jacking Contractor and/or Sub-Contractor: The Jacking Contractor or Sub-Contractor shall demonstrate that he has a successful performance record of at least five (5) years in the use of hydraulic jacking equipment in projects of similar scope and magnitude to the work herein. The Contractor and/or Sub-Contractor shall demonstrate that he is familiar with the operational characteristics of the jacks actually supplied. A field demonstration of the jacking operation shall be performed in the presence of the AR prior to any jacking of the aerial structure box girders.

1.03 SUBMITTALS

A. Qualifications of the jack manufacturer and the jacking contractor.

B. Proposed jacking procedure.

C. Proposed hydraulic configuration.

D. Certified calibration charts.

E. Proposed procedure for replacing jacks in the event of a jack malfunction.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The Contractor shall load, transport, unload, store, handle, install and use the jacks so as to keep them clean and free from damage.

B. Contractor shall provide dial gauges to monitor movement of the aerial structure box girders.

PART 2 - PRODUCTS

2.01 HYDRAULIC JACKS

A. Hydraulic jacks shall have lock nut cylinders, retraction valves, two inch stroke

minimum, six inch stroke maximum. Each jack shall be capable of lifting 150 percent of the jacking load (dead load).

B. Jacking of the steel box girders shall not be done under live load.

C. Jacks shall be synchronized for vertical movement during raising and lowering of the superstructure. The maximum differential movement between any two adjacent jacks shall not exceed 1/8 inch. Locknuts shall be continuously lowered to lock jacks.

D. Where required, as indicated on the drawings by a negative (-) jacking load, hydraulic or mechanical hold-down devices shall be used to limit and control the upward movement of the structure at the jacking location. Hold-down devices shall be continuously adjusted as required to control the differential movement between adjacent jacks.

E. Jacks shall be as manufactured by:

1. ENERPAC
6100 N. Baker Road
Milwaukee, WI 53209
1-262-781-6600
1-800-433-2766
www.enerpac.co
m

2. Richard Dudgeon,
Inc.
1565 Railroad Avenue
Bridgeport, CT 06605
1-203-336-4459
1-888-383-4366
www.dudgeonjacks.co
m

3. SPX Power Team Hydraulic Technologies
5885 11th Street
Rockford, IL 61109
1-815-874-5556
1-800-477-8326
www.powerteam.co
m

4. Simplex Division
Templeton, Kenly & Co., Inc.
2525 Gardner Road
Broadview, IL 60155
1-708-865-1500
1-800-323-9114
www.tksimplex.co
m

F. Contractor shall provide Ames Dial Gauges, or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor shall sequence their work so that conflict between jacking of the girders does not interfere with other work.

B. Proceed in accordance with the contract documents and the approved jacking procedure.

C. Jacking of girders is to be performed only during approved track outages.

D. All beam ends at a substructure unit are to be jacked simultaneously.

E. Only one end of a girder can be jacked and supported at a time. Girders must be set back in place prior to the other end being jacked.

F. Jacking shall be limited to the amount listed on the Drawings.

3.02 JACKING SYSTEM

A. The Contractor shall design a system to raise the ends of the steel box girders. The system can be attached to the existing bearing pedestals.

B. The jacking system shall be designed to raise a minimum of 150% of the listed dead loads.

C. The box girders shall be lifted only after the AR has given approval; the running rail and contact rail fasteners, and the hand rail above that pier(s) have been released, and only under dead load.

D. The calculations and plans showing the jacking system shall be stamped and signed by a Professional Engineer registered in the state where the work is being performed. The engineer shall have experience in designing this type of work.

E. The engineer shall list on the plans the procedures that the contractor shall follow for the installation and jacking.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 05843

BOX GIRDER VENTILATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section consists of providing ventilation inside the box girders during the replacement of bearings and the performance of other work within the girders.

1.02 REFERENCES

A. Codes, Regulations, Reference Standards, and Specifications:
   1. Codes and regulations of jurisdictional agencies.
   2. OSHA: All applicable laws, codes, rules, and regulations.

1.03 SUBMITTALS

A. Submit for approval in accordance with the General Requirements of the Specifications and the requirements of the agencies having jurisdiction over the work area.
B. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified:
   1. Working Drawings: Verify by site investigation the location, sizes, means of access and egress, and interior conditions of the existing aerial structure.
   2. Prepare working drawings showing method of providing ventilation and location of equipment.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor shall provide ventilation necessary for the replacement of the aerial structure bearings in accordance with OSHA. New access openings require cutting of steel plates, grinding edges of new openings, and grinding of welds. Measurement of air quantity and quality shall be recorded and available for inspection by the AR.

3.02 CLEAN-UP

A. At the completion of the bearing replacement, as approved by the AR, Contractor shall remove ventilation equipment.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 07125

MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall provide all labor, materials and equipment necessary to install waterproofing as shown on the drawings and specified herein for the installation of new paving systems for the Grosvenor and Rhode Island Station platforms.

B. The General Conditions, the Supplementary Conditions, the Instructions to Bidders and Division One General Requirements shall be read in conjunction with and govern this section.

C. The Specification shall be read as a whole by all parties concerned. Each Section may contain more or less than the complete work of any trade. The Contractor is solely responsible to make clear to the Subcontractors the extent of their work.

D. Related Work Specified Elsewhere:
1. Section 03300 - Cast-in-Place Structural Concrete.
2. Section 03214 - Replacement of Quarry Tile with Concrete Paver
3. Section 04050 - Mortar.
4. Section 04415 - Granite

1.02 REFERENCE STANDARDS

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

B. ASTM C 836: High Solid Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane.

C. ASTM C578, Type [VI], [VII] Extruded Polystyrene Insulation for Roofing and Waterproofing.

1.03 SUBMITTALS

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

A. 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.

B. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

C. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions. Include joint and anchorage details, materials and description of sequence of operation.

D. Samples: Four of each type of the following materials used in the work:

1. Membrane: 12 inches square.
2. Fabric Reinforcement: 12 inches square.
3. Flashing and Crack Treatment Membrane: 12 inches square.
4. Liquid Membrane and Termination Sealant: Small container.

E. Certification:
1. Certification that materials furnished meet specified requirements and are compatible with each other.
2. Certification that the applicator is approved by the manufacturer.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with the printed requirements of the membrane manufacturer and this specification. Advise designer of any discrepancies prior to commencement of the Work.

B. Qualifications of Waterproofing Applicator:
1. Use applicator that is approved by the manufacturer.
2. Employ workers who have had experience in waterproofing of specified type on jobs of similar size and comparable structures. Have approved full-time superintendent or foreman supervise and direct waterproofing operations.
3. Inform the A.R. of proposed schedules and locations of waterproofing work.

C. Obtain waterproofing materials through one source from a single manufacturer.

D. Pre-installation Conference: Conduct conference at Project site. Review requirements for waterproofing, including surface preparation specified under other Sections, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

E. Regulatory Agency Approvals:
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.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver products to job site in original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type and class, as applicable.

B. Store products in approved dry area with roll goods standing on ends. Protect from contact with soil and from exposure to the elements. Keep products dry.

C. Handle products so as to prevent breakage of containers and damage to products.

D. Store membrane at temperature of 40 degrees F and above to facilitate handling.

E. Store adhesives and primers at temperatures of 40 degrees F and above to facilitate handling.

F. Keep solvents away from open flame or excessive heat.

G. Do not store modified membranes at ambient temperatures below 20 degrees F.

1.06 JOB CONDITIONS

A. Environmental Requirements:
1. Application of waterproofing to unprotected surfaces in wet weather or to surfaces on which ice, frost or dampness is visible is prohibited.
2. Unless otherwise approved, application of waterproofing unless ambient temperature is at least 40F and rising is prohibited.
3. Maintain rolls of material at a temperature of at least 50F for a period of not less than 24 hours prior to installation.

B. Provide ventilation in accordance with specified safety requirements.

PART 2 – PRODUCTS

2.01 WATERPROOFING SYSTEMS MANUFACTURER

A. Fluid-Applied Membrane System:
1. Elasto-Seal CM100 by Henry Company is the basis of design.
2 Or equal as determined by WMATA..

2.02 MATERIALS

A. Waterproofing Membrane:
Primary waterproofing membrane shall be Henry CM100 Cold Applied Elastomeric Membrane manufactured by Henry, a moisture cure, solvent free elastomeric waterproofing compound having the following characteristics:
1. Conforms to ASTM C 836,
2. Solvent content: 0%,
3. Non Flammable, Flash point > 450 F,
4. Elongation: 200%,
5. V.O.C < 40 grams/ Liter,
6. Can be applied to “green” concrete.

B Fabric Reinforcement:
Fabric reinforcement shall be Polyester Fabric with a minimum thickness of 8 mils and:
1. Grab Tensile Strength (ASTM 5034):
MD: 25 lbs/in
CD: 13 lbs./in
2. Trapezoid Tear (ASTM D1117):
MD: 3 lbs
CD: 6 lbs.
3. Mullen Burst: 17 psi

C. Flashing and Crack Treatment Membrane:
Flashing and crack treatment membrane shall be elastomeric sheet membrane having a thickness of 60 mils as supplied by Henry.

D. Liquid Membrane and Termination Sealant:
Termination Sealant shall be HE925 BES Sealant manufactured by Henry; a moisture cure, medium modulus polymer modified sealing compound having the following physical properties:
1. Compatible with sheet air barrier, roofing and waterproofing membranes and substrate,
2. Complies with Fed. Spec. TT-S-00230C, Type II, Class A,
3. Complies with ASTM C 920, Type S, Grade NS, Class 25,
4. Elongation: 450 – 550%,
5. Remains flexible with aging,

6. Seals construction joints up to 1 inch wide.

E. Protection Course/ Separation Sheet:
Protection course/separation sheet membrane for horizontal surfaces shall be Filter Fabric GR08 as supplied by Henry, a 100% post-consumer recycled polyester fabric having a minimum thickness of 120 mils.

PART 3 - EXECUTION

3.01 PREPARATION

A. All surfaces must be sound, dry, clean and free of oil, grease, dirt, excess mortar, frost or other contaminants. Fill spalled areas in substrate to provide an even plane and remove scaling or laitant concrete. Remove curing compounds or any foreign matter detrimental to the adhesion of the primary waterproofing membrane or membrane flashings.
B. New concrete should be cured for a minimum of 3 days and must be dry before waterproofing membranes are applied. C. Concrete shall have a wood float finish. Decks with a steel float finish must be sandblasted or shot blasted prior to the application of the waterproofing system.
D. Expansion joint assemblies should be in place prior to the application of the primary waterproofing assembly.

3.02 INSTALLATION OF CRACK TREATEMENT AND FLASHINGS

A. Deck to Vertical Junctures:
1. Apply a 55 mil thick coating of the primary waterproofing membrane extending 4 inches onto horizontal and vertical faces.
2. Embed elastomeric flashing sheet flat into wet membrane extending a minimum of 3 inches out onto the horizontal and vertical surfaces, avoid wrinkles or fish mouths.
3. When height of elastomeric flashing sheet exceeds 12 inches mechanically attach the flashing sheet to vertical surface with metal termination bar. Lap flashing sheets a minimum of 3 inches on end laps and bond with 55 mils thick coating of primary membrane.

B. Crack Treatment:
1. Seal cracks and joints up to 1/8 inch in width with a 12 inch wide by 55 mil thick coating of the primary membrane and a 6 inch wide strip of fabric reinforcement centered over the joint.
2. Seal cracks and joints up to 1/4 inch in width with a 12 inch wide by 55 mil thick coating of the primary membrane and a 6 inch wide strip of elastomeric crack treatment membrane centered over joint.

C. Membrane Flashing At Protrusions:
1. At mechanical vent protrusions and pipe penetrations provide elastomeric lashing sheet set into a 55 mil thick coating of primary membrane. Overcoat and seal with membrane. Install clamps as required.
2. At pitch pockets, place the pan on top of a 55 mil thick coating of primary membrane and attach into roof deck. Set flashing sheet into 55 mil thick coating of primary membrane over top of flange. Fill pitch pocket with primary waterproofing membrane in order to shed water.

D. Expansion Joints:
1. Elastomeric sheet membrane can be applied in a bed of primary waterproofing membrane. Place elastomeric sheet membrane into primary liquid as recommended by manufacturers' written instructions.

2. Loop elastomeric sheet membrane down into expansion joint, embedded into a 55 mil thick layer of primary waterproofing membrane. Ensure that the depth of loop is a minimum 1-1/2".
3. Extend elastomeric sheet membrane minimum of 3" on each side of joint. Seal end joints a minimum of 6" and seal with a 55 mil thick coat of membrane. Fill loop with membrane as required.
4. Secure top of expansion joint membrane with continuous fixing bar at vertical wall locations.

3.03 HIGH BUILD COLD APPLIED ELASTOMERIC MEMBRANE APPLICATION

A. Application of Base Coat Layer:
   1. Ensure substrates are ready to receive primary waterproofing membrane.
   2. Apply membrane by squeegee, roller or trowel ensuring full bond of membrane to substrate.
   3. Apply base coat layer of primary membrane evenly to a minimum thickness of 55 mils to form a continuous monolithic coating over horizontal and vertical surfaces including previously reinforced areas.
   4. Embed fabric reinforcement into primary membrane ensuring no wrinkles or fish mouths are created and allow to set up. Firmly press into base coat layer of primary membrane. Overlap fabric reinforcement no more than 1/4 inch ensuring waterproofing membrane is applied between the overlapping plies so that no dry mat-to-mat overlap exists.

B. Application of Top Coat Layer:
   1. Allow base coat layer to firm up and cure prior to application of subsequent layers.
   2. Apply top coat layer of primary membrane over the fabric to a minimum thickness of 110 mils on horizontal surfaces providing a total thickness of 165 mils and 55 mils on vertical surfaces providing a total thickness of 110 mils.

3.04 INSTALLATION OF PROTECTION COURSE/SEPARATION SHEET (Horizontal)

A. Place specified protection course/separation sheet onto top coat layer of primary membrane while it is still wet and has not skinned over.

B. Lap protection course 2 inches on side laps and 6 inches on end laps.

C. Start at the low points, lay the protection course membrane in full continuous sheets in a shingle pattern. Stager all end laps.

3.05 CURING AND PROTECTION

A. Allow membrane to dry thoroughly. Protect from rain until fully cured. Allow membrane to fully cure prior to installing drainage composite, covering material or backfilling. Patch or repair damaged areas using same material as original coating.

B. Protect cured membrane from damage caused by backfilling with drain boards prior to commencing backfill.

3.06 INSTALLATION OF INSULATION & FILTER FABRIC (Horizontal)

A. Install insulation loose over the completed membrane, firmly butting each insulation board to surrounding board.

B. The end joints of the insulation shall be staggered. The insulation shall be cut to fit closely to all cants, protrusions and obstructions.

C. Install only as much insulation as can be covered by filter fabric in the same day.

D. Install filter fabric over the insulation as indicated on drawings. Overlap all edges a minimum 12 inches. Do not use lengths of less than 8 feet.

E. At penetrations, cut and fit sections of filter fabric to surround the penetration or drain, extend up vertically and secure. Slit fabric to fit tightly over penetrations, cut out around roof drains and other openings.

F. Extend fabric up perimeter and vertical surfaces where required or as indicated on drawings.

3.07 FIELD QUALITY CONTROL

A. Final Inspection and Approval: Final inspection of completed work shall be carried out by the owner's representative, the contractor and Henry.

3.08 CLEAN-UP

A. Promptly as the work proceeds and on completion, clean up and remove from the premises all rubbish and surplus materials resulting from the foregoing work.

B. Clean to the consultant's approval, soiled surfaces, spatters, and damage caused by work of this Section.

C. Check area drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from the site.

END OF SECTION

SECTION 07130

WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY:

A. This section specifies all labor, materials, transportation, equipment and services necessary to install a waterproofing system on the Medical Center precast arch as shown on the drawings. Sample waterproofing application will need to be done on top of mock-up panels.

1.02 REFERENCES:

A. Factory Mutual (FM Global) - *Approval Guide*

B. ASTM International (ASTM) - *Annual Book of ASTM Standards*

C. National Roofing Contractors Association (NRCA)

D. American Society of Civil Engineers (ASCE)

1.03 PERFORMANCE REQUIREMENTS:

A. Provide an installed flexible waterproofing membrane that does not permit the passage of water.

B. Manufacturer shall provide all primary waterproofing materials that are physically and chemically compatible when installed in accordance with manufacturers current application requirements.

1.04 SUBMITTALS:

A. Provide product data sheets for each type of product indicated in this section.

B. Provide manufacturers standard details and approved shop drawings for the specified system.

C. Installer shall provide written documentation from the manufacturer of their authorization to install the system.

D. Certification showing full time quality control of production facilities and that each batch of material is tested to ensure conformance with the manufacturers published physical properties.

E. Manufacturers certification that all waterproofing system products meet current Volatile Organic Compound (VOC) regulations as established by the State in which they are being installed; and stating total VOC content, in grams per liter, for all system components (i.e. primers, adhesives, coatings, etc.).

F. Provide certification that the waterproofing will be installed by an approved installer experienced in installing of this product.

G. Provide installation plan including installation schedule and any requirements such as preparation, overlap and methods for protection of work.

H. Provide submittal for application of the entire waterproofing system on top of mock-up panels.

1.05 QUALITY ASSURANCE:

A. Manufacturers Qualifications: Manufacturer shall demonstrate qualifications to supply materials of this section by certifying the following:
   1. Membrane Manufacturer must show evidence that the specified membrane has been manufactured by the same organization or direct affiliate for fifteen (15) years.
   2. Membrane Manufacturer shall have available an in-house technical staff to assist the contractor, when necessary, in application of the products and final inspection of the assembly.

B. Installer's Qualifications: The Contractor shall demonstrate qualifications to perform the work of this Section by submitting the following documentation:
   1. Contractor shall present proof or training or certification by the waterproofing membrane manufacturer as a trained applicator for all materials to be installed.
   2. Minimum project history of three successful projects in the past two years with the specified system. Projects should have the same or greater complexity and scope.

C. Source Limitations: All components listed in this section shall be provided by a single manufacturer or approved by the primary waterproofing manufacturer.

D. Field Inspection(s)
   1. Manufacturer shall provide a Field Technical Service (FTS) representative to perform site inspections at no cost to the owner, contractor or designer. Manufacturer FTS representative must be a dedicated technical service professional and not the manufacturers sales representative. Inspections shall include at minimum, a comprehensive final inspection after completion of the waterproofing system. All application errors must be addressed and final punch list completed. A field report documenting each site visit / inspection are to be furnished by the FTS.

E. 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.

1.06 JOB CONDITIONS:

A. Waterproofing will be installed over top of precast arch sections inside of a tunnel. Installation will need to be done in limited headroom area with limited access and limited time. This work needs to be coordinated with General Contractor. Installers will need to protect the surface from overhead dripping water during and after installation. Substrate might be damp. Contractor is required to install waterproofing on top of mock-up panels prior to installation inside of tunnel. Fall protection will be installed at top of arch sections and will be available for use by waterproofing installers.

1.07 PRE-INSTALLATION CONFERENCE:

A. Prior to scheduled commencement of the waterproofing installation and associated work, conduct a meeting at the project site with the installer, WMATA Architect, Engineer, QC Manager, Project Manager and manufacturer's representative and any other persons directly involved with the performance of the work. The installer shall record conference discussions to include decisions and agreements reached (or disagreements), and furnish copies of

recorded discussions to each attending party. The main purpose of this meeting is to review foreseeable methods and procedures related to waterproofing work. Conference shall be held only after precast arch panels have been installed accepted in place, no sooner than 24 hours prior to installation of waterproofing and only after all submittal requirements are complete and review comments have been resolved. Pre-installation conference attendees will visit the site.

1.08 REGULATORY REQUIREMENTS:

A. All work shall be performed in a safe, professional manner, conforming to all federal, state and local codes.

B. All waterproofing system components shall meet current VOC regulations as established by the State in which they are being installed; and stating total VOC content, in grams per liter, for all system components (i.e. primers, adhesives, coatings, etc.)

1.09 DELIVERY, STORAGE, AND HANDLING:

A. Deliver all waterproofing materials to the site in original containers, with factory seals intact.

B. Store all pail goods in their original undamaged containers in a clean, dry location within their specified temperature range.

C. Do not expose materials to moisture in any form before, during, or after delivery to the site. Reject delivery of materials that show evidence of contact with moisture.

D. Handle the specified product as recommended by the manufacturer.

1.10 WARRANTY:

A. Membrane manufacturer/installer to provide a Watertight Warranty including labor and material for a minimum duration of ten (10) years from project completion.

PART 2 PRODUCTS

2.01 MATERIALS:

A. Single component formulated acrylic ester copolymer emulsion waterproofing coating: Belzona 3111 or Approved equal.
   1. Product shall have the following properties:
      a. Water vapor permeable
      b. Can bridge dynamically moving cracks

B. Surface Conditioner: Belzona 3921 or approved equal.

C. Reinforcing Sheet: Belzona 9311 or approved equal.

D. Anti-slip Aggregate: Surefoot 9221

2.02 PERFORMANCE CRITERIA:

A. Properties of the waterproofing coating:
   1. Density: 1.235 – 1.275 g/cm^3
   2. Gel strength at 77°F (25°C): 80 – 110 g/cm

3. Freezing point: 32°F (0°C)
4. Volatile by volume: 38.0%
5. Elongation (BS 2782) 7 day cure at 68°F (20°C):
   a. 20% lengthwise
   b. 100% crosswise
6. Tear Strength (ASTM D624) 7 day cure at 68°F (20°C):
   a. 188 pli (33.0 N/mm) lengthwise
   b. 188 pli (33.0 N/mm) crosswise
7. Tensile Properties (BS 2782) 7 day cure at 68°F (20°C):
   a. 1450 psi (10.0 N/mm^2) lengthwise
   b. 580 psi (4.0 N/mm^2) crosswise

PART 3 EXECUTION

3.01 SITE INSPECTION AND TESTING:

A. Inspect surfaces for contamination and other critical factors at time of installation. Surfaces to receive coatings must be structurally sound. Report in writing to Engineer, with copy to manufacturer, of deficiencies that could impair work. Do not proceed with coating application until unsatisfactory conditions have been corrected as part of this work.

3.02 SURFACE PREPARATION:

A. Substrate must be clean, sound, and free of surface contaminants. Remove mineral chippings of ¼ in or more and sweep the area clean before proceeding. Condition concrete with Belzona 3911 following manufacturer's instructions for use. To provide a smooth surface, use plastic backed adhesive tape to bridge joints or any other surface irregularities. Contractor may be required to temporarily block or direct existing drips of water inflows during the time of waterproofing application through final curing.

3.03 APPLICATION:

A. Layout reinforcing sheet over the conditioned area to be treated.

B. Use spray or brush to apply waterproofing coating over the reinforcing sheet. Do not exceed the manufacturers recommended coverage rate.

C. Allow waterproofing coating to dry thoroughly (2-4 hours in moisture-free areas). In areas subject to standing water, allow to dry for a minimum 24 hours.

D. Apply a second layer of waterproofing coating with manufacture recommended aggregate mixed in or spread on top of top coat for a textured pedestrian surface. In no instance shall more than 5 days elapse between applications. Do not exceed quoted coverage rate.

E. Adhere to all limitations and cautions for the waterproofing coating in the manufacturers printed literature including use of plastic backed adhesive tape to bridge joints.

3.04 CLEANING:

A. The uncured waterproofing coating can be cleaned from tools with cold water. The cured coating can only be removed mechanically.

B. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

C. Spray water over entire waterproofing area to demonstrate proper installation of waterproofing.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 07900

SEALS AND SEALANTS

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies providing any sealants not specified elsewhere.

1.02 REFERENCE STANDARDS

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

1.03 QUALITY ASSURANCE

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. ASTM: C920, C1193, D412, D1752, D2628.

B. Manufacturer Qualification:
1. General: Provide the products of established manufacturers. Insofar as possible, provide products from a single manufacturer.
2. Sealant color-selection capability: Have color-selection capability resolved early in the submittals process to prevent delay of the work.
a. Where sealants are exposed, provide products of a manufacturer who can match the colors of adjacent materials by either having an acceptable range of standard colors or by factory blending custom colors as acceptable to the A.R. and at no additional cost
b. Where a manufacturer's colors are insufficient for proper color- match, use acceptable colors from another acceptable manufacturer.
3. On-site representation: Use only a sealant manufacturer who has a local, knowledgeable representative who can visit the project site prior to construction and at least twice during sealant installation to observe conditions and recommend solutions at no additional cost to the Authority.

C. Design Criteria:
1. Designed width of exterior joints: Joint widths indicated on drawings are shown at their designed width. This is measured when the joint would be at the average air temperature for the year, which is approximately 50F, based on an average minimum air temperature of zero degrees F and an average maximum air temperature of 100F.
2. Designed width of interior joints: Joint widths indicated on the drawings are shown at their designed width at 50F.
3. Joint width at time of seal or sealant application: Make joint widths at time of installation never less than the calculated width, which at 0 degrees F is 25 percent wider than the designed width and at 100F is 25 percent narrower than the designed width for exterior joints and 1-1/2 percent smaller than the designed width for each degree the ambient temperature exceeds 50F, and 1-1/2 percent larger

than the designed width for each degree the ambient temperature is less than 50F.

a. It is recommended that seals and sealant be installed when the average daily air temperature is 50 degrees F plus or minus five degrees, when joint should be at its designed width.

b. If joints are less than the calculated width at the time of proposed installation, take corrective action, which may include saw cutting of joint or other remedial measures approved by the Engineer and by the seal or sealant manufacturer.

c. If the joint depth is not sufficient for the designed width of the joint, sealant and backup, cut out the joint to the required depth for the sealant and backup.

d. Perform cutting and remedial measures that are acceptable to the Engineer. Cost of cutting and remedial measures are at no additional cost to the Authority.

4. Joint size and sealant size: Except as otherwise indicated, make sealant at least 1/4-inch wide x 1/4-inch deep. In joints 3/8 inches wide, make sealant 1/4-inch deep. In joints wider than 3/8-inch and up to 1-inch wide, make sealant depth 1/2 of the joint width. For joints wider than 1 inch, make sealant depth as recommended by the sealant manufacturer.

1.04 SUBMITTALS

A. See Procurement Documents, for submittal procedures.

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

1. Samples:

a. Material samples: Four of each type of the following materials used in the work:

1) Sealant and lubricant-adhesive: Half-pint containers.

2) Sealant colors: Fully cured beads of each color used, each six inches long.

3) Backup material: 12 inches long.

4) Joint filler: 12 inches long.

5) Color chips: 12 inches long, one for each color used in the work.

b. Demonstration samples: Make demonstration installation of each seal and sealant installation type and color. Use approved materials, installed and cured as required. Remove demonstration samples as directed. Perform testing on sealant demonstration samples as specified under Field Testing.

2. Technical Information:

a. General: Submit manufacturer's technical product data for each product proposed to be used, together with standard and custom color-selection samples.

b. Test results: Inspection and adhesion test results performed by sealant manufacturer.

3. Certification by each manufacturer that the products provided will perform as required and will not stain adjacent materials.

C. 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.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver products to jobsite in original unopened containers clearly marked with manufacturer's name and brand designation, referenced specification number, type and class as applicable.

B. Store products in approved dry area and protect from contact with soil and from exposure to the elements. Keep products dry.

C. Handle products to prevent breakage of containers and damage to products.

1.06 JOB CONDITIONS

A. Environmental Requirements:
1. Application of seals or sealants, including their related products, when ambient temperature is lower than 40F or when there is ice, frost or dampness visible on surfaces to be sealed is prohibited.
2. Comply with manufacturer’s environmental recommendation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide joint sealant, backup rod, primer, and other related materials that are compatible with one another and with the joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on field experience and submitted test reports.

B. Sealant (Polyurethane): Polyurethane-based or epoxidized polyurethane based, multi-part elastomeric sealant, ASTM C920, Type M (multi-component), Class 25 (withstands an increase or decrease of 25 percent of the joint width) as follows:
1. For joints in horizontal surfaces: Grade P (pourable or self-leveling), Uses T (traffic areas), M (on masonry) or O (other than standard substrates).
2. For joints in sloped surfaces: Grade NS (non-sag), Uses T (traffic areas), M (on masonry) or O (other than standard substrates).
3. For joints in overhead and vertical surfaces: Grade NS (non-sag), Uses NT (non-traffic areas), M (on masonry), A (on aluminum), or O (other than standard substrates).

C. Primer: Colorless, non-staining liquid material of types suited to each substrate surface, as tested and recommended in writing by the manufacturer of each sealant to be used.

D. Backup Rod: Pre-formed, compressible, resilient, non-waxed, non-extruding, non-staining, closed-cell rod stock of polyethylene or polyethylene-jacketed foam which will maintain a uniform round or oval cross-sectional shape when compressed into the joint.
1. Select backup rods as recommended by the manufacturer of each sealant to be used; compatible with joint substrates, sealants, primers, and other joint fillers; that will not bond with sealants and primers; and are approved for applications indicated based on field experience and laboratory testing.
2. Select backup rod of the sizes and shapes to suit the various conditions and at about 30 percent wider than the joint width.

a. Where depth of joint is too shallow for round backup rod use 1/2- round backup rod, factory manufactured with cut surface fused by heat process so that it cannot release gas.

b. Where depth is too shallow for 1/2-round rod, use bond breaker tape.

E. Bond-Breaker Tape: Polyethylene tape, as recommended by the manufacturer of each sealant to be used, for preventing sealant from adhering to joint-filler materials or joint surfaces at back of joint where such adhesion would promote sealant failure, or result in less than optimal performance. Provide tape sized properly for the joint. Provide self-adhesive tape where applicable.

F. Cleaning Agent: Joint cleaning compound tested and recommended in writing by sealant manufacturer for cleaning joint surfaces before priming. Use only a cleaner which is non-staining, non-harmful to masonry, does not leave oily residues, and does not have a detrimental effect on adhesion or in-service performance.

G. Masking Tape: Non-staining, nonabsorbent type, compatible with joint sealants and to surfaces adjacent to joints. Use only a masking tape which will easily come off entirely, including adhesive.

H. Joint Filler for Sealant Joints: Non-staining joint filler compatible with backer rod and sealant:
1. Sponge rubber: Preformed strips complying with ASTM D1752 Type I.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

A. Inspection:
1. With installer present, examine joints for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting the performance of joint seals and sealants.
2. Have sealant manufacturer's representative visit the site and review the project joint conditions and details for sealant work of this Project and perform adhesion testing. Have sealant manufacturer representative report to the A.R. in writing the results of his inspections and tests.
3. Do not proceed with work of this section until unsatisfactory conditions have been corrected.

B. Preparation: Comply with the recommendations of ASTM C1193 and the following:
1. Cleaning:
a. Clean joint surfaces receiving seals or sealants. Ensure that they are sound, smooth, clean, dry, and free of foreign substances and contaminants, including curing compounds and release agents.
b. Remove factory or field-applied coatings that will be detrimental to adhesion of seals, sealants or primers.
2. Masking: Use masking where required to prevent contact of sealant and primers with adjoining surfaces that otherwise would be stained or damaged by such contact or by cleaning methods required to remove sealant or primer smears.

C. Priming: Unless sealant manufacturer specifically recommends in writing against priming, apply primer to prepared surfaces that will receive sealant. Apply primer on clean, dry surfaces, and prior to installation of backup rod. Completely wet both inner faces of the joint

with primer.

D. Backup rod: Install backup rod in joints (after primer is dry) to provide backup and give proper shape for sealant bead. Where there is insufficient joint depth for backup rod, install half- round backup rod or bond breaker tape as approved in lieu of backup rod.

1. Proper cross-sectional shape for sealant bead is a very slight hourglass shape with back and front faces having slight concave curvature, unless indicated otherwise. Use special blunt T-shaped tool or roller to install backup rod to the proper and uniform depth required for the sealant.
2. Install size of backup rod that will provide approximately 30 percent compression.
3. Do not stretch, twist, braid, puncture, or tear backup rod. A broken surface will emit gas (out-gassing) that blisters the installed sealant, thereby requiring complete removal and reinstallation of primer, backup rod, and sealant.
4. Tightly butt backup rods at joints and intersections. At outside corners, provide sufficient length of backer rod so that rod can be bent around corner rather than cut at corner, so that out-gassing will not occur.

E. Bond breaker tape: Where space for a backup rod is inadequate, use bond breaker tape to prevent three-sided adhesion. Install bond breaker tape smoothly over back of joints so that sealant adheres to the sides of joint but not to the back of joint.

3.02 INSTALLATION
Sealant:

1. Comply with ASTM C1193 and with manufacturer's recommendations, except where more stringent requirements are shown or specified.
2. Set joint-filler units at depth or position in joint as shown to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint-filler units.

3. Install back-up material, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application used.

4. Install bond-breaker tape where shown and where recommended by manufacturer to ensure that sealants will perform as intended.

5. Employ installation techniques which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete wetting of joint bond surfaces equally on opposite sides.
   a. Except as otherwise shown, fill sealant rabbet to slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between horizontal surface and vertical surface, fill joint to form slight cove, so that joint will not trap moisture and dirt.
   b. Fill joints to a depth equal to 50 percent of joint width, but not more than 1/2- inch deep nor less than 1/4-inch deep.
   c. Ensure that temperature of sealant, as well as of substrates, at time of sealant application, is as recommended by sealant manufacturer and as specified herein. Apply sealant at optimum time after primer application.
   d. Remove masking immediately after tooling of sealant and before sealant face starts to skin over. Do not cause dislocation of sealant, or migration of sealant to adjacent surfaces when removing masking tape.

6. Spillage: Do not allow sealants or compounds to overflow from confines of joints, to spill onto

adjoining work or to migrate into voids of exposed finishes. If spillage occurs, eliminate evidence of spillage to the Engineer's satisfaction.

7. Seal joints in granite work with sealant, except granite-paving joints that are shown to be grouted. Ensure joint depths of at least 3/4 inch before placing backup. If necessary, rake-out joints to a minimum depth of 3/4 inch.

3.03 CURING AND PROTECTING

A. Cure sealants in compliance with manufacturer's recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

B. Cure and protect joint sealers during construction period, so that they will be without deterioration, soiling or damage, other than normal wear and weathering, at time of final acceptance.

C. Cure and protect sealants so as to minimize increases in modulus of elasticity and other accelerated aging effects.

D. Replace or restore sealants damaged or deteriorated during construction and from testing as directed. Cut out or remove damaged sealant immediately and properly prepare and reseal joint with new materials to produce sealant installation with repaired areas indistinguishable from other work.

3.04 FIELD TESTING

Sealant: Field test cured sealant installations in the presence of and where directed by the Engineer. Test each type of joint sealant for adhesion to joint substrates by hand-pull method as follows:

A. Make knife cuts as follows: A transverse cut from one side of joint to the other, followed by parallel cuts approximately 2 inches long at each side of joint and meeting the transverse cut at the end of the 2-inch cuts. Place a mark 1 inch from the top of 2-inch piece.

B. Use fingers to grasp the 2-inch piece of sealant just above the 1-inch mark; pull firmly away at a 90-degree angle while holding a ruler along side of sealant; pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than the distance equaling the specified maximum movement capability in extension; hold this position for 10 seconds.

C. Report whether or not the sealant in joint (connected to pulled-out portion) failed to adhere to joint substrates or failed cohesively or adhesively. Include data on pull distance used to test each type of sealant and joint substrate.

D. Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered acceptable, subject to certification of design and performance criteria by the manufacturer.

E. Make a minimum of 10 such tests unless otherwise directed by the Engineer. Submit report of testing to the Engineer.

3.05 CLEANING

A. Immediately clean off excess primers, drippings, sealants and sealant smears as work progresses, using methods and with cleaning materials approved by manufacturer of each joint primer and sealant and by manufacturers of materials where joints occur.

B. Use only materials and methods acceptable to the Engineer.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 07911

EXPANSION JOINT SEAL REPLACEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies providing replacement of expansion joint seals, in bridge decks and other locations with Evazote foam joint seals or approved equivalent, including the following:

1. Removal and disposal of existing joint seal materials.
2. Cleaning and preparing joint opening surfaces for installation of new seals.
3. Furnishing and installing new joint seals.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Performance Standards and Specifications:

1. Comply with codes and regulations of the jurisdictional authorities.
2. ASTM: D545, D624, D638, D695, D1056, D3575.
3. AASHTO: T42.

B. Obtain foam joint seal material and epoxy bonding adhesives through one source from a single manufacturer. Coordinate compatibility with adjoining surface repair and/or sealing materials

C. Provide qualified manufacturer's representative on site to supervise and direct adhesive mixing and application procedures, and joint seal installation methods. The manufacturer's representative will certify that materials and installation procedures are in full conformance with manufacturer's recommendations.

1.03 SUBMITTALS

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

A. Product Data: Include manufacturer's product specifications, technical data, tested physical and performance properties, manufacturer's written instructions for preparing substrate, and installation procedures.

B. Shop Drawings:

1. Placement Drawings: Include schematic diagrams for typical joint Installations, showing plans, elevations, direction changes, location of splices, if any, in seals. Include tabulation of seal sizes and lengths installed.
2. Provide description for any proposed access equipment, surface preparation and/or installation equipment, methods of protecting adjacent facilities, and site specific work plan for procedures to be used during the performance of the work.

3. Provide description of sequence of operations.

C. Samples:

1. Submit four samples, 8 inches long, of each size of foam joint seal to be installed.

D. Certification:

1. Certification that materials furnished meet specified requirements and are compatible with each other.

2. Certification that the installer is trained and experienced in this type of joint seal installation, and is approved by the manufacturer.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Replacement Joint Seals

1. Joint Seals shall be Evazote foam joint seals, held in place by a two component, 100% solids epoxy adhesive or an approved alternate.

2. Foam joint seal material shall be an impermeable, closed-cell, cross- linked, ethylene vinyl acetate, low density polyethylene copolymer, nitrogen blown, resilient, non extrudable foam material with a UV stabilizer. The foam seals shall have ⅛" wide by ⅛" deep grooves spaced between ¼" to ½" apart, running the entire length of the side wall bonding surfaces.

Foam joint seal material shall have the following properties:

Property	Specification Value	Test Method
Elongation at break	255% +/- 25%	ASTM D3575; Suffix: T
Tensile Strength, psi (kPa)	115 psi +/- 21%	ASTM D3575; Suffix: T
Tear Resistance	15.0 lbs/inch +/- 20%	ASTM D624
Density	2.7 – 3.2	ASTM D3575; Suffix: W, Method A
Water Absorption	0.02 lbs/sf	ASTM D3575; Suffix: L
Compression Recovery (% of original width) 22 hr.@ 73°F (23°C) ½ hr. recovery	No Deterioration	AASHTO T42 50%
Weather/Deterioration	No Deterioration	AASHTO T42 Accelerated Weathering

Compression Set 50% compression for 22 hours @ 73°F (23°C) 2 hr. recovery 50% compression for 22 hours @73°F (23°C) 24 hr. recovery	 10% set 9% set	ASTM D3575; Suffix: B
Extrusion (specimen compressed 60% of original thickness with 3 restrained sides)	Extrusion on free side does not exceed 0.25 inches (6.4mm)	ASTM D545

3. Foam joint seal shall be beige in color, and be shop marked to indicate the top or bottom side of the seal in such a way as to be clearly visible during installation.

B. Epoxy Bonding Adhesive

1. Epoxy Bonding Adhesive for installing joint seals shall be a 100% solids, two-part, moisture insensitive modified epoxy adhesive meeting the following requirements:

Property	Specification Value	Test Method
Compressive Strength	7000 psi	ASTM D695
Tensile Strength	3500 psi	ASTM D638
Elongation at Break	3-5%	ASTM D638
Shore D hardness	75	ASTM D2250
Water Absorption	0.25%	ASTM D570
Bond Strength	430 psi	ASTM C-882

2. Uncured epoxy bonding adhesive shall have the following properties:

	Part A	Part B	Mixed
Color	White	Carmel	Beige
Shelf Life	2 Years	2 Years	
Mixing Ratio (by Volume)	3	1	3:1
Specific Gravity	1.47	1.15	

Density (lbs/gal) @ 77°F (25°C)	12.2 +/- 0.2	9.6 +/- 0.2	11.6 +/- 0.2
Viscosity (cps) @ 77°F (25°C)	22,000	33,000	26,000
Pot Life (200 gms)			30 Minutes minimum
Initial Set @ 77°F			2 Hours maximum
Initial Cure			8 – 12 Hours
Full Chemical Cure			7 Days

C. Patching Material

1. Material used for patching joint edges and/or repairing existing concrete surfaces at joint openings shall be a moisture insensitive, thixotropic, 100% solids trowel grade epoxy containing no solvents and having the following properties:

Property	Specification Value	Test Method
Tensile Strength	5,000 psi mm @ 75°F	D638
Compressive Strength	12,000 psi min	C109 Mod
Bond Strength (Slant Shear)	3.500 psi min —7 Days	C882-78

2. Fine aggregate filler, approved by the epoxy manufacturer, may be added to the thixotropic epoxy to create a mortar for larger voids. Do not exceed one (1) part filler to one (1) part epoxy by volume.

C. Silicone Rubber Sealant

1. For deck joint locations with a cross slope ≤6% sealant shall be a self-leveling, cold-applied, rapid-cure, two-part, water resistant, 100% silicone rubber sealant having the following properties:

Property	Specification Value	Test Method
Color	Grey	--
Slump	Self-Leveling	--
Durometer	45 (Shore 00)	ASTM C661

Elongation	600%	ASTM C1135
Modulus	8 psi max @ 150% Elongation	ASTM C1135
Service Temperature Range	-113°F - 300°F	--
Specific Gravity	1.26 – 1.34 @ 77°F	--
V.O.C Content	34 g/L	--
Movement Capability (Joint Size = ½" x ½" x 2", 10 cycles)	+100% / -50%	ASTM C793

1. For deck joint locations with a cross slope >6% sealant shall be a one-part, non-sag, water resistant, 100% silicone rubber sealant that cures to a low-modulus having the following properties:

Property	Specification Value	Test Method
Color	Grey	--
Slump	<0.30"	ASTM D2202
Durometer	45 (Shore A-2)	ASTM C661
Elongation	1000%	ASTM D412
Tensile Stress	28 psi max @ 150% Elongation	ASTM D412
Specific Gravity	1.48 @ 77°F	ASTM C792
Movement Capability (Joint Size = ½" x ½" x 2", 10 cycles)	+100% / -50%	ASTM C719

2.02 MANUFACTURERS

A. Evazote foam joint seals and epoxy bonding adhesive may be obtained from one of the following, or approved equal:

1. Epoxy Engineered Materials, LLC, Albany, NY:

a. Evazote 380 E.S.P with H.A.L.S. (Hindered Amine Light Stabilizer) Added, Foam Joint Seals.

b. Eva-Pox Bonder #1, Epoxy Bonding Adhesive.

2. Watson Bowman Acme Corp., Amhurst, NY:

a. WABO Evazote UV Foam Joint Seals.

b. WABO Evazote Bonder, Epoxy Bonding Adhesive.

B. Trowel grade epoxy for patching concrete joint edges and surfaces may be one of the following or approved equal:

1. Fox Industries, Baltimore, MD:

a. FX-753 Hydro Ester High Modulus Trowel Grade Epoxy.

2. SIKA Corporation, Lyndhurst, NJ:

a. SIKA Dur 33 Trowel Grade Epoxy.

B. Silicone rubber sealant for final sealing of the deck joints shall be the following or approved equal:

1. Dow Corning Corporation, Midland, MI:

a. *Dow Corning*® 902 RCS Joint Sealant.

b *Dow Corning*® 888 Silicone Joint Sealant.

2.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver products to job site in original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type and/or class, as applicable.

B. Store products in WMATA approved clean and dry area meeting manufacturer's requirements.

Protect from contact with soil and from exposure to the elements. Keep products dry.

C. Handle product so as to prevent breakage of containers and damage or contamination of products.

D. Materials shall be kept in a heated area maintained at a temperature of at least 50°F (10°C) and not to exceed 90°F (32°C) during all phases of delivery, storage and handling.

E. Damaged, open containers shall not be used.

G. Soiled or damaged joint material shall not be used without written consent and instructions from the manufacturer, and the AR.

PART 3 – EXECUTION

3.01 JOB CONDITIONS:

Comply with all applicable OSHA and WMATA safety regulations and procedures.

3.02 PREPARATION

A. Remove existing seals and sealing materials from joints where seals are to be replaced. Do not damage joint surfaces or adjacent facilities. Dispose of removed seal materials properly in approved spoil areas and/or containers.

B. Verify size of existing joint openings to receive new joint seals, prior to final ordering of joint seal materials. Include recorded joint surface and air temperatures at time of measurement Adjust seal sizes planned for installation at various locations as required. Seals as shown on plans are sized to always be in compression within the range of maximum anticipated movement.

C. Thoroughly clean existing concrete joint surfaces to receive new joint seals to remove all dirt, laitance, oils, grease, waxes, existing coatings, adhesives, sharp edges, or protrusions, etc. to provide clean, sound bonding surfaces. The recommended method of surface preparation is abrasive blast cleaning. Where blast cleaning is not permitted, disc grinding may be required. Coarse discs should be used for grinding, to provide an abraded surface. Blow dirt or debris from joint openings and joint surfaces with oil free compressed air. Mask areas adjacent to joints as required to protect existing facilities including rails, conduits, wires, etc. from damage. Provide means for collecting blast cleaning residue, and protecting adjacent facilities from damage or contamination from cleaning operations.

D. Repour existing concrete faying surfaces and edges at joint openings as required by patching with trowel grade epoxy. Remove any loose and/or flaking concrete along the joint edges and faces, and fill voids, edge spalls, and irregularities with epoxy as required to provide an uninterrupted uniform surface for installation of the seals.

3.03 JOINT SEAL INSTALLATION

A. Foam joint seals shall be installed in strict accordance with the manufacturers published, written installation procedures, as directed by the manufacturer's on-site representative and approved by the Authority Representative (AR).

B. Prior to installation, the foam seals should be uncoiled from their shipping packages and allowed to reach a relaxed condition. Care should be taken to extend the seals to their full length without exerting any tension or stretching of the seals.

C. Seals may be cut to length on the job site. All required directional changes and splices should be cut and made prior to seal Installation. Required splices and directional changes in joint material must be done using the heat welding method. Heat welding is done by placing each of the ends to be joined against a Teflon coated heating iron at 350°F (176°C) for 10-20 seconds. The ends are then pressed tightly together and fusion bonded. All welds/splices should be allowed to cool completely before testing the strength of the bond, and before installation.

D. Mix epoxy bonding adhesive in accordance with manufacturer's instructions. Mix only the quantity at one time that can be applied, within the pot life of the mixed adhesive, and/or within any scheduled installation work period. The two component epoxy adhesive should be thoroughly mixed in approved containers until a uniform color results.

E. Apply the epoxy bonding adhesive using brushes, trowels, caulking guns, or by hand with rubber gloves.

F. First, apply the epoxy adhesive to both sides of the concrete substrate surfaces, starting at one end or at an intersection/comer. Apply enough adhesive to coat the substrate to an approximate thickness of 4Omils (1mm). Apply the epoxy bonder on both surfaces working it in the direction ahead of the joint material, not more than 20' (6m) ahead. Next, apply the epoxy adhesive to both sides of the joint material. Apply enough to coat and fill the grooves on the joint material, approximately 40mils (1mm) thick.

G. Install the coated seal material where the epoxy was initially applied on the substrate. The joint material should be installed approximately ½" below the joint edge and should not protrude above the joint edge. Continue installation of the seal in the same direction as the epoxy was initially applied. DO NOT push at an angle or pull the material as this will stretch the material, and is not acceptable. With gloved hands compress the material and with the help of a blunt probe push the seal down into the joint until it is recessed approximately ½" below the surface.

H. Clean the epoxy left on the surface of the material as soon as it is pushed in to the desired depth. DO NOT allow the epoxy to cure before removing it. Use a clean trowel or a putty knife tilted at an angle opposite the direction of movement. DO NOT allow any epoxy bonder near any area to be cut and welded until the weld is completed, otherwise the weld will not hold. Once the joint is installed and cleaned, remove the tape from the joint edges before the epoxy cures.

I. Allow the bonder to set, approximately 20 minutes, at 77°F (25°C), before traffic is allowed onto the joint. Slightly longer time is required during cooler weather.

J. When a continuous joint cannot be finished, the epoxy bonder on the substrate and also on the joint material must end evenly, Install the joint past the epoxied surfaces at least 6 to 12 inches (150 - 300mm) dry, or without epoxy. This can be pulled out later to be re-welded and the installation continued.

K. Allow the epoxy bonding adhesive to fully cure before applying silicone sealant. Apply the one-part, non-sag, water resistant, 100% silicone rubber sealant to deck joint locations with cross slopes >6% as per the manufacturer's directions. The sealant shall be applied as to result in its finished surface being even with the concrete deck on both sides of the joint.

L. Use the one-part, non-sag, water resistant, 100% silicone rubber sealant to create a dam within the joint recess at break points that bound the low side of joint sections with cross slopes ≤6%.

M. Apply the self-leveling, cold-applied, rapid-cure, two-part, water resistant, 100% silicone rubber sealant to deck joint locations with a cross slope ≤6% as per the manufacturer's directions. The sealant shall be applied as to result in its finished surface being even with the concrete deck on both sides of the joint.

END OF SECTION

SECTION 08800

GLASS AND GLAZING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes: This Section specifies requirements for providing glass and glazing (sealing) of glass areas.

B. Related Requirements:
   1. Granite edge: Section 04415.

1.03 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

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. Samples: Submit three each of the following:
      a. Cast glass lens.
      b. Setting blocks and edge blocks.
      c. Sealant: Cured color samples.
         1) Sealant for sealing platform granite edge glass lenses: Clear silicone sealant,, one six-inch long bead.
      d. Gasket material: 12 inches long.

1.05 REFERENCES

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. American National Standards Institute (ANSI):
      a. ANSI: Z97.1.
   3. American Society for Testing and Materials (ASTM):
      a. ASTM C509, Standard Specification for Cellular Elastomeric Pre-Formed Gasket and Sealing Material.
      b. ASTM C542, Standard Specification for Lock-Strip Gaskets.
      c. ASTM C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
      d. ASTM C920, Standard Specification for Elastomeric Joint Sealants.
      e. ASTM C1036, Standard Specification for Flat Glass.

f. ASTM C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
g. ASTM C1172, Standard Specification for Laminated Architectural Flat Glass.
h. ASTM C1281, Standard Specification for Preformed Tape Sealants for Glazing Applications.
i. ASTM D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
j. ASTM D1044, Standard Test Method for Resistance of Transparent Plastics to Surface Abrasion.
k. ASTM D1925, Test Method for Yellowness Index of Plastics.
l. ASTM E774, Standard Specification for the Classification of the Durability of Sealed Insulating Glass Units
m. ASTM E1300, Standard Practice for Determining Load Resistance of Glass in Buildings.

4. CPSC: 16 CFR 1201, Category II.
5. Underwriters' Laboratories (UL):
   a. UL 9, Fire Tests of Window Assemblies.
   b. UL 10B, Fire Tests of Door Assemblies.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

D. Source Limitations: Obtain glass and glazing accessories from single source from a single manufacturer.

E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver products to the jobsite in original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type, class and rating as applicable.

B. Deliver glass with each light bearing manufacturer's label showing strength, grade, thickness, type, quality and safety marking. Do not remove labels from glass until it has been set and inspected.

C. Store products in approved dry area; protect from contact with soil and from exposure to the elements.

D. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

E. Handle products to prevent breakage of containers and damage to products.

1.08 JOB CONDITIONS

A. Environmental Limitations:
1. Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes. Do not install glass when the ambient temperature is below 40F or expected to fall below 40F, unless otherwise approved.
2. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).
3. Do not apply glazing materials to unprotected surfaces in wet weather or to surfaces on which ice, frost, water or dampness is visible.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Glass Lens: Cast, clear glass, flat top with light sandblast texture, or acid etched if approved, to make it translucent, not transparent; vertical side (perimeter) roughened; top outer perimeter edge chamfered to 1/16 inch. Corning Glass Works, Pittsburgh Plate Glass Co., Blenko Glass Company distributed by Southern Plate Glass Company, or equal. Match texture, quality limiting defects, and translucency of existing units within the Metro system as directed by Engineer.
1. Defects shall be limited to a maximum of six air bubbles of 3/16 inch diameter or less with not more than three air bubbles occurring within the central three-inch diameter of lens.
2. Single-Component Clear Silicone Sealant: ASTM C920, Type S, Grade NS, Class 25, Use T; as manufactured by Dow, GE and Pecora, or approved equal.
3. Lead Shims or Lead Rope: Section Shims die-cut from soft sheet lead; sized to suit field conditions, generally 6-1/2 inch outside diameter, five-inch inside diameter; 1/16-inch and 1/8-inch thicknesses as approved; ropes of lead wool may be substituted for shims as approved; fabricated to ensure that glass lenses can be set flush with granite.

B. Glazing Accessories:
1. Sealant: Multi-component polyurethane; ASTM C920, Type M, Grade NS, Class 25, Use G; colored as required to match framing system in which installed.
2. Pressure-Sensitive Tape: Vinyl electrical tape, 3M Company or equal.
3. Setting Blocks: ASTM C864 neoprene extrusions, 70-90 durometer Shore A hardness; approximately full channel width, four inches long and high enough to afford correct cover and 3/8-inch edge clearance for the glass.
4. Glazing Clips and Points: Type, material and quantities as required and recommended by the manufacturers of the glazing media.
5. Lead-Shim Ring: Continuous ring of sheet lead, of thickness required to bring top of cast glass lens level with surrounding granite.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine for compliance with the following:
1. Manufacturing and installation tolerances.
2. Minimum required face and edge clearances.
3. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Verify dimensions before proceeding; obtain measurements at structure for work to be fitted to other construction, including wall-to-wall dimensions, floor-to-ceiling dimensions and those controlled by other trades.

B. Remove dirt, dust, oil, moisture and other foreign substances from surfaces to receive glass and glazing accessories.

C. Clean glass surfaces and wipe dry.

D. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.03 INSTALLATION

A. Coordinate work of this section with work of other trades.

B. Set lead-shim rings on lips at bottom of openings and glass lenses. Set glass lenses to bring flat face level with the top of granite, centered in openings. Use spacers to maintain lenses in position while filling the annular space with backer rod and sealant as shown.

3.04 INSTALLATION/RE-INSTALLATION OF PLATFORM GRANITE EDGE GLASS LENSES

A. Install lead shims or lead rope.

B. Install glass lenses.

C. Apply sealant.

3.05 CLEAN-UP

A. At completion of work, remove labels, except fire labels, clean glass and remove excess glazing compound and sealant from frames and surrounding finish work.

B. Remove from site rubbish and debris resulting from work of this section.

C. Leave areas surrounding work in broom-clean condition.

END OF SECTION

SECTION 09513

SNAP IN METAL PAN CEILINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing exterior grade snap-in metal pan ceiling panels and concealed suspension systems.

B. Related Work Specified Elsewhere:

1. 02411 – Selective Ceiling Demolition
2. 05120 – Fabricated Structural Steel
3. 05501 – Miscellaneous Metals
4. Division 15 – Mechanical
5. Division 16 – Electrical

1.02 SUMMARY

A. Section includes:

1. Exterior grade un-perforated and perforated snap-in metal ceiling panels.

2. Accessories: including devices for attachment overhead construction, secondary members, splines, splices, connecting clips, wall connectors, wall angles, and other devices required for a complete installation.

3. Coordinate layout and installation of items penetrating or being installed in ceiling systems with responsible trades.

1.03 DEFINITIONS

A. Not Required

1.04 PERFORMANCE REQUIREMENTS

A. Structural Performance: Exterior grade snap-in metal pan ceilings shall withstand exterior exposure and the effects of gravity loads and the following loads and stresses without showing permanent deformation of ceiling system components including pans and suspension system; noise or metal fatigue caused by vibration, deflection, and displacement of ceiling units; or permanent damage to fasteners and anchors.

1. Wind Load: Uniform pressure 40 lbf/sq. ft. acting inward or outward.

2. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials.

a. Temperature Change (Range): 100 deg F (55 deg C).

1.05 REFERENCES

A. Codes, Regulations, Reference Standards and Specifications:

1. Codes and regulations of the jurisdictional authorities.
2. CISCA: Ceiling Systems Handbook.
3. NAAMM: Metal Finishes Manual for Architectural and Metal Products.

B. American Society for Testing and Materials (ASTM):

1. A 653 – “Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip process.
2. B 209 – “Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate”
3. C 423 – "Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method"
4. C 635 – “Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings”
5. C 636 – “Recommended Practice for Installation of Metal Ceiling Suspensions Systems for Acoustical and Lay-in Panels”
6. D 1044 – Practice for Abrasion Resistance
7. D 1002 – Practice for Adhesion Resistance
8. E 84 – “Standard Test Method for Surface Burning Characteristics of Building Materials”
9. E 580 – “Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Moderate Seismic Restraint”
10. E 1264 – Classification for Acoustical Ceiling Products
11. E 1477 – "Standard Test for Luminous Reflectance Factor of Acoustical Materials by use of Integrating-Sphere Suspension System.

C. NEMA Standard 11-14-95 for Chemical Resistance

D. Aluminum Association Standards for Anodic Coatings

1.06 SUBMITTALS:

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

1. Product Data: For each type of product specified provide manufacturer’s printed product information including maintenance information.

2. Performance Data: For installed products indicated to comply with design loads and other criteria including governing codes, include structural analysis and other analytical data signed and sealed by the qualified professional engineer responsible for their preparation.

3. Shop Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

a. Ceiling suspension system members.
b. Method of attaching suspension system hangers to building structure.
c. Ceiling-mounted items including light fixtures; air outlets and inlets; speakers; sprinklers, sensors, CCTV’s, and special moldings at walls, penetrations, and other junctures of metal ceilings with adjoining construction.
d. Minimum Drawing Scale: 1/8 inch = 1 foot.

4. Samples for Initial Selection: Manufacturer's color charts consisting of actual metal panels or sections of metal panels, suspension systems, and moldings showing the full

range of colors, textures, and patterns available for each type of ceiling assembly indicated.

5. Samples for Verification: Full-size units of each type of ceiling assembly indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics. Provide three of each type.
    a. Full-size samples of each metal panel type, pattern, and color.
    b. Set of 12-inch-long samples of exposed suspension system members, including moldings, for each color and system type required.
    c. Fasteners: Each type.
    d. Accessories.

6. Manufacturer's certifications that products comply with specified requirements, including laboratory reports and product test reports: indicating compliance of metal panel ceilings and components with requirements based on comprehensive testing of current products.

7. Manufacturer's installation instructions.

8. Maintenance Data: For finishes, to include in maintenance manuals.

1.07 QUALITY ASSURANCE:

A. Source Limitations for Metal Pan Ceilings: Obtain each combination of metal pans and exposed suspension systems from one source with resources to provide products of consistent quality in appearance, physical properties, and performance.

B. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class A Materials as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Seismic Standard: Provide metal pan ceilings designed and installed to withstand the effects of earthquake motions according to the following: SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads" and 2012 International Building Code with Montgomery County, Maryland Amendments,

D. Mockups: Build one mockup to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

E. Installer Qualifications:

1. Engage an experienced installer with a minimum of 5 years' experience who has completed metal panel ceilings similar in material, design, and extent to that indicated for this Project.
2. Provide list of at least 5 successful installations with similar products and scope.

F. Fire-Test-Response Characteristics: Provide metal panel ceilings that comply with the following requirements:
1. Fire-response tests were performed by UL, ITS/Warnock Hersey, or another independent testing and inspecting agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.

2. Surface-burning characteristics of metal panels comply with ASTM E1264 for Class A materials as determined by testing identical products per ASTM E84.
    a. Flame Spread: 25 or less

3. Products are identified with appropriate markings of applicable testing and inspecting agency.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Deliver metal panels and suspension system components to Project site in original, unopened packages, clearly labeled with the manufacturer's name, brand designation, specification number, type, class and ratings as applicable.

B. Store metal panels and suspensions system components in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

C. Before installing metal panels, permit them to reach room temperature and a stabilized moisture content.

D. Handle metal panels carefully to avoid chipping edges or damaging units in any way.

1.09 PROJECT CONDITIONS:

A. Environmental Limitations: Do not install metal panel ceilings until spaces are weatherproof, wet-work in spaces is complete and dry, and work above ceilings is complete.

B. Painted Panels: Building areas to receive ceilings shall be free of construction dust and debris. Products may be installed where temperatures are between 32°F (0°C) and 120°F (49°C). Such installations shall not be exposed to abnormal conditions, namely: chemical fumes, presence of standing water, or contact with moisture, as could result from condensations or building leaks.

1.10 COORDINATION:

A. Coordinate layout and installation of metal panels and suspension system with other construction that penetrates ceilings or is supported by them, including but not limited to light fixtures, HVAC equipment, public address speakers, security cameras, etc.

1.11 WARRANTY

A. Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to: Ceiling Panels and Suspension System: Rust and manufacturing defects.

B. Warranty Period:
1. One (1) year from date of substantial completion.
2. Grid: Ten (10) years from date of substantial completion.
3. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.12 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Metal Pan Ceiling Panels: Full-size un-perforated and perforated snap-in units equal to 5.0 percent of amount installed of each type of panel.

2. Suspension System Components: Quantity of each exposed component equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS:

2.01 METAL PAN CEILINGS

A. Metal Pan Standard: Provide manufacturer's standard metal pans of configuration indicated that comply with ASTM E 1264 classifications as designated by types and light reflectance unless otherwise indicated.

1. Aluminum Sheet: Roll-formed aluminum sheet, complying with ASTM B 209; alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.02 ALUMINUM PANS FOR METAL PAN CEILING

A. Aluminum Metal Pans:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Armstrong World Industries, Inc. “MetalWorks” Torsion Spring
b. Ceilings Plus; “Illusions”.
c. Hunter Douglas Architectural Products, Inc.; “Luxalon” Tile.

B. Classification: Units complying with ASTM E 1264, other types described as unperforated aluminum facing (pan) units.

1. Pattern: none.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Exterior Designer Torsion-Spring-Hinged Pans: Designed to be securely retained in pre-slotted exposed suspension grid by torsion springs, with concealed access. No access holes will be permitted.

2. Cutouts for light fixtures, sprinklers, and other ceiling devices shall be factory fabricated to the extent possible.

D. Surface Texture: Smooth

E. Pan Thickness: Not less than 0.040 inch (1.0 mm).

F. Pan Edge Detail: Square.

G. Pan Joint Detail: Butt.

H. Pan Size: 30 by 30 inches [760 by 760 mm].

I. Pan Face Finish: Painted in color selected from manufacturer's full range.

J. LR: Not less than 0.70.

2.03 ALUMINUM PANS FOR METAL PAN CEILING AT SPEAKER LOCATIONS

A. Aluminum Metal Pans

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Armstrong World Industries, Inc. “MetalWorks” Torsion Spring
   b. Ceilings Plus; “Illusions”.
   c. Hunter Douglas Architectural Products, Inc.; “Luxalon” Tile

B. Classification: Units complying with ASTM E 1264, other types described as perforated aluminum facing (pan) units with no backing.

1. Custom Perforation Pattern: Panel to be perforated around speaker area above ceiling with a 12” diameter perforated pattern. Speaker perforated pattern will have a diameter 0.118” holes @1/4” staggered centers with ±1/4” unperforated borders.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Exterior Designer Torsion-Spring-Hinged Pans: Designed to be securely retained in pre-slotted exposed suspension grid by torsion springs, with concealed access. No access holes will be permitted.
2. Cutouts for light fixtures, sprinklers, and other ceiling devices shall be factory fabricated to the extent possible.

D. Surface texture: Smooth

E. Pan Thickness: Not less than 0.040 inch (1.0 mm).

F. Pan Edge Detail: Square.

G. Pan Joint Detail: Butt.

H. Pan Size: 30 by 30 inches [760 by 760 mm].

I. Pan Face Finish: Painted in color selected from manufacturer's full range.

J. LR: Not less than 0.70.

K. The plenum shall be 100% accessible. Every panel must be removable. Progressive panel access is not acceptable. Heavy duty torsion springs and steel clip assemblies to be mounted to every panel for downward access, without potential for damage to panel face or hinge assembly. Hinge assembly shall be mounted to every panel with minimum two flush to face, counter sunk chamfered fasteners. Attaching torsion spring directly to panel with fastener will not be acceptable.

2.04 METAL SUSPENSION SYSTEMS, GENERAL:

A. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.

B. Metal Suspension System Standard: Provide manufacturer's standard aluminum suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.

C. Suspension Systems: Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.

D. Hanger Rods or Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8 inch (22 mm) wide; formed with 0.04-inch-(1.0-mm-) thick, galvanized-steel sheet complying with ASTM A 53/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

F. Metal Sheet-Metal Edge Moldings and Trim: Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fascias at changes in ceiling height, and for other conditions; of metal and finish matching metal pan ceiling units, unless otherwise indicated. Provide moldings with exposed flange of the same width as exposed runner.

2.05 GENERAL FINISH REQUIREMENTS

A. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance."

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.06 ALUMINUM FINISHES

A. Metal Finish: Panel Finish shall be: Flouropolymer “Painted” finish – 3105 alloy.

B. Color and Gloss: as selected by the Owner from manufacturer's full range of colors and glosses.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates, areas, and conditions, including structural framing to which metal pan ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of metal pan ceilings.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Coordination: Furnish layouts for cast-in-place anchors, clips, and other ceiling anchors whose installation is specified in other Sections.
   1. If indicated, furnish cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.

B. Measure each ceiling area and establish layout of Metal Pan Ceiling to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans and Coordination Drawings.

3.03 INSTALLATION:

A. General: Install metal panel ceilings to comply with publications referenced below per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
   1. Standard for Ceiling Suspension System Installations: Comply with ASTM C636.

B. Install edge moldings and trim of type indicated at perimeter of metal panel ceiling area and where necessary to conceal edges of metal panels.
   1. Screw attach moldings to substrate at intervals not more than 16 inches on center and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely. Miter inside and outside corners accurately and connect securely.
   2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

C. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

D. Cut metal pan units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.

E. Install metal pans in coordination with suspension system and exposed moldings and trim.
   1. For torsion-spring-hinged pans, position pans according to manufacturer's written instructions.

F. Install metal panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

   1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
   2. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated or required.
   3. Align joints in adjacent courses to form uniform, straight joints.
   4. Fit adjoining units to form flush, tight joints.

3.04 FIELD QUALITY CONTROL INCLUDING POWER-ACTUATED FASTENERS AND POST-INSTALLED ANCHORS:

A. Inspections: Engage an inspector with prior experience of installation of approved manufacturer’s ceiling system within the last 5 years, to perform the following inspections.

1. Suspended ceiling system.
2. Hangers, anchors, and fasteners.

B. Testing Agency: Contractor will engage a qualified independent testing agency to perform field quality-control testing.

C. Extent and Testing Frequency: Testing will take place in successive stages in areas described below. Proceed with installation of metal pan ceilings only after test results for previously installed hangers comply with requirements.

1. Existing hangers and support for existing framing: This applies if existing hangers and framing are to be reused. Test 1 in 20 hangers and support framing for 200 lbf tension. When testing discovers hangers and support framing that fails the test, testing agency will test other hangers and support framing not previously tested until 20 pass consecutively. Failed hangers and support framing will be considered defective and will be removed / replaced. Perform tests for each level of the station.
2. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
3. Within each test area, testing agency will select one of every 10 powder-actuated fasteners and post-installed anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two post-installed anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
4. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 consecutively pass and then will resume initial testing frequency.

D. Ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.

E. Testing agency will report test results promptly and in writing to Contractor and Engineer.

F. Remove and replace those fasteners and anchors that test results indicate do not comply with specified requirements

G. Additional Testing: Where fasteners and anchors are removed and replaced, additional testing will be performed to determine compliance with specified requirements.

3.05 CLEANING:

A. Replace damaged and broken metal pan ceiling.

B. Clean exposed surfaces of metal panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

C. Clean up rubbish and debris and remove from site.

D. Leave work areas in a broom clean condition.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 09900

PAINTING AND COATING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. All labor, materials and equipment necessary for painting or touch-up of finishes related to replacement of paver systems on the platform and the reinstallation of platform furnishings.

B. Surface preparation.

1.02 PAINTING AND COATING

A. Field application of paints.

B. Scope: Finish all surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:

C. 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.

1.03 RELATED REQUIREMENTS

A. Section 05500 - Metal Fabrications

1.04 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this section.

1.05 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.

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 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.

1.07 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.

1.08 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.

1.09 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. Paints 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.

C. Primer Sealers: Same manufacturer as top coats.

D. Block Fillers: Same manufacturer as top coats.

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: To be selected from manufacturer's full range of available colors.
1. Selection to be made by Owner after award of contract.

2.03 PAINT SYSTEMS

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 MgE-OP-3A - Galvanized Metals, Alkyd, 3 Coat:
   1. One coat galvanize primer.
   2. Semi-gloss: Two coats of alkyd enamel.

2.04 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.

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. Masonry, Concrete, and Concrete Unit Masonry: 12 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. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

H. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

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

F. 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

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 09901

WATERPROOFING COATING

PART 1 GENERAL

1.01 SUMMARY:

A. Section Includes: Requirements for surface preparation and coating.

1.02 REFERENCES:

A. Occupational Safety and Health Act (OSHA):

1. OSHA 1910.144, Safety Color Code for Marking Physical Hazards.
2. OSHA 1910.145, Specifications for accident prevention signs and tags.

B. The Society for Protective Coatings (SSPC):

1. Surface Preparation Specifications:
   a. SSPC-SP 1, Solvent Cleaning.
   b. SSPC-SP 2, Hand Tool Cleaning.
   c. SSPC-SP 3, Power Tool Cleaning.
   d. SSPC-SP 6, Commercial Blast Cleaning.
   e. SSPC-SP 7, Brush-Off Blast Cleaning.
   f. SSPC-SP 8, Pickling.
   g. SSPC-SP 10, Near-White Blast Cleaning.

1.03 DEFINITIONS:

A. The term "paint" as used in this Section means coating system materials.

B. The term "exposed" as used in this Section means all exposed to view items not covered with concrete, masonry, wallboard, or similar building material.

1.04 SYSTEM DESCRIPTION:

A. Design Requirements:
1. Ensure surfaces are properly prepared, proper primer applied to correct mil thickness, and finish coat is compatible with primer coat and applied to correct mil thickness.

1.05 SUBMITTALS:

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

B. Product Data:
1. Submit material manufacturer's technical information, including paint label analysis and application instructions for each material proposed.
   a. Submit paint schedule in same format as indicated in this section. Include surface preparation with schedule. List each material and cross-reference to specific paint and finish system and application. Identify by manufacturer's catalog number and general classification.

C. Quality Assurance/Control Submittals:
   1. Applicator Qualifications: Submit qualifications as specified under Quality Assurance Article below.

1.06 QUALITY ASSURANCE:

A. Applicator Qualifications:
   1. Has successfully painted utility or industrial installations for at least five years. Submit name and experience record of painting applicator to Engineer. Include a list of at least five utility or industrial installations painted within last five years, along with responsible officials, architects or engineers concerned with project, and the approximate contract price.
   2. Painting applicators whose submissions indicate a lack of experience required to perform the work, or have performed work in an unsatisfactory manner, will not be approved.

B. Pre-Installation Meeting: Prior to any painting, arrange a meeting between a representative of the paint manufacturer, the Engineer, and the Contractor's personnel involved in painting. Purpose of meeting is to have paint manufacturer's representative address the following:
   1. Define surface preparation requirements for the different items which are to receive paint.
   2. Review which paint is used on which items and summarize application procedures.
   3. Answer questions.

C. 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.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Deliver, store and handle paint in accordance with manufacturer's recommendations and as supplemented below.

B. Delivery of Materials:

   1. Deliver materials to job site in original, new, and unopened packages and containers bearing manufacturer's name and label with following information:
      a. Name or title of material.
      b. Manufacturer's stock number and date of manufacture.
      c. Manufacturer's name.
      d. Contents by volume, for major pigment and vehicle constituents.
      e. Thinning instructions where recommended.
      f. Application instructions.
      g. Color name and number.

C. Storage of Materials:

   1. Store only acceptable project materials on project site.
   2. Store in a suitable location approved by Engineer. Keep area clean and accessible.
   3. Restrict storage to paint materials and related equipment.
   4. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.
   5. Keep temperature of storage area above 50 degrees F or manufacturer's recommended storage temperature, whichever is higher.

1.08 PROJECT CONDITIONS:

A. Environmental Requirements:
1. Adhere to manufacturer's data on air and surface temperature limits and relative humidity during application and curing of coatings.
2. Schedule coating work to avoid dust and airborne contaminants.
3. When painting in confined spaces, or because of unfavorable ambient conditions, longer drying times will be necessary.
4. Provide supplementary ventilation such as fans and blowers in confined or enclosed areas to carry off solvents during evaporation stage.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Warren Environmental, Inc.

PART 3 EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions where painting work is to be performed. Notify Engineer in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.02 SURFACE PREPARATION:

A. Perform all preparation and cleaning procedures as specified and in strict accordance with paint manufacturer's instructions for each particular substrate and atmospheric condition.

B. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items not to be finish painted, or provide surface applied protection prior to surface preparation and painting operations. Following completion of painting of each space or area, reinstall removed items by workmen skilled in the trades involved or remove applied protection, if applicable.

C. Clean sand, dirt, dust and all other foreign matter from surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall in wet, newly painted surfaces.

D. Concrete:
1. Remove oil, grease, dirt, etc. by steam cleaning or scrubbing with a strong commercial type detergent and flushed with water.
2. Remove fins, projections, and abrupt irregularities, including those under 1/8-inch, by grinding so unnoticeable transitions are achieved.
3. Fill exposed aggregate or deep pits and air holes with cement grout and trowel to a uniform surface texture.
4. Perform work only on cured, clean and dry concrete surfaces.

E. Existing Surface Conditions: In the opinion of the Engineer, the following surface preparation requirements represent the minimum preparation necessary for existing painted and unpainted surfaces. However, the Contractor will perform the level of surface preparation

exceeding the specified minimums as is necessary to maintain the manufacturer's product performance guarantee.

1. Notice: Where paint failure occurs as an obvious result of inadequate surface preparation, the Owner will require remedial work at no increase in Contract Price.
2. Due to the nature of the types of surface preparation being required in the project, it is necessary to coordinate such preparation work to be performed after existing equipment and material removal and before new equipment and material installation.

F. Hydro-Cleaning Existing Surfaces: Perform hydro-cleaning (power washing) on all surface areas to receive waterproofing coating before other forms of surface preparation are performed.

1. Perform hydro-cleaning with TSP and Clorox solutions in the hydro-cleaning water. Make the concentrations of these solutions of sufficient strength to neutralize the surfaces and to effectively eliminate future fungus growth.
2. During the hydro-cleaning operations provide a suitable means of preventing the washdown debris from entering the floor drainage systems. Dispose of the collected washdown debris in a lawful manner.
3. Hydro-cleaned surfaces will air dry or be force-dried, as determined by moisture-meter or test-patch, prior to paint application.

G. Hand-Cleaning Existing Surfaces: Perform hand-cleaning where the mechanical cleaning and surface preparation methods specified previously cannot be used, such as in areas not machine accessible.

1. Remove existing oil, grease, and surface contaminants (which cannot be removed by hydro-cleaning).
2. Just prior to application of paint or coatings, the prepared surfaces will be dry, clean and free of loose dirt, dust and grit.
3. Collect and dispose of hand-cleaning debris in a lawful manner off site.

H. Water Diversion: Use blocking to divert any water inflows from the areas to receive waterproofing coating. All prepared surfaces to be dry prior to application.

3.03 MATERIALS PREPARATION:

A. Mix and prepare painting materials in strict accordance with manufacturer's directions.

B. Do not mix coating materials produced by different manufacturers.

C. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in a clean condition, free of foreign materials and residue.

D. Stir all materials before application to produce a mixture of uniform density, and as required during application of materials. Do not stir any film which may form on surface into material. Remove film and, if necessary, strain material before using.

E. If material has thickened or must be diluted for application, buildup coating to same film thickness achieved with undiluted material.

F. Paint all exposed surfaces, except where natural finish of material is specifically noted as a surface not to be painted. See Part 3, Paint Schedule, for painting requirements.

G. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas.

H. Protection: Protect those surfaces not being painted both during and after the painting work, and protect adjacent work and materials from accidental drops, splashes over-spray, etc., using impervious material coverings.

1. Clean up and perform the remedial work necessary to restore surfaces damaged by misplaced paint and coatings.
2. Provide in-place protection for fully factory finished construction products, appliances, including lighting fixtures, fire detection systems, sprinkler heads, and prefinished building panels.
3. Provide DUST-TIGHT in-place protective coverings (masking where possible) to seal openings in items such as motors, controls, bearings and similar areas which may be damaged internally by the inclusion of debris and dust created by surface preparation operations.

3.04 APPLICATION:

A. Strictly follow paint manufacturer's label instructions for proper application, spreading rate and drying time.

B. Apply paint by brush, roller, air spray, or airless spray in accordance with manufacturer's directions. Use brushes best suited for type of material being applied. Use rollers of carpet, velvet back, or high pile sheep’s wool as recommended by paint manufacturer for material and texture required. Do not use rollers having nap exceeding 3/8-inch.
1. Apply prime coats by roller, brush, or spray.

C. Apply paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 and 95 degrees F, and will remain in this range during curing, unless otherwise permitted by paint manufacturer's printed instructions.

D. Do not apply paint when relative humidity exceeds 85 percent; or to damp or wet surfaces.

E. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

F. Provide adequate illumination and ventilation in areas where painting operations are in progress.

G. No substitutions will be considered that decrease film thickness, number of coats, surface preparation, or generic type of coating specified. Furnish same color selection of substituted manufacturers as manufacturers specified, including accent colors in coating systems.

H. Maintain number of coats and minimum paint film thickness per coat required regardless of application method. Do not apply succeeding coats until previous coat has completely dried or the minimum time recommended by manufacturer elapsed, whichever is longer.

I. Minimum Coating Thickness: Apply each material at not less than the manufacturer's recommended spreading rate, and provide total dry film thickness as specified. In no case allow area coverage per gallon to exceed manufacturer's recommendations. Apply extra coat at no additional expense to obtain specified total dry film thickness.

J. Scheduling Painting:
   1. Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

K. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling such as laps, irregularities in texture, skid marks, or other surface imperfections.

L. Brush Application:
   1. Brush-out and work all brush coats onto surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are not acceptable.
   2. Brush apply all primer or first coats, unless otherwise permitted to use mechanical applicators.

M. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements as required by Engineer.

N. Placing Into Service: Do not place painted items into service until paints and coatings are fully cured (dry-hard).

3.05 REPAIR/RESTORATION:

A. Assume complete responsibility for quality of repaint work insofar as proper surface preparation will affect finished appearance. Quality of finishes is subject to Engineer's approval or rejection. Recoat work as a result of rejection will be at no expense to Owner.

B. Prepare previously painted surface where powdering, scaling, peeling or flaking is present by wirebrushing, scraping, sanding and blast cleaning to solid material. Sand solid edges smooth.

C. Prepare hard, glossy, repaint surfaces for paint adhesion by sandpapering, followed by surface washing and rinsing. When a de-glosser is used, washing and rinsing may be eliminated.

D. Just prior to application of paint or coatings, re-paint surfaces must be dry, clean and free of loose dirt, dust and grit.

E. At completion of work of other trades, touch up and restore damaged or defaced painted surfaces as determined by Engineer.

F. Patch test unknown old coatings for compatibility.

3.06 FIELD QUALITY CONTROL:

A. Engineer reserves right to invoke following material testing procedure at any time, and any number of times during the period of field painting:
   1. Engage the service of an independent testing laboratory to sample any paint being used. Samples of materials delivered to Project site will be taken, identified and sealed, and certified in presence of Contractor.
   2. Have independent testing laboratory perform appropriate tests for any or all of following characteristics: abrasion resistance, apparent reflectivity, flexibility,

washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance, quantitative materials analysis, and compatibility of coatings.

3. If test results show that material being used does not comply with specified requirements, a directive may be made, at no expense to Owner, to stop painting work and remove noncomplying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two (2) coatings are noncompatible.

3.07 CLEANING:

A. During progress of Work, remove from site all discarded paint materials, rubbish, cans and rags at end of each work day.

B. Upon completion of painting work, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. Remove paint from existing structures, piping and other facilities which were not to be painted.

3.08 PROTECTION:

A. Protect work of other trades against damage caused by painting and finishing work. Correct damages by cleaning, removing paint splatter, repairing or replacing, and repainting, as acceptable to Engineer.

B. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided after completion of painting operations.

C. Protect painted surfaces from damage. Touch up and restore damaged or defaced painted surfaces as determined by Engineer.

3.09 PAINT SCHEDULE:

A. General Requirements: The Engineer will select the proper painting systems from the Paint Schedule (as well as color) for such surfaces, items, apparatus, materials and equipment, which are not specifically named in the Schedule, but requiring paint according to the Engineer's direction in the field. The anachronism ‘dft’ stands for dry film thickness.

B. Concrete:
   1. Interior waterproofing coating where shown on Drawings:
      a. Apply S-301 Epoxy Spray System by Warren Environmental, Inc per manufacturer’s instructions.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 09920

FIELD PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies furnishing and applying paint at the site.
   1. Specific surfaces and areas which require field painting and required paint systems are listed in the schedule of painting.
   2. Unless an item is shown not to be field painted or specified otherwise paint it in accordance with these specifications.

B. Definitions:
   1. Paint: Includes primers and undercoaters, sealers, stains, paint, varnish, enamel, epoxy and special coatings.

C. Items Not Included In Field Painting:
   1. Stainless steel, ornamental metals, glass, resilient tile, ceramic tile, paving, acoustical tile, plastic laminate and similar items which are prefinished.
   2. Mill-, factory- and shop-applied primers and finishes.
   3. Corrosion-resistant structural steel, ASTM A242.
   4. High-strength structural corrosion-resistant steel shapes, plates and bars, ASTM A588.
   5. Galvanized-metal surfaces except fire stand pipes, unless exposed to public view.
   6. UL labels on fire-rated doors and frames.
   7. Precast or prestressed concrete with a sandblast finish, concrete sealer, or other special finish unless noted otherwise

D. Related Work Specified Elsewhere:
   1. Mill-, factory- and shop-applied prime and finish coats: Specified with the product.

1.02 REFERENCE STANDARDS:

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

1.03 SUBMITTALS:

A. See Procurement Documents for submittal procedures.

B. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Samples:
      a. Three each of each color and texture, with identification of materials keyed to those specified and application methods.
      b. Samples of paint scheduled for application to smooth finishes applied to 12-inch square hardboard or metal panels.
      c. Samples of paint scheduled for application to concrete masonry units applied to 16-inch square by two-inch thick panel of concrete masonry units, including one tooled masonry joint. Subdivide panel to define prime or filler, intermediate and finish coats.

C. 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.

1.04 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
    1. Comply with codes and regulations of the jurisdictional authorities.
    2. FS: TT-E-489, TT-E-490, TT-E-509, TT-F-336, TT-F-1098, TT-P-19, TT-P-29, TT-P-636, TT-P-641, TT-P-645, TT-P-650, TT-P-664, TT-P-1510, TT-P-001984, TT-S-71, TT-S-300, TT-V-86, TT-V-119.
    3. ASME: A13.1.
    4. ANSI: Z535.1.
    5. ASTM: A242, A588, B117, C476, C920.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to the jobsite in their original unopened containers clearly labeled with the manufacturer's name and brand designation, referenced specification number and type, as applicable.

B. Store products in an approved ventilated dry area, protect from contact with soil and from exposure to the elements. Always keep products dry. Do not allow paint to freeze.

C. Handle products in a manner that will prevent breakage of containers and damage to products.

1.06 JOB CONDITIONS:

A. Environmental Requirements:
    1. Do not apply paint to non-protected surfaces in wet weather or to surfaces on which ice, frost, water or dampness is visible.
    2. Do not apply exterior paint when the temperature is below 40F or expected to fall below this temperature. Do not apply interior paint when the temperature is lower than 60F or expected to fall below this temperature.
    3. Avoid painting steel which is at a temperature which can cause blistering, porosity, or otherwise be detrimental to the life of the paint. When paint is applied in hot weather or thinned in cold weather ensure that the specified thickness of paint coating is obtained.
    4. Do not apply paint in rain, wind, snow, fog or mist or when the steel surface temperature is below the dew point, resulting in condensation of moisture.
    5. Do not apply interior paint when, in the Engineer's opinion, satisfactory results cannot be obtained due to high humidity and excessive temperature; however, failure of the Engineer to notify the Contractor of the conditions will not relieve the Contractor of responsibility to produce satisfactory results.

PART 2 – PRODUCTS

2.01 GENERAL:

A. To the maximum extent practicable, use the materials of one manufacturer throughout the project. No claims as to the suitability of a material specified, or of inability to produce first-class work with these materials, will be considered unless such claims are made in writing and submitted with the Contractor’s Bid Proposal.

B. Provide a primer suitable for each substrate type and which is manufactured or recommended by the paint manufacturer as part of a complete painting system.

C. Previously Primed Surfaces:
   1. If surfaces have been primed off-site at the mill, factory or shop, omit specified primer, but only if the off-site primer is acceptable to the paint system manufacturer for best performance of the specified paint system.
   2. For touch-up of off-site primer, use primer of the same composition as the mill, factory or shop primer.

D. VOC Requirements: Provide products in compliance with local volatile organic compound regulations. If the listed product of a manufacturer does not comply, provide an accepted equivalent product which does comply.

E. Colors:
   1. Prior to beginning work, the Contractor will be furnished sample color chips and a Color and Material Schedule for surfaces to be painted.
   2. Match the colors of the chips and submit samples before proceeding. Label samples for surface finishes such as satin, flat or gloss as listed in the Color and Material Schedule.
   3. Tint each coat of paint slightly lighter or darker than the preceding coat or the finish coat.
   4. Final approval of colors will be made by the Engineer on samples applied on the job.
   5. Safety Colors: Items specified to be safety colors, e.g. OSHA red (safety red) and ANSI orange, to be in compliance with ANSI Z535.1, Safety Color Code.

F. Listed materials are a guide to quality intended. Substitute materials and paint systems acceptable to the Engineer, as an equal or of superior quality for each intended use, may be used in the work at no additional cost to the Authority.

G. Accessory Materials:
   1. General: Provide miscellaneous materials and accessories, whether listed or not, as necessary to complete the work in an approved manner.
   2. Caulk: Single-component, chemically curing, synthetic rubber, non-sag, ASTM C920, Type S, NS, Class 25.
   3. Spackling compound: Ready-mixed type, U.S. Gypsum Ready-Mixed Joint Compound - Topping, ASTM C476 or equal.
   4. Thinner: As recommended by the paint manufacturer.

2.02 EXTERIOR PAINTING SYSTEMS:

A. Exterior Paint Schedule: Provide the paint systems scheduled below for the various substrates, as indicated. Provide a complete paint system by one manufacturer for each substrate. Unless otherwise indicated, provide the following:
   1. Ferrous metal: Silicone-alkyd, semigloss.
   2. Zinc-coated metal: Silicone-alkyd, semigloss.
   3. Aluminum: Alkyd, semigloss.
   4. Mechanical and electrical items (not finish painted): See substrate materials above.

B. Ferrous Metal - Silicone-Alkyd, Semigloss: Two coats over primer.(Apply a second coat of primer on steel which is at grade, at slab, or passing through floor slabs. Apply to a uniform line six inches above top of grade or slab.)
   1. Primer: Lead and chromate-free high solids primer which chemically inhibits rusting and is recommended by the manufacturer for application to steel which has been prepared in accordance with SSPC SP2. Rated 10 (less than 0.01% surface rusting)

when tested in accordance with ASTM B117 for 500 hours. Exceeds performance requirements of FS TT-P-636:

a. Con-Lux: Rust Arrestor 50.
b. S-W: Kem Kromik Universal Metal Primer B50NZ6.
c. Tnemec: Series P10.

2. Undercoat: Alkyd enamel recommended by manufacturer of finish coat as an intermediate coat over specified primer for application of silicone-alkyd finish coat:
   a. Con-Lux: Ferrox Primer.
   b. S-W: Silicone Alkyd Enamel B-56 Series.
   c. Tnemec: Series 23 Enduratone.
3. Finish Coat: Silicone-alkyd enamel with a minimum of 30% silicone content meeting the qualitative requirements of FS TT-E-490:
   a. Con-Lux: Steel-Master 9500 Series.
   b. S-W: Silicone Alkyd Enamel B-56 Series.
   c. Tnemec: Series 82 Silicone-Alkyd Enamel.

C. Ferrous Metal - Alkyd, Semigloss: Two coats over primer (primer is not required on shop-primed items):
1. Primer: Quick-drying, rust-inhibiting primer for priming ferrous metal under alkyd enamel (FS TT-P-664):
   a. Con-Lux: Ferrox Primer, 25 Red.
   b. Devoe: 41820 Bar-Ox Alkyd Shop/Field Primer.
   c. Moore: Ironclad Retardo Rust-Inhibitive Paint #163.
   d. S-W: Kem Kromik Metal Primer B50N2/B50W1.
2. Undercoat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated ferrous metal (FS TT-E-489, Class A):
   a. Con-Lux: Enamelite Semi-Luster Series
   b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
   c. Moore: Impervo Enamel #133.
   d. S-W: Industrial Enamel, B-54Z Series.
3. Finish Coat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated ferrous metal (FS TT-E-489, Class A):
   a. Con-Lux: Enamelite Semi-Luster Series.
   b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
   c. Moore: Impervo Enamel #133.
   d. S-W: Industrial Enamel, B-54Z Series.

D. Aluminum - Alkyd, Semigloss: Two coats over primer:
1. Primer: Alkyd-type zinc chromate primer used for priming aluminum under alkyd enamels (FS TT-P-645), or one of the following.
   a. Con-Lux: Bond-Plex 46 Barrier Green.
   b. Devoe: 41839 Bar-Ox Zinc Chromate Primer.
   c. Moore: Ironclad Retardo Rust Inhibitive Paint #163.
   d. S-W: Zinc Chromate Primer B50Y1.
2. Undercoat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated aluminum (FS TT-E-489, Class A):
   a. Con-Lux: Enamelite Semi-Luster Series.
   b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.
   c. Moore: Impervo Enamel #133.
   d. S-W: Industrial Enamel, B-54Z Series.
3. Finish Coat: Weather-resistant, air-drying, semigloss alkyd enamel for use on the exterior over prime-coated aluminum (FS TT-E-489, Class A):
   a. Con-Lux: Enamelite Semi-Luster Series
   b. Devoe: 70XX Mirrolac Interior/Exterior Alkyd Enamel.

c. Moore: Impervo Enamel #133.
d. S-W: Industrial Enamel, B-54Z Series.

2.03 INTERIOR PAINTING SYSTEMS:

A. Interior Paint Schedule: Provide the paint systems scheduled below for the various substrates, as indicated. Provide a complete paint system by one manufacturer for each substrate. Unless otherwise indicated, provide the following:
1. Ferrous metal:
a. Exposed steel structure: Silicone-alkyd, semigloss.
b. Other interior ferrous metal: Alkyd, semigloss.
2. Non-ferrous metal: Alkyd, semigloss.
3. Mechanical and electrical items (not finish painted): See substrate materials above.

B. Ferrous Metal - Silicone-Alkyd, Semigloss: Two coats over primer:
1. Primer: Lead and chromate-free high solids primer which chemically inhibits rusting and is recommended by the manufacturer for application to steel which has been prepared in accordance with SSPC SP2. Rated 10 (less than 0.01% surface rusting) when tested in accordance with ASTM B117 for 500 hours. Exceeds performance requirements of FS TT-P-636:
a. Con-Lux: Rust Arrestor 50.
b. S-W: Kem Kromik Universal Metal Primer B50NZ6.
c. Tnemec: Series P10.
2. Undercoat: Alkyd enamel recommended by manufacturer of finish coat as an intermediate coat over specified primer for application of silicone-alkyd finish coat:
a. Con-Lux: Ferrox Primer.
b. S-W: Silicone Alkyd Enamel B-56 Series.
c. Tnemec: Series 23 Enduratone.
3. Finish Coat: Silicone-alkyd enamel with a minimum of 30% silicone content meeting the qualitative requirements of FS TT-E-490:
a. Con-Lux: Steel-Master 9500 Series.
b. S-W: Silicone Alkyd Enamel B-56 Series.
c. Tnemec: Series 82 Silicone-Alkyd Enamel.

C. Ferrous Metal - Alkyd, Semigloss: Two coats over primer with total dry film thickness not less than 2.5 mils.
1. Primer: Quick-drying, rust-inhibiting primer made for priming ferrous metal under an odorless alkyd enamel (FS TT-P-664):
a. Con-Lux: Ferrox Primer.
b. Devoe: 41820 Bar-Ox Alkyd Shop/Field Primer.
c. Moore: Ironclad Retardo Rust-Inhibitive Paint 163
d. S-W: Kem Kromik Metal Primer B50N2/B50W1.
2. Undercoat: Enamel undercoat made for use as an undercoat over a primer on ferrous metal under an odorless alkyd enamel:
a. Con-Lux: Satin-Lite 900 Series.
b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
c. Moore: Moore's Alkyd Enamel Underbody 217.
d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
3. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on ferrous metal surfaces (FS TT-E-509):
a. Con-Lux: Satin-Lite 900 Series.
b. Devoe: 26XX Velour Alkyd Semigloss Enamel
c. Moore: Moore's Satin Impervo Enamel 235.
d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.

D. Ferrous Metal - Epoxy, Gloss: Two coats over primer:

1. Primer: Corrosion-inhibitive primer recommended by manufacturer for priming ferrous metal under an epoxy undercoat:
    a. Con-Lux: Epolon Mastic 36 White.
    b. Duron: Dura Clad Universal Phenolic Alkyd Fast Dry Metal Primer.
    c. Moore: IronClad Epoxy Rust Inhibitive Primer
    d. S-W: Recoatable Epoxy Primer.
2. Undercoat: Epoxy undercoat made for use as an undercoat over a primer on metal under a gloss epoxy enamel:
    a. Con-Lux: Epolon Series.
    b. Duron: Dura Clad Polyamide Epoxy.
    c. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
    d. S-W: ArmorSeal 100HS Series.
3. Finish Coat:
    a. Gloss epoxy enamel made for use over a primer and epoxy undercoat on metal surfaces.
        1) When the finish coat is applied to a floor surface, add anti-slip aggregate.
    b. Con-Lux: Epolon Series.
    c. Duron: Dura Clad Polyamide Epoxy.
    d. Moore: IronClad Chemical and Water Resistant Epoxy Enamel.
    e. S-W: ArmorSeal 100HS Series.

E. Non-Ferrous Metal - Alkyd, Semigloss: Two coats over primer with total dry film thickness not less than 2.5 mils.
1. Primer: Corrosion inhibitive primer recommended by manufacturer for priming non-ferrous metal under an odorless alkyd enamel:
    a. Con-Lux: Bond-Plex 46 Barrier Green.
    b. Devoe: 13201 Mirrolac Galvanized Metal Primer.
    c. Moore: Ironclad Retardo Rust-Inhibitive Paint 163.
    d. S-W: Kem Kromik Metal Primer B50N2/B50W1.
2. Undercoat: Enamel undercoat made for use as an undercoat over a primer on non-ferrous metal under an odorless alkyd enamel:
    a. Con-Lux: Satin-Lite 900 Series.
    b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
    c. Moore: Moore's Alkyd Enamel Underbody 217.
    d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100 Series.
3. Finish Coat: Semigloss odorless alkyd enamel made for use over a primer and undercoat on non-ferrous metal surfaces (FS TT-E-509):
    a. Con-Lux: Satin-Lite 900 Series.
    b. Devoe: 26XX Velour Alkyd Semigloss Enamel.
    c. Moore: Moore's Satin Impervo Enamel 235.
    d. S-W: Pro-Mar Alkyd Semi-Gloss Enamel B34WZ1100

PART 3 - EXECUTION

3.01 PREPARATORY WORK:

A. Inspect surfaces for their suitability to receive a finish. In the event that imperfections due to materials or workmanship appear on surfaces, make the appropriate corrections at no additional cost to the Authority. Correct damage to painted or decorated finishes due to carelessness or negligence of other trades.

B. Protect hardware, hardware accessories, plates, lighting fixtures and similar items installed prior to painting; remove protection upon completion of each space. Where necessary to

remove installed products to ensure their protection, arrange for removal and reinstallation by mechanics of the trade involved. Disconnect equipment adjacent to walls; where necessary, move to permit painting of wall surfaces, and following completion of painting, replace and reconnect.

C. Clean surfaces to be painted as necessary to remove dust and dirt. Sand as necessary to properly prepare surfaces to receive paint or varnish.

D. Wash metal surfaces with benzine or mineral spirits to remove dirt, oil or grease before applying paint. Where rust or scale is present, wire brush or sandpaper clean before painting. Apply galvanized metal primer to degreased galvanized metal before applying additional coats.

E. Fill nail holes and cracks after first coat with non-shrinking putty of a color to match that of the finish.

F. Sand, dust and touch up scratches, abrasions or other disfigurements and remove foreign matter from prime coats before proceeding with the following coat. Featheredge spotpriming or spot coating into adjacent coatings to produce a smooth and level surface.

G. Coordinate the work of this section with the work of other trades.

3.02 APPLICATION:

A. Touch-up painting of miscellaneous metal and other materials which have been prime coated as may be required where the shop coat has been damaged by welding or abrasion during the handling and erection operations; also rivets, bolts and welds which are unpainted after assembly and erection.

B. Apply paint by spray in accordance with the manufacturer's directions to achieve required dry film thickness (DFT). Where specifically approved by the Engineer, use rollers or brushes as best suited for material being applied. For covers on rollers use carpet with velvet back and high-pile sheep's wool or use short-hair covers, as best suited for material and texture specified. Except where otherwise noted, apply paint to a minimum dry-film thickness (DFT) of five mils, excluding filler coats, using no less than the number of coats specified in Part 2 – Products.

C. Apply material evenly and smoothly without runs, sags or other defects with edges of paint adjoining other materials or color sharp and clean, without overlapping.

D. Do not paint and finish while surfaces are damp. Allow sufficient time between coats, in accordance with manufacturer's directions to produce an evenly smooth finish.

E. Do not apply final coats until after other trades, whose operations would be detrimental to finish painting, have finished their work in the areas to be painted and the areas have been approved for painting.

3.03 **PROTECTION:**

A. Dispose of soiled cleaning rags and waste at the close of each day's work or store such soiled rags and waste in metal containers with tight-fitting covers. Provide buckets of sand during painting operations for use in the event of fire. Post NO SMOKING signs as necessary and as directed.

B. Protect the work of other trades against damage or injury by use of suitable covering during the progress of the painting and finishing work. Repair damage to the satisfaction of the Engineer.

3.04 **CLEANING:**

A. Upon completion of work, remove staging, scaffolding and containers from the site. Remove paint spots, oil or stains from glass, floors and other surfaces not to be painted, and leave job clean and acceptable to the Engineer.

3.05 **COLOR CODING OF PIPING AND EQUIPMENT:**

A. General Requirements:
   1. Color coding is required for accessible piping systems and related equipment, except associated supports, brackets, hangers and similar accessories.
   2. Identify piping systems and related equipment which are to be color coded as follows:
      a. Apply color to entire length of piping.
      b. Apply lettered legends indicating the name of the contents of the system as specified.

B. Location of Legends and Bands:
   1. Stencil lettered legends on the piping at the horizontal or vertical centerline. Where pipe lines are too close together and where located above the operator's normal line of vision, place the lettering below the horizontal centerline at a point which will be easily visible.
   2. Locate lettered legends and bands at points where pipes enter and leave rooms or spaces, at junction points and points of distribution, close to valves and equipment, at changes in direction, and at intervals along piping where necessary for identification.
   3. Stencil piping in accordance with ASME A13.1 and as follows to show service and direction of flow, space within sight of each other and not more than 40 feet apart on long runs.

C. Size of Stencil Letters for Piping Identification:

Outside Diameter of Pipe Covering in Inches	Size of Letter in Inches	Width of Color Band in Inches
3/4 to 1-1/4	1/2	4
1-1/2 to 2-1/2	3/4	6
3 to 6	1-1/4	8
7 to 10	2-1/2	12
Over 10	3-1/2	12

D. Schedule of Colors and Legends:

	Pipe	Black

Line	Color	Stenciled Legend
Fire lines	Red	F (use White Stencil instead of black)

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 11242

OVERHEAD FALL PROTECTION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES:

A. Furnishing, installing and testing horizontal fall protection system, complete with stainless steel cable, energy absorber, overhead travelers, stainless steel retracting lifeline, and attachment brackets at locations indicated on the Contract Drawings. The system will be designed and installed to use when employees are on top of precast arch panels.

1.02 RELATED SECTIONS:

A. Section 05501: Miscellaneous Metals.

B. Section 05521: Stainless Steel.

C. Section 03621: Non-Metallic Non-Shrink Grouting

1.03 QUALITY CONTROL:

A. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall take effect.

B. Design of the Overhead Fall Protection System shall follow all of the federal, state, and local safety codes and standards. All structural steel members of the fall arrest system shall be designed in accordance with the specifications of the AISC, current edition. And all welded construction shall be in accordance with the American Welding Society.

C. All components shall be approved by the American National Standards Institute.

D. Reference Standards: Requirements of regulatory agencies: Comply with all applicable Federal, State and with local codes having jurisdiction including:
   1. American Institute of Steel Construction (AISC).
   2. American National Standards Institute (ANSI):
      a. ANSI Z359.1-2007, Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components.
      b. ANSI A10.32, Standard Personal Fall Protection for Use in Construction and Demolition Operations.
      c. Requirements for harness: Self Retracting Lifeline (SRL) and drop lines for construction and industrial use.
   3. American Welding Society (AWS).
   4. ASTM International (ASTM).
   5. Occupational Safety and Health Administration (OSHA) – Title 29, Chapter XVII, Part 1910 and 1926.

E. Furnish all materials and labor necessary to meet these requirements and to obtain approvals of inspections and tests.

F. 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.

1.04 SUBMITTALS:

A. Contractor shall submit:
1. Material and equipment list itemizing products furnished to satisfy the requirements of this section.
2. Product data including catalog cuts, manufacturer's assembly and installation data, manufacturer's certificates of compliance, and samples.
3. Shop drawings
4. Schedule of work
5. Operations and maintenance data
6. List of recommended spare parts and maintenance materials
7. Evidence of manufacturers and installers experience including names, addresses and phone numbers of reference clients
8. Calculations and certification specified
9. Documentation of field tests

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Ship all equipment and components securely wrapped, crated or packaged and labeled for safe handling to avoid damage.

1.06 WARRANTY:

A. Following completion, the Contractor shall provide the owner with a one (1) year warranty starting at project acceptance, covering all parts, materials, and labor. All warranty work shall be performed by a local manufacturer's representative at the Project Site location, who has capabilities of responding to all problems within 24 hours. Any shipping and delivery costs associated with the warranty of this equipment shall be the responsibility of the Contractor.

1.07 SUBSTITUTIONS, BASIS OF DESIGN, AND ACCEPTABLE MANUFACTURERS:

A. Where a specific manufacturer or product is identified as the Basis of Design or listed first in the list of acceptable manufacturer, 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 effort 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: change in 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 architecture 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' products(s) have been verified to satisfy the specified requirement, 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, rates, features, dimension, and function as indicated.

PART 2 PRODUCTS

2.01 OVERHEAD FALL PROTECTION SYSTEM:

A. Acceptable Manufacturers:

1. Products of the following manufacturer are specified as the standard of quality for the Fall Arrest System:
   a. Capital Safety (DBI SALA), www.capitalsafety.com
      Telephone (800) 328-6146
   b. CAI Safety Systems
      Telephone (951) 271-6999
2. Products of equal quality and utility of other approved manufacturers will be accepted.
   a. Approved equal

B. Design Criteria
1. System shall consist of the following primary components of horizontal lifeline, Self-Retracting Lifelines (SRL), Overhead Travelers, Stainless Steel Cable with energy absorber and structural steel supports required for support of lifeline and connection to the structural steel ribs. All other hardware (snap hooks, D-rings, etc.) necessary to make a safe and complete system shall be provided.
2. The system shall be designed to allow three users to walk interrupted the entire length.
3. The system shall be designed to support three users in case of a fall. The system shall be designed to allow hands-free operation once the user is properly attached to the system.
4. Lanyards, D-rings, snap hooks and all other necessary hardware shall be capable of sustaining a minimum tensile load of 5,400 pounds.
5. In order to assure uniform quality, ease of maintenance and minimal parts storage, all equipment for the system shall be supplied by a single source.
6. The manufacturer of the system shall be regularly engaged in manufacturing and production of fall arrest systems for a minimum of five years with at least a dozen systems installed within the last two years.
7. All materials shall be new and shall be properly stored during construction to prevent physical damage and damage from the weather.
8. All components and hardware shall meet the requirements of ANSI Z359.1
9. Horizontal Lifeline: Will be a stainless steel cable without paint finish. All brackets and headers to be of stainless steel construction. Horizontal Lifeline to have in line shock absorber.
10. Overhead Traveler shall be Uni 8 Overhead Traveler.
11. SRL: Shall be a self-retracting lifeline suitable for the provided horizontal lifeline and the minimum clearance required from nearest obstruction level to the working level. DBI SALA Ultra-Loc SRL (30 feet) or equal.
12. Body Harness: Lightweight nylon full body Class III harness with back D-ring and tongue buckle sub pelvic straps. DBI SALA or equal.
13. Each horizontal lifeline will include a warning label measuring 12” X 8” that will outline the limitations and proper use of the fall protection system. Each warning label will be permanently stamped with a unique manufacturers serial number

C. Design
1. A registered professional engineer shall design the entire fall protection system to include all requirements for Maryland including National, State and Local codes having jurisdiction.
2. Calculations shall be submitted to the Owner's Representative for review.
3. The system shall be designed for three (3) workers at a time, with full body harness and SRL with a maximum arresting force of 900 pounds per worker x 3 to 1 safety factor = 1800 pound x 3 Workers = 5400 pounds.
4. Design the system to be supported at the locations described on plans.

D. Dimensions and Capacities:
1. Two hundred eighteen feet (218) Cable horizontal system

2. Retractable lifeline, D-rings, snap hooks and all other hardware: Minimum tensile load of 5,400 pounds.
3. Arresting Force: 900 pounds per worker.

E. Fall Arrest System shall be manufactured by Capital Safety (DBI SALA).

PART 3 EXECUTION

3.01 INSTALLATION:

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

B. Provide a training session on use and maintenance of system. Training shall consist of a single session, held at completion of installation. Furnish six (6) copies of an operation and maintenance manual.

3.02 FIELD QUALITY CONTROL:

A. Upon completion of installation, the overhead fall protection system shall be tested to meet the America National Standards Institute, Z359.1-2007, A10.32. Requirements for harness: Self Retracting Lifeline (SRL) and drop lines for construction and industrial use.

B. Provide the services of a qualified manufacturer's representative to perform the following:
1. Inspect preparatory work performed by other disciplines.
2. Inspect installation.
3. Observe testing, by the Contractor in the presence of the Owner, to ensure proper operation of the equipment.
4. Instruct the operating personnel in the proper safe operation and maintenance of the equipment.

END OF SECTION

SECTION 13110

STRAY CURRENT AND CATHODIC PROTECTION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing and connecting stray-current, cathodic-protection equipment, and galvanic anodes to mitigate corrosion of reinforcing steel in concrete.

B. Related Work Specified Elsewhere:
1. Grading, excavation and backfilling: Section 02320.
2. Corrosion control system testing: Section 13115.
3. Grounding and bonding: Section 16060.
4. Wire, cable and busways: Section 16120.
5. Wire connection accessories: Section 16125.
6. Raceways, boxes and cabinets: Section 16130.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of jurisdictional authorities.
2. ICEA: S-61-402.
3. ASTM: B418, D256, D570, D638, D693, D1248, E11, A82.
4. MS: MIL-A-18001.
5. 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. Galvanic anodes:
1. Convene a pre-placement meeting prior to placing galvanic anodes with contractor and manufacturer's representative. Review surface preparation, placement, protection, and coordination with other work.
2. All galvanic anodes, galvanic anode accessory parts and materials, shall originate from a single manufacturer.
3. All repair mortars used in repairs containing galvanic anodes shall originate from same source manufacturer as galvanic anodes.
4. Repair mortars, concrete, and bonding agents shall be Portland cement-based materials with volumetric resistivity below 15,000 ohm/cm, as measured after 28-day wet cure and in saturated condition.
5. Contractor shall provide submittals confirming resistivity of repair materials prior to beginning work. Non-conductive repair materials such as epoxy, urethane, or magnesium phosphate shall not be permitted.

C. <u>Reinforcing Steel:</u>
1. Contractor shall confirm and provide documentation verifying electrical continuity of reinforcement steel prior to and after placement of anode.
2. Maintain electrical continuity of the reinforcing steel by welding all longitudinal lap splices and longitudinal interrupted steel sections.
3. Electrically interconnect all top layer of reinforcing steel by welding to existing or added #4 transverse collector bar installed at breaks in the longitudinal reinforcing steel at expansion joints. Connect collector bars installed on each side of breaks with 1/0 AWG insulated cable. Refer to Specification 16060 Section Grounding and Bonding.

1.03 SUBMITTALS:

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

1. Product data: Manufacturer's literature completely describing each material, standard, test data, installation instructions, and special instructions or safety precautions applicable to the materials.
    a. Samples:
        1) Submit material samples of anode(s) and related materials.
2. Shop Drawings.
3. Certification:
    a. Certified test reports of field quality-control testing.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mark each item with manufacturer's name, brand designation, referenced standard, type, class and rating, as applicable.

B. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.

C. Store equipment in secure and dry storage facility.

D. Galvanic Anodes:
1. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
2. Storage: Store materials in clean, dry area in accordance with manufacturer's instructions. Keep containers sealed until ready for use. Avoid extreme temperatures.
3. Handling: Protect materials during handling and placement to prevent damage or contamination.
4. Installation: Install Anodes and cover within 48 hours of removal from original sealed packaging.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. Galvanic Anodes:
1. Description: Pre-manufactured concrete casing containing zinc, around a pair of galvanized steel tie wires designed to mitigate corrosion of reinforcing steel in concrete.
2. Current: Anode will have a current output equal to or greater than 0.4 milliamps at 90 days. Testing maintained at room temperature and about 55% RH and conducted in a concrete block containing not more than 0.3ft2 (0.028m2) of reinforcing steel.
3. Encasement: High alkaline cementitious shell that shall not contain a high pH chemical which can accelerate ASR reaction.
4. Designed with configuration that snugly fits any size rebar, and easily installed with standard tools.
5. Creates insulating barrier to prevent excessive dumping of protective current into attached area of reinforcing bar.

6. Basis For Design:
    a. Sentinel-Silver available from the Euclid Chemical Company: www.euclidchemical.com, subject to the Buy America Act as noted in 1.02.A.5.

B. Repair Mortars Compatible with Galvanic Anodes
    1. Vertical Repair Mortar for use at Column Base Repairs: Shall be prepackaged, cementitious repair mortar. Repair mortar shall be capable of achieving a minimum 1 day compressive strength of 3,000 psi and 8,000 psi at 28 days per ASTM C 109 as certified by manufacturer, volumetric resistivity of less than 12,000 ohms/cm @ 28 days, and maximum 1100 coulombs. Chloride Permeability when tested per ASTM C 1202. Manufacturer to provide written certification of compatibility with galvanic anode corrosion protection system.
        a. Verticoat or Tamms Structural Mortar by The Euclid Chemical Company: www.euclidchemical.com, subject to the Buy America Act as noted in 1.02.A.5.

C. Cast-Iron Anodes:
    1. Size and type: As shown.
    2. Chemical composition:

Element	Percent
Silicon	14.33
Chromium	4.5
Carbon	0.85
Manganese	0.65
Iron	Remainder

    3. Physical properties:
        a. Tensile strength: 15,000 psi.
        b. Compressive strength: 100,000 psi.
        c. Brinell hardness: 520.
        d. Density: 7.0 grams per cubic centimeter.
        e. Melting point: 2,300F.
        f. Specific resistance: 72 microhms per centimeter cube at 20C.
        g. Coefficient of expansion: 7.33 x 10^{-6} per degree F from 32F to 212F.
    4. Lead wire: Single-conductor insulated cable, 8AWG minimum, factory-connected to anode with connection sealed with cast epoxy-resin encapsulation.
    5. Anode packaged as follows:
        a. Stove pipe: Galvanized steel, 30-gauge minimum, in accordance with the one of the following:
            1) Diameter: Eight inches; Length: Eight feet.
            2) Diameter: Five inches; Length: Six feet.
        b. Ends of pipe crimped to end seal of ½-inch interior-grade plywood.
        c. Containing compacted backfill of coke breeze of graded coal or recalcined petroleum coke, with the following additional requirements:
            1) Resistivity on dry basis: 60 ohms per centimeter cube, maximum.

2) Chemical composition:

Material	Percent
Fixed carbon	78.22 - 78.40
Ash	18.6 maximum
Moisture	9.50 - 14.70
Volatile matter	3.00 - 3.14
Sulphur	1.2 maximum

3) Gradation:
Sieve size in accordance with ASTM E11.
Requirements:

Percent Passing	Sieve Size
½ inch	100
3/8 inch	85
No. 6	65

D. Magnesium Anodes:
1. Packaged anodes, type and size as shown.
2. Chemical composition for high-potential type anodes:

Element	Percent
Aluminum	0.010 maximum
Manganese	0.50 - 1.30
Zinc	0.050 maximum
Silicon	0.050 maximum
Copper	0.020 maximum
Nickel	0.001 maximum
Iron	0.030 maximum

Element (Cont.)	Percent (Cont.)
Other metallic elements	0.050 each or

	0.300 maximum total
Magnesium	Remainder

3. Lead wire: Single-conductor insulated cable, 12AWG minimum, factory-connected to anode with connection sealed with cast epoxy-resin encapsulation.
4. Anode packaged in permeable cloth sack containing compacted backfill of mixture with the following requirements:

Material	Percent
Gypsum	75
Bentonite	20
Sodium sulphate	5

E. Zinc Anodes: MS MIL-A-18001, bare-ribbon 5/8 by 7/8-inch section or packaged anode, type and size as shown, with the following additional requirements:
   1. Lead wire: Single-conductor insulated cable, 12AWG minimum, factory-connected to the anode with connection sealed with cast epoxy-resin encapsulation.
   2. Anode packaged in permeable cloth sack containing compacted backfill of mixture consisting of 50-percent hydrated gypsum and 50-percent bentonite.

F. Reference Electrode: ASTM B418, Type II, one galvanized-steel rod, factory-connected to electrode and equipped with two bolted connectors suitable for 12AWG single-conductor insulated cable.

G. Test Boxes:
   1. Cathodic-protection test boxes: Plastic, each five inches inside diameter by 18 inches long, with cast-iron lid, collar and terminal board.
   2. Stray-current test boxes: Six inches cubical, galvanized cast-iron box with watertight cover.

H. Wire and Cable:
   1. Header cable, bond wire and cast-iron anode lead wire in accordance with the following:
      a. Single-conductor.
      b. Size: As shown.
      c. Insulation: HMWPE, 600 volt, in accordance with the following:
         ASTM D1248, Type I, Class C, Grade 5.
         ICEA S-61-402.
   1. Magnesium or zinc anode lead and test wire:
      a. Single-conductor.
      b. Size: 12AWG unless otherwise shown.
      c. Color: As shown; anode lead as furnished.
      d. Insulation: TW, 600-volt, moisture-resistant thermoplastic in accordance with UL 83.

I. Pipeline-Casing Spacers:
   1. Virgin polyethylene, molded.
   2. Runner height: Sufficient to provide ½-inch clearance between pipe, couplings and hubs as well as internal casing wall.
   3. Color: Natural.

4. In accordance with the following:

Characteristic	Reference	Requirement
Compressive strength	ASTM D693	3,200 psi
Tensile strength	ASTM D638,	3,100 - 5,500 psi
Impact strength	ASTM D256	1.5 - 2.0 foot-pound per inch notch
Water absorption	ASTM D570	0.1 percent
Temperature	-	180F (80C) maximum

5. Bolts:
    a. Steel, cadmium-plated.
    b. Sizes: As standard with the manufacturer.
6. Nuts:
    a. Steel, cadmium-plated, square.
    b. Sizes: To match bolts.

J. Pipeline-Casing End Seals:
1. Type L:
    a. Modular mechanical-type.
    b. Consisting of interlocking synthetic-rubber links with cadmium-plated steel nuts and bolts.
    c. Depth limitations: As shown.
2. Type H:
    a. Compression-ring seals.
    b. Nonconductive sleeve: Fiberglass reinforced epoxy (FRE), Adyl Type D or equal, with cadmium-plated steel nuts and bolts.
    c. Depth limitations: As shown.

K. Insulating Gasket:
1. Asbestos, all-temperature.
2. Full-face.
3. Thickness: 1/8 inch.
4. Johns-Mansville 71 or equal.

L. Insulating Sleeves and Washers:
1. Up to 300F:
    a. Sleeve: Mylar tube, 1/32-inch thick.
    b. Washer: Phenolic, 1/8-inch thick.

2. 300F and above:
   Sleeve: Klingerit or equal, 1/32-inch thick.
   Washer: Johns-Mansville 71 or equal, Teflon.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Bury anodes or electrodes of type and at location shown. Excavate and backfill holes in accordance with Section 02320, with the following additional requirements:
   1. Wet packaged anode thoroughly before backfilling hole.
   2. Use fine clay soil, free from stones and bricks, for backfilling.

B. Install header cable of size and at location shown, in accordance with Section 16120.

C. Install test boxes of type and at location shown.

D. Connect anode lead wires to header cable or test boxes as shown.

E. Isolate pipes of different metals and Authority pipes from utility-company pipes using insulated union, compression insulating couplings, or insulated flange and bolt connections. Connect each side of insulated joints to test box using conductors as shown.

F. Where Authority pipes cross utility-company pipes, connect Authority pipes to test boxes using two 12AWG and one 4AWG conductors as shown.

G. Bond joints in buried metallic pipe and structure in accordance with Section 16060. Connect buried metallic pipe and structure to test boxes using single-conductor insulated cable of size shown.

H. Install conduit of type shown, in accordance with Section 16130.

I. Install single-conductor insulated cable in accordance with Section 16120. Leave one foot of slack in test boxes.

J. Use thermit weld sealed with cast epoxy-resin encapsulation for splices made in direct-burial cable.

K. Use compression-type connectors in accordance with Section 16125.

L. Install casing spacers in accordance with manufacturer's recommendation, except maximum spacer distance not to exceed 10 feet.

3.02 IDENTIFICATION:

A. Identify wire and cable in each test box using nonmetallic fiberboard or plastic tags or pressure-sensitive labels.

3.03 FIELD QUALITY CONTROL:

A. Provide necessary equipment and perform testing in the presence of the Engineer in accordance with Section 13115.

3.04 GALVANIC ANODES:

A. Examination:
   1. Examine surfaces to receive anode. Notify Engineer if surfaces are not acceptable. Do not begin placement until unacceptable conditions are corrected.

B. Surface Preparation:
   1. Concrete removal and preparation of concrete surface for patching shall be conducted according to Section 03720.
   2. Electrical continuity of rebar within repair area shall be confirmed with use of a high-impedance multi-meter indicating a reading of 1.0mV or less. Refer to Corrosion Control System Testing: Section 13115 for testing requirements.
   3. Prepare concrete surfaces in accordance with manufacturer's instructions.
   4. The area to be repaired should be prepared in accordance with ICRI Guidelines.
      a. All unsound concrete should be removed from around and behind steel reinforcement.
      b. Provide minimum ¾" clearance between anode and substrate or ¼" larger than top size aggregate of repair material, whichever is larger.
      c. Clean exposed reinforcing steel remove all rust, mortar, etc. to provide bright metal surface that will provide sufficient electrical connection.
      d. Secure loose reinforcing steel by tying tightly to other bars with steel tie wire. Newly secured reinforcing steel shall also be tested to ensure electrical continuity according to Section 3.04 B 2.

C. Placement:
   1. Place anodes as close as practical to edge of repair area (within 6" or 150 mm) while providing sufficient clearance for anode to be completely surrounded by repair mix.
      a. Minimum 1.5" of repair mix cover shall be provided over galvanic anode unit.
      b. Anode is normally installed top face parallel to concrete surface, but may be angled down in cases where concrete cover is very shallow.
   2. Anodes shall be spaced as indicated on drawings.

D. Protection:
   1. Anodes should be installed and covered with specified repair mortar within 24 hours or removal from their original package. Temporarily store in plastic sealed bag for protection if removed from original package.

END OF SECTION

SECTION 13115

CORROSION CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies test procedures for corrosion-control systems.

B. Related Work Specified Elsewhere:
   1. Wire, cable and busways: Section 16120.

1.02 QUALITY ASSURANCE:

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

B. Instrument Calibration:
   1. Calibrate test instruments within six months prior to use on this project.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Working Drawings:
      a. Layout of system being tested, showing location of system components, including test stations.
      b. Instrument hook-up for each test.
   2. Certification:
      a. Certified test report for each test conducted including the following:
         1) Types, models, serial numbers, and dates of calibration of all instruments.
         2) Data resulting from specified test procedures, in approved format.
      b. Certificates of inspection.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Wire and Cable: Section 16120.

PART 3 - EXECUTION

3.01 TEST EQUIPMENT:

A. DC Voltmeter: Multi-scale, center zero, minimum sensitivity 50,000 ohm/volt, accurate to within one percent of full scale, covering the following full-scale ranges: 0-10 and 0-100 millivolts; 0-1, 0-10, 0-100 volts.

B. DC Ammeter: Multi-scale, maximum shunt drop of 20-mV sensitivity, or millivolt meter and shunts, accurate to within one percent of full scale, covering the following full-scale ranges: 0-1, 0-10, 0-100 amperes.

C. Resistivity Meter: Self-contained, synchronous-vibrator, battery-powered unit. Instrument readings unaffected by resistance of leads or probes.

D. DC-Power Sources: Automotive wet-cell batteries, six or 12 volts. For circuits with high internal resistance use two or more batteries, a dc generator or cathodic-protection rectifier.

E. Test Cable: Single-conductor cable, stranded copper, assorted sizes and lengths to suit test conditions.

F. Steel probes for making electrical contact to buried structures in absence of test stations.

G. Slide-Wire Resistors: 0-400 ohm, 15-ampere capacity over full-range of adjustment.

H. Reference Half-Cell: 7/8-inch diameter by eight inches long, saturated copper-copper sulfate.

3.02 TEST PROCEDURES:

A. Electrical Continuity:
1. Test the following items for continuity:
a. Mechanical and bell-and-spigot pipe joints: Test after backfilling is completed. Test individual and multiple bonds.
b. Metallic tunnel-liner joints: Test after invert has been cast. Test longitudinal bonds individually or in sections not to exceed 150-linear feet.
c. Concrete reinforcement in tunnel, station, retaining wall, reinforced-concrete pipe, aerial, floating slab and building structures: Test after concrete has been cast. Test bonded joints individually or in sections not to exceed 150 feet for tunnel and station structures, not to exceed 500-linear feet for other structures.
d. Underpinning, soldier and structural piles: Test prior to backfilling or use leads in structure after backfilling. Test bonded piles individually or in longitudinal sections not exceeding 600-linear feet.
e. Existing reinforcement steel: Test at existing test stations as specified for single bond test prior to chipping of concrete. If test station does not exist, verify electrical continuity of the rebar within the repair area prior to installation of galvanic anode.
2. Test Procedure:
a. Single bond: Connect instruments across bond to be tested as shown. Use separate set of wires and contact points to structures for voltage and current circuits. Beginning with highest scales on voltmeter and ammeter, close switch and observe meter readings. Reduce meter ranges until lowest possible scale is reached. Adjust current level to less than five amperes. Read ON values of voltage and current, break circuit and immediately read OFF values. Record ON and OFF readings on data sheet and determine incremental change for current and voltage. Obtain minimum of three readings to ensure accuracy. Determine and record bond resistance for each reading. Resistance of bond not to exceed calculated theoretical resistance by more than 10 percent.
b. Multiple bonds in parallel: Where two structures are bonded by multiple bonds in parallel, test as specified for single bond. Record resistance readings obtained. Actual resistance not to exceed 10 percent of calculated theoretical resistance of bonds.
c. Multiple bonds in series: Connect instruments as shown. Determine and record resistance between points A and B, including bonds in series as specified for single-bond test. Total resistance measured between points A and B not to exceed 10 percent of theoretical resistance of sum of bonds plus theoretical resistance of structure between points A and B.
d. Multiple bonds in parallel on reinforcing steel: Connect instruments as shown. Determine and record resistance between points A and B, including bonds in parallel as specified for single-bond test.
e. Existing reinforcing steel in concrete: Verify electrical continuity of reinforcement steel where galvanic anodes will be installed with high-impedance multimeter. Test results of 1.0mV or less on the voltmeter

indicates good continuity between steel. Record existing resistance readings. Retest electrical continuity of reinforcement steel after installation of galvanic anode.

B. Wire and Cable: Install in accordance with Section 16120.

C. Coal-Tar Epoxy Coating:
   1. Subject final coating to spark test for capability of maintaining dielectric integrity at 5,000 volts minimum.
   2. Visually inspect coating prior to installation; repair damaged areas in accordance with field-correction recommendations of the coating manufacturer.
   3. Backfilling prior to approval of coating is prohibited.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 13905

FIRE PROTECTION, SUPPRESSION AND ALARM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing dry standpipe systems.

B. Related Work Specified Elsewhere:
1. Identification of mechanical equipment and piping: Section 15075.
2. Grounding and bonding: Section 16060.

C. Description of System:
1. Dry standpipe system: Consists of siamese fire-department connection, dry fire line, check valves, automatic air vents, drain valves and angle hose valves.

1.02 REFERENCE STANDARDS:

A. Reference Standards:
1. U.S. Government:
a. Federal Transit Administration (FTA):
1) 49 CFR 661 Buy America Requirements.
2. National Fire Protection Association:
a. NFPA: 12A, 13, 14, 15, 24, 2001.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. AWS: A5.13
3. FM Approval Guide.
4. NFPA: 12A, 13, 14, 15, 24, 2001.
5. UL: 262, 312, 1479, Fire Protection Directory.
6. ANSI/ASME: B16.1, B16.5, B16.9, B31.1.
7. ANSI: Z535.1.
8. NEMA: 250.
9. FS: A-A-1992 SS-C-153, WW-P-421, WW-P-501, WW-U-516, WW-U-531.
10. MSS: SP-58.
11. ASTM: A36, A47, A53, A135, A183, A234, A 240, A276, B766, D1752, D2000.

B. Design Criteria:
1. NFPA 12A, 13, 14, 15 and 2001 as applicable.

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. Methods of joining, welding, fastenings, and anchoring.
b. Materials and locations for wet standpipe, dry standpipe, sprinkler, clean agent suppression and external systems.
c. Pipes and piping layout, including pipe hangers and supports.
d. Pipe hangers and supports.

e. Valves.
f. Escutcheons.
g. Gauges.
h. Automatic air vents.
i. Pipe sleeves.
j. Mechanical couplings.
k. Layout of sprinkler and clean agent suppression systems and detail drawings approved by Fire Marshal of jurisdiction in which work is to be performed.
l. Reports covering test materials.

2. Certification:
   a. Fire line test results.
   b. Manufacturer's certification that pipe-joint gaskets and lubricants are satisfactory for use with pipe and fittings specified and that couplings are designed and tested as specified.
3. Operation and Maintenance Manuals.

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.

1.05 JOB CONDITIONS:

A. Do not perform welding when the temperature of the base metal is less than zero degree F.

B. Do not perform welding when surfaces are wet or during periods of high winds unless operator and work are properly protected.

1.06 OPERATION AND MAINTENANCE TRAINING:

A. Upon completion of installation and in accordance with the General Requirements furnish for a period of not less than one half man-days services of a manufacturer's field engineer with specialized experience in the components of the system to instruct Authority personnel in the proper operation and maintenance of the systems.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General Requirements:
   1. In design and purchase of equipment, provide for interchangeability of items of piping and electrical equipment sub-assemblies, parts and relays.

B. Pipe and Fittings:
   1. Underground fire-protection system:
      a. Ductile-iron pipe and fittings:
         1) Piping embedded or otherwise inaccessible: FS WW-P-421, Type III, Grade C, 250-pound pressure class.
         2) Piping from point of connection to inside of structure: FS WW-P-421, Grade C, 250-pound pressure class, flanged. Flanges: ANSI B16.1.
         3) Pipe coated on outside with bituminous coating and lined with cement mortar of twice standard thickness specified for pipe size used.
            a) Cement-mortar lining having seal coat of nontoxic, tasteless and odor-free bituminous material.
         4) Neoprene gaskets furnished for joints.

C. Above Ground dry standpipe piping
   1. Piping not embedded and otherwise accessible.
   2. Steel Pipe: ASME B36.10; Schedule 40 galvanized.
   3. 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.
   4. 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.

D. VALVES
   1. Hose Connection Valve: Angle type; [brass] [chrome plated] <_____> finish; 2-1/2 inch (65 mm) size, thread to match fire department hardware, 175psi working pressure, with threaded cap and chain of brass finish.

E. Fire Department Siamese Connection:
   1. Free standing:
      a. Paved areas: Double clapper, with sidewalk sleeve, sidewalk plate, two rocker-lug plugs and chains, polished brass, two female inlets with 2-1/2 inch American National Standard Fire Hose Threads, UL Fire Protection Directory listed or FM Approval Guide listed, working pressure of 200 psig and with cast recessed Type B Metro logo and inscription, as shown, except inside fenced Authority property.
   2. Wall-mounted: Double clapper rectangular wall plate for flush mounting, two rocker-lug plugs and chains, polished brass, two female inlets with 2-1/2 inch American National Standard Fire Hose Threads, UL Fire Protection Directory listed or FM Approval Guide listed, working pressure of 200 psig, and with cast raised Type B Metro logo and inscription as shown. Provide sill cock where necessary for drainage.

F. Sprinkler Test Connections:
   1. Drain piping, valves and fittings necessary for testing in accordance with listed NFPA Standards.

G. Supporting Devices:
   1. Pipe hangers and supports:
      a. Adjustable, stainless steel, clevis-type, threaded full length, with diameter consistent with pipe size and the load imposed: MSS SP-58.
      b. Hanger rods: 3/8-inch minimum diameter, stainless steel, ASTM A276,Type 304, threaded full length, with diameter consistent with pipe size and the load imposed: MSS SP-58.
      c. Nuts and washers: Stainless steel.
      d. Supported from stainless steel inserts in concrete slab: MSS SP-58.
   2. Adjustable U-bolt type:
      a. U-Bolt: Fabricated from stainless steel, MSS SP-58.
      b. Nuts and washers: Stainless steel..
      c. Chair: Cast iron or fabricated from stainless steel.
   3. Z-bar: Fabricated from stainless steel: ASTM A240, Type 304.
   4. Pipe anchors:
      a. Designed to withstand a minimum of five times anchor load.
      b. Vertical pipes anchored by means of clamps welded around pipes and secured to wall or floor construction.
   5. Expansion-bolt anchors:
      a. Consisting of bolt, expander, star lock washer and nut.
      b. Fabricated of stainless steel, Alloy S30300 in accordance with ASTM E527, including expander and star lock washer.
      c. Anchor assemblies: FS A-A-1992, Group II, Type 4, Class 1.

6. Self-drilling anchors:
    a. Self-drilling, expansion anchors with self-cutting annular broaching grooves.
    b. Anchor and expander plug: Double-plated, FS A-A-1992, Group III, Type 1.
7. Pipe sleeves:
    a. Through interior masonry-unit walls: PVC, as shown, large enough to accommodate pipe but minimum two sizes larger than pipe size.
    b. Through cast-in-place concrete interior walls and concrete ceilings: Factory-made cast iron with anchor flange and cast-iron plate collar screw-fastened to slab and pipe.
        1) Sleeves minimum two sizes larger than pipe; for floors and ceilings projecting four inches above finish floor.
    c. Through exterior structural elements: Minimum two sizes larger than pipe and as shown.
    d. Sleeves designed for pipe-movement allowance due to expansion and contraction.
8. Escutcheon plates:
    a. Polished brass or stainless steel, screw-fastened to wall or ceiling.
    b. Plate collars caulked with silicone sealant or intumescent putty.
    c. Sealant: UL-1479.

H. Bonding Strap: 2AWG single-conductor cable: Section 16060.

I. Preformed Joint Filler: ASTM D1752.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Fit equipment and appurtenances to space provided and make serviceable.

B. Provide support beams, concrete pads, platforms, and hangers necessary for proper installation of equipment as recommended by manufacturer.

C. Install complete fire-protection systems as shown and as specified. During installation, protect work, equipment, and materials. Plug or cap pipe openings.

D. Flush underground mains before connection to wet-standpipe risers at following minimum flow rates:
1. Six-inch pipe: 750 gpm.
2. Eight-inch: 1,000 gpm.
3. 10-inch pipe: 1,500 gpm.
4. 12-inch pipe: 2,000 gpm.

E. Fasten escutcheon plates to wall or ceiling. Seal plate collars watertight with mastic.

F. Steel-Pipe Installation:
1. Maintain OSHA required head clearance.
    a. Install horizontal piping with minimum pitch of one inch in 40 feet.
    b. Provide drains at low points: Minimum 3/4-inch valves with hose connection.
    c. Install vertical pipes near wall from which they are supported.
2. Make connections to equipment without placing strain on piping and equipment.
3. Tunnel, vent and fan-shaft piping:
    a. Joints of the following types:
        1) Butt weld joints in pipe recessed in tunnel lining.
        2) Use mechanical grooved couplings for remainder of joints in horizontal and vertical mains unless otherwise shown.
        3) Use threaded joints in branch lines 2-1/2 inches or smaller.

b. Provide number of mechanical couplings necessary to allow minimum 1-1/4 inch expansion per 100 feet of main.
c. Use reducing tee for mechanical couplings or mechanical branch outlet at main-to-branch connections.
d. Make in-line cut-off valves accessible from floor or walkway level.

G. Mechanical-Type Groove Couplings: Install couplings according to manufacturer's instructions and as follows:
1. After grooving, remove indentations, projections and roll warps as necessary. Cut pipe ends square to tolerance of plus-or-minus 0.03 inch. Provide zinc coating on exposed surface.
2. Lightly coat pipe ends and coupling gasket with non-petroleum-based lubricant.
3. Center gasket, install housing and ensure that keys are securely located in pipe grooves.
4. In underplatform station piping, provide separation of 1/8 inch between ends of adjacent sections of pipe within coupling, based on air temperature of plus 60F. Adjust based on actual air temperature at time of installation.
5. Install bolts and nuts tightened uniformly to manufacturer's recommended limits using torque wrench, without pinching gaskets.
6. Provide bonding across couplings for stray-current protection.

H. Pipe Sleeves: Fill annular space between pipe and sleeves with preformed joint filler, tightly placed to form effective seal against groundwater.

I. Bonding: In accordance with Section 16060, and with the following additional requirements:
1. Bond mechanical joints and fittings, including valves, by exothermic-welding method.
2. Make welds in accordance with manufacturer's recommendations. Clean and coat with coal-tar epoxy.
3. Bond pipe using bonding strap welded to each side of joint not less than six inches from joint. Allow sufficient slack in conductor for expansion of pipe.

3.02 PROTECTION OF PIPING AND EQUIPMENT:

A. Protect pipe, openings and valves from dirt, foreign objects and damage during construction.

B. Replace damaged piping, valves and other appurtenances, should damage occur prior to final acceptance of the work.

3.03 FIELD QUALITY CONTROL:

A. Field Tests:
1. Flush piping with water until clean and free of scale, slag, dirt, oil, grease and other foreign material.
2. Perform final testing, acceptance, and certification in accordance with NFPA 13, 14, and 24, as applicable.
3. Test electrical continuity of bonded joints by measuring resistance. Total resistive value of joint not to exceed calculated resistance of bond cable plus 10 percent.

B. Water-Pressure Testing:
1. In the presence of the Engineer, test piping, prior to burial or concealment, using specified procedures specified.
2. In the presence of the Engineer, completely test piping system for leaks until approved.
3. Notify the Engineer at least 36 hours prior to tests.
4. Test piping at the following pressures:
a. Fire-protection piping, inaccessible: 400 psi-minimum.

b. Ductile-iron pipe: At lowest point in system, 150 psi or 1-1/2 times maximum working pressure, whichever is greater.
c. Fire-protection piping, exposed and accessible: At lowest point in system, 150 psi or 1-1/2 times maximum working pressure, whichever is greater.

C. Test Procedures:
1. Test fire-protection piping in accordance with NFPA.
2. Fire-protection piping, inaccessible:
a. Avoid excessive pressure on safety devices and mechanical seals.
b. Fill entire system with water and vent air from system at least 24 hours before test pressure is applied.
c. Apply test pressure when water and average ambient temperature are approximately equal and constant.
d. Maintain test pressure for six hours minimum without drop after force pump has been disconnected.
3. Water-test entire system with pressure at highest point of 250 psig.
4. After filling system, shut off water supply and allow it to stand for two hours under test without loss or leakage.
5. Coordinate with and assist local fire department and/or WMATA in performing flow tests. After performing hydrostatic test, drain water from firelines. Perform flow test at rate of 500 gpm with pumper connected to siamese connection, starting testing with sudden full flow into empty firelines.
6. Drain system immediately after hydrostatic and flow testing.

D. Repair of Leaks:
1. The following are prohibited:
a. Repair of leaks by mechanical caulking.
b. Introduction of material inside piping system to stop leakage.
2. Repair leaks in threaded piping by breaking joint, cutting new threads on pipe and installing new pipe fitting.
3. Coat field welds and repair damages to zinc-coated surfaces as follows:
a. Wire brush areas to be coated to bright metal.
b. Apply galvanizing repair compound at rate of two ounces per square foot.
4. Replace defective coupling assembly as necessary.
5. Remove defective welds by chipping or gouging.
a. Reweld the chipped-out places.
b. When base metals of fillet welds are cut back or throat of welds are less than specified, repair defect by adding additional weld metal.

3.04 CLEANING:

A. Flush firelines with water to remove sediment after completion of tests, repairs or replacements.

B. Disinfect firelines connected to potable-water system as follows:
1. Use chlorine for disinfection in form of hypochlorite solution or in form of compressed gas applied through approved chlorinator.
2. Operate valves and equipment during chlorination to ensure that chlorine reaches entire system.
3. Feed water and chlorination agent into system at rate providing for 50 ppm of chlorine and allow to stand 24 hours before flushing.
4. Residual chlorine, at end of 24-hour retention period, not less than 10 ppm.
5. Flush treated water from system completely after disinfection.
6. Continue flushing until samples show that quality of water delivered is comparable to public water supply and satisfactory to public-health authority having jurisdiction.
7. Do not take samples from hydrants or through unsterilized hose.

3.05 IDENTIFICATION OF PIPING AND VALVES: Section 15075.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 15075

IDENTIFICATION OF MECHANICAL EQUIPMENT AND PIPING

PART 1 - GENERAL

1.01 DESCRIPTION:

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

B. Related work specified elsewhere:
   1. Field Painting – Section 09920

1.02 REFERENCE STANDARDS:

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

1.03 SUBMITTALS:

A. See Procurement Documents for submittal procedures.

B. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Samples:
      a. Labels and tags in each size.
   2. Documentation:
      a. Charts for valves; include valve identification number, location and purpose.

C. 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.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. Nameplates: Laminated plastic.

B. Tags: 18-gauge stainless steel.

C. Identification Plates: Bronze, Contractor-furnished.

PART 3 - EXECUTION

3.01 IDENTIFICATION:

A. Piping:
   1. Stencil legends and bands on piping showing service and direction of flow.

3.02 INSTALLATION:

A. Cement nameplates with permanent adhesive on equipment and apparatus.

B. Affix labels to surface of control and switch boxes by means of sheet-metal rivets. Cement labels to surface with permanent adhesive when rivets cannot be used.

C. Fasten tags securely to valves, orifice flange, venturi tube with brass jack chain, so as to permit easy reading.

D. Mount valve charts in aluminum frames with clear Lucite front cover in locations as directed.

E. Fire-Protection and Suppression System:
   1. Stencil legends on piping as shown to identify service and direction of flow.
   2. Stencil vent-shaft and fan-shaft identification as shown on piping adjacent to angle hose valves in tunnels.
   3. Stamp information on Authority-furnished identification plates as shown and fasten to sleeve on siamese fire-department connections for tunnel systems as shown.

END OF SECTION

SECTION 15205

PIPING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing piping, fittings, valves, drains, specialties and supporting devices.

B. Related Work Specified Elsewhere:

1. Fire Protection, Suppression, and Alarm: Section 13905
2. Identification of mechanical equipment and piping: Section 15075.
3. Grounding and bonding: Section 16060.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. The Model Plumbing Code.
3. ASSE Standards.
4. AWWA Standards.
5. ASME Code for Unfired Pressure Vessels.
6. ANSI/ASME: A21.15/C115, B16.1, B16.3, B16.5, B16.9, B16.11, B16.18, B16.22, B16.39, B31.1, Z21.22.
7. ANSI/AWS: A5.8, E8016, E8018.
8. CISPI: HSN 85.
9. FS: A-A-1192, SS-C-153C, WW-P-51F, WW-P-460D, WW-P-501, WW-U-516B, WW-U-531, WW-V-51F.
10. MSS: SP-58, SP-67, SP-70, SP-80.
11. PDI: WH-201.
12. ASTM: A53, A74, A105, A126, A234, A276, A395, A536, B32, B61, B62, B88, B150, B280, B306, F709.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Shop Drawings:
a. Complete catalog information and shop drawings for material and equipment.
b. Submittals include, but are not limited to, the following:
1) Pipes and piping layout, including locations of hangers and supports.
2) Pipe hangers and supports.
3) Cleanout deck plates and wall plates.
4) Escutcheons.
5) Expansion anchors.
6) Pipe sleeves.
7) Drains.

2. Certification:

a. Certificates from manufacturers verifying the following:
   1) That pipe-joint gaskets and lubricants are satisfactory for use with pipe and fittings specified.
   2) That expansion joints are designed and tested as specified.

1.04 JOB CONDITIONS:

A. Do not perform welding when the temperature of base metal is less than zero degree F.

B. Do not perform welding when surfaces are wet from rain, snow, ice or during periods of high wind unless operator and work are properly protected.

PART 2 – PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. General Requirements:
   1. In design and purchase of equipment, provide for interchangeability of items of piping equipment, subassemblies and parts.

B. Piping:
   1. Hub and spigot, cast-iron soil pipe and fittings
      a. Pipe and Fittings: ASTM A 74, service classes.
      b. Gaskets: ASTM C 564, rubber
      c. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.
   2. Hubless, cast-iron soil pipe and fittings
      a. Pipe and fittings: ASTM A 888 or CISPI 301
      b. CISPI, hubless-piping couplings
      c. Standards: ASTM C 1277 and CISPI 310.
      d. Description: Stainless-steel corrugated shield with stainless-steel bands and lightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
   3. Cast Iron, Hubless-Piping Couplings
      a. Standard: ASTM C 1277.
      b. Description: Two piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and AST< C 564, rubber sleeve with integral, center pipe stop.
   4. Galvanized Steel Pipe and Fittings
      a. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight. Include square-cut-grooved or threaded ends matching joining method.
      b. Galvanized Cast-Iron Drainage Fittings: ASME B16.12 threaded.
      c. Cast-Iron Flanges: ASME B16.1, Class 125
         1) Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2 mm) maximum thickness unless thickness or specific material is indicated.
         2) Flange bolts and nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
      d. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances
         1) Galvanized, Grooved-end fittings for galvanized-steel piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged-steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
         2) Grooved mechanical couplings for galvanized-steel piping: ASTM F 1476, Type 1. Includes ferrous housing sections with continuous

curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

5. Glass Fiber Reinforced Pipe (for exposed drainage piping in the subway tunnel):
    a. The structural wall of fiberglass pipe shall have continuous glass fibers in a matrix of aromatic amine cured epoxy resin.
    b. The integral, reinforced resin-rich liner shall consist of C-glass and a resin/hardener system identical to that of the structural wall, and shall have a 20 mil nominal thickness. Non-reinforced pure resin-type corrosion barriers (liners) shall not be allowed due to their potential for severe fracturing during transportation, installation and operation of the pipe.
    c. Pipe in 1 through 16-inch sizes shall be rated for a minimum of 165 psig at 250°F. In 1 through 6-inch sizes the pipe shall have full vacuum capability at 70°F, when installed above ground with a safety factor of 3:1.
    d. Pipe shall be manufactured according to ASTM D2996 specification for filament wound Reinforced Thermosetting Resin Pipe (RTRP). When classified under ASTM D2310, the pipe shall meet Type 1, Grade 1 and Class F (RTRP-11FE or W) cell limits in 1 through 16-inch nominal pipe sizes.
    e. Filament-wound epoxy fiberglass pipe shall be translucent to allow for inspection of damage.
    f. Pipe in 2 through 8-inch sizes shall be furnished in 30 or 40-ft. length to minimize the number of field-bonded joints for rapid installation.
    g. Fittings:
        1) Adhesive bonded tapered bell and spigot.
        2) Fittings in 1 through 16-inch sizes shall be filament wound with a reinforced resin rich liner of 50 mil minimum thickness and of the same glass and resin type as the pipe. Pipe, filament-wound fittings and adhesive shall, as an assembly, provide a continuous liner throughout the system.
        3) Contact-molded, spray-up or hand-layup fittings shall not be allowed. Pipe and fittings shall be joined using a straight spigot by socket with a 0.5° taper angle and a pipe stop inside the socket to allow precise makeup.
6. Polyvinyl Chloride (PVC) pipe and fittings:
    a. Solid-Wall PVC pipe: ASTM D 2665, drain, waste and vent.
    b. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 80 pipe.
    c. Adhesive Primer: ASTM F 656
        1) Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    d. Solvent Cement: ASTM D 2564
        1) PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59 Subpart D (EPA Method 24).
7. Unions:
    a. 1-1/2 inch and smaller: Threaded, ASME B16.39, Type A or B to match piping.
    b. Two inch and larger unions: ASTM A126, Class B, flanged.
        1) Two, 2-1/2 and three-inch union flanges: Steel, FS WW-U-531 or of cast iron, ANSI/ASME B16.1, 125-pound class.
    c. Four inch and larger union: Forged steel, 150-pound class, slip-on weld-neck flanges, ANSI/ASME B16.5.
    d. Nonferrous-piping unions: Brass, FS WW-U-516B.
    e. Unions of Cast Iron pipe to PVC pipe
        1) Manufacturers: Fernco coupling or approved equal.
8. Cleanouts:

a. For cast-iron bell-and-spigot pipe: SVCI, ferrule caulked into cast-iron fittings and extra-heavy brass tapered screw plug with recessed head.
b. For wrought-iron pipe: Extra-heavy brass plug in drainage fitting.
c. Except for test openings, cleanout plugs for pipes up to four inches to be same size as pipe.
d. On pipe sizes five inches and larger, cleanout plugs to be of four inches and pipe reduced to plug size with bushing.

9. Modular Seals:
a. Provide Link-Seal or approved equal.
1) Rated at minimum of 20 psig (40 feet of head)
2) Two-part zinc dichromate and corrosion inhibiting coating
b. Fernco Coupling
1) Positive seal against infiltration and exfiltration
2) Leakproof, rotproof, and resistant to chemicals, ultraviolet rays, fungus growth, and normal sewer gasses.
3) Corrosion-resistant, rustproof stainless steel clamps

C. Supporting Devices:
1. Pipe hangers and supports:
a. Provide adjustable steel pipe hangers and supports as follows:
1) Clevis and clamp, cadmium-plated or zinc-plated: MSS SP-58, Type 1 and Type 8 for steel and cast-iron piping.
2) With cast-iron roller and sockets: MSS SP-58, Type 41 for chilled-water piping.
3) Space not greater than six feet for pipe sizes up to and including 1-1/2 inches; 10 feet for pipe sizes two inches through six inches; 16 feet for pipe sizes eight inches and larger
b. Hanger rods minimum diameter 3/8 inch, constructed of steel, cadmium-plated, threaded full-length and diameter required by pipe size and load imposed.
c. Hanger rod nuts and washers: Steel, cadmium-plated.
d. Supported from malleable-iron, hot-dip galvanized inserts in concrete slab: MSS SP-58, Type 18.
e. Pipe hangers and supports in tunnels and shafts: MSS-SP-58, stainless steel, ASTM A276, Type 304.
2. Pipe anchors:
a. Designed to withstand five times anchor load minimum.
b. Vertical pipes anchored by means of clamps welded around pipes and secured to wall or floor construction.
3. Expansion bolt anchors:
a. Consisting of bolt, expander, star lock washer and nut.
b. Fabricated of stainless steel, Type 303, including expander and star lock washer.
c. Anchor assemblies: FS: A-A-1992, Group II, Type 4, Class 1.
4. Self-drilling anchors:
a. Self-drilling expansion anchors, with self-cutting annular broaching grooves.
b. Anchor and expander plug: FS: A-A-1992, Group III, Type 1, double-plated.

5. Pipe sleeves:
a. Through exterior structural elements: Minimum two sizes larger than pipe and as shown.
b. Sleeves designed to allow expansion/contraction movement of pipe.

D. Drains:
1. Roof drains:

a. Cast iron having integral flange and a clamping device for securing the roof covering to make a watertight connection.
b. Drains for promenade roofs with removable, loose-set, round flat grate in square frame secured to non-puncturing flashing clamp collar with weep holes and for two inch or more roof fill.
c. Other roof drains furnished with cast-iron beehive or dome-shaped strainer.
d. Openings in each strainer having a combined-area minimum twice the area of drain outlet.
e. Each drain outlet having same size as downspout and with parts to make watertight connection to threaded pipe or cast-iron pipe as required.
f. Meeting requirements shown.

2. Canopy drains (Roof Drain - Type 5):
   a. Ductile iron: ASTM A536, Grade 65-45-12.
   b. 30 square inches minimum grate free area.
   c. Removable gratings, contoured to match opening in concrete rib and as shown.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Pipe Anchors:
   1. Securely anchor piping where shown and where necessary for proper installation to force pipe expansion in proper direction.

B. Expansion-Bolt Anchors:
   1. Drill holes and install expansion-bolt anchors as recommended by anchor-bolt manufacturer. Do not locate less than eight inches from concrete edge.

C. Pipe Sleeves:
   1. Exterior walls:
      a. Install as shown.
      b. For cathodically protected pipe, test in accordance with Section 13115.
   2. Interior walls:
      a. Install as shown. Seal to maintain integrity of walls.

D. Attachments to Prestressed-Concrete Girders:
   1. Attach pipes and similar items to prestressed girders by welding to embedded plates or bolting to embedded fittings. Drilling into prestressed girders is prohibited, except as shown.

E. Bonding: In accordance with Section 16060, and with the following additional requirements:
   1. Bond mechanical joints and fittings, including valves, by exothermic-welding method.
   2. Make welds in accordance with recommendations of the manufacturer. Clean and coat with coal tar epoxy.
   3. Bond pipe using bonding strap welded to each side of joint not less than six inches from joint. Allow sufficient slack in conductor for expansion of pipe.

F. Drains:
   1. Install floor drains with traps.

3.02 PROTECTION OF PIPING AND EQUIPMENT:

A. Protect pipe, openings, valves and fixtures from dirt, foreign objects and damage during construction.

B. Replace damaged piping, valves, fixtures and appurtenances.

C. Prior to testing, flush piping with chemically treated water until systems are clean and free of scale, slag, dirt, oil, grease and other foreign material.

D. Hand-clean expansion joints and strainers.

E. Coal-Tar Epoxy Coating for Protection of Ferrous Piping: Apply as specified in Section 02535 and test as specified in Section 13115.

3.03 FIELD QUALITY CONTROL:

A. Water-Pressure Testing:
1. Prior to burial or concealment, test affected piping in presence of the Engineer using specified procedures.
2. Test entire piping systems and test until found leak-free in presence of and to satisfaction of the Engineer.
3. Notify the Authority at least 36 hours in advance of making tests.
4. Test piping at following pressures:
a. Soil, waste and vent piping: Requirements of local plumbing code but not less than equivalent to ten feet of water.

B. Test Procedures:
1. Soil, waste and vent piping:
a. Water test to include entire system from lowest point to highest point.
b. After filling system, shut off water supply and allow it to stand two hours without loss or leakage.
c. Conduct final test by smoke test or peppermint test as prescribed by jurisdictional authority.

C. Repair of Leaks:
1. Do not repair by mechanical caulking leaks in threads or welds occurring while pipeline is under test or in service.
2. Introduction into piping system of material intended to stop leakage is prohibited.
3. Repair leaks in threaded piping by breaking joint, cutting new threads on pipe and installing new pipe fitting.

4. Remove defective welds by chipping or gas gouging from one or both sides of joint.
a. Reweld chipped-out places.
b. When base metals of fillet-weld are cut back or throat of weld is less than specified, repair defect by adding additional weld metal.

3.04 DISINFECTION:

A. Adjust and Clean:
1. Flush entire hot and cold-water piping and other piping and equipment connected downstream from the domestic-water inlet main shutoff valve with water to remove sediment after completion of tests, replacements or repairs.
a. Use chlorine for disinfection in form of hypochlorite solution or in form of compressed gas applied through approved chlorinator.
b. Operate valves and equipment during chlorination to ensure that chlorine reaches entire system.

c. Feed water and chlorination agent into system at rate providing for 50 ppm of chlorine and allow to stand 24 hours before flushing.
d. Residual chlorine at end of 24-hour retention period: Two-ppm minimum.

2. Flush treated water from system completely after disinfection.
3. Continue flushing until samples show that quality of water delivered is comparable with public water supply and satisfactory to jurisdictional public-health authority.
4. Do not take samples from hydrants or through unsterilized hose.

3.05 FIELD PAINTING:

A. Paint exposed soil and waste pipe lines in accordance with Section 09920.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 16052

BASIC MATERIALS AND METHODS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SUMMARY

The scope includes furnishing and installing basic materials.

A. Related Sections:
1. Section 16051 – Electrical Scope of Work
2. Section 16060 – Grounding And Bonding
3. Section 16120 – Wire, Cable and Busways.
4. Section 16125 – Wire Connection Accessories
5. Section 16130 – Raceways, Boxes, and Cabinets
6. Section 16145 – Wiring And Control Devices
7. Section 16440 – Circuit Breakers, Panelboards And Load Centers
8. Section 16525 – Lighting Fixtures And Mounting Poles
9. Section 16565 – Flasher And Dimmer Control System

B. Compensation for work specified in this section will be made in the following manner:
1. Basic Materials: Lump Sum.
2. Installation: Lump Sum.
3. Additional Work: Work not included in lump sum price but required to complete work, such as replacement of cables that did not pass testing, shall be based on Unit Price Schedule.

1.02 REFERENCES

A. Codes, Regulations, Reference Standards and Specifications:
1. Codes and regulations of jurisdictional authorities
a. NEC
b. NFPA 130
c. UL: 6, 50, 67, 94, 198D, 224, 360, 486, 489, 496, 508, 514, 651, 870, 1029, 1572
d. ASTM: A36, A47, A123, A153, A325, A386, A500, A507, A523, A525, A532, A536, B138, B187,
B633, D149, D150, D257, D412, D495, D570, D638, D648, D696, D790, D792, D1000, D1056,
D1518, D1682, D1784, D2240, D2583, E84, F593, F594, G21, G235
e. ANSI: C80.1, C80.5, Z55.1, A14.1, B18.21.1, C119.1
f. NEMA: VE1, AB1, PB1,CC1, ST-20, FG-1, 250
g. FS: TT-S-227, FF-S-760, FF-S-325,
h. ACI: 318
i. MS: MIL-I-23053/15Xxxxx

1.03 SUBMITTALS

A. Submit the following for review in accordance with the instructions elsewhere in this Specification and with the additional requirements as specified for each:
1. Shop Drawings: Shop drawings for complete ETS Enclosure including all devices and components, ETS light fixture and remote ballast, ETS relay cabinet, panelboards, fiberglass panels, wire, cable, and supports.
2. Certification: Certificates from manufacturers verifying that equipment furnished conforms to the specified requirements.
3. Product Data: Manufacturer's product data for all materials.
4. Samples: ETS enclosure and light fixture, one of each size nameplate, tags, wire labels, cable supports and clamps, and danger markers.

1.04 QUALITY ASSURANCE

A. Qualifications: Select manufacturers who are regularly engaged in production of specified materials. Select installation contractors who are regularly engaged in the installation of specified materials.

B. For Codes, Regulations, Reference Standards and Specifications, refer to Article above.

C. 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.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Mark each item in accordance with applicable reference standard.

B. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage.

C. Store products in secure and dry storage facility.

2.01 EQUIPMENT

A. Conduit, Boxes, Cabinets and Fittings: Spec section 16130.

B. ETS Enclosures:

a. Enclosure: Nonventilated, single-door fiberglass enclosure NEMA 250, Type 3R, with mounting brackets as shown, complying with applicable requirements of UL 508.

1) Molded fiberglass reinforced polyester material 1/8 inch thickness, minimum, and in accordance with the following:

PhysicalProperties	Value	Method
Flexural Strength	17,000 PSI	ASTM D790
Deflection Temp	400F	ASTM D648
Water Absorption (24 hours)	0.5%	ASTM D570
Tensile Strength	6,500 PSI	ASTM D638
Specific Gravity	1.8	ASTM D792
Flammability	V-O	UL94
Dielectric Strength	400 Volts/Mil	ASTM D149
Arc Resistance	180 Sec	ASTM D495

2) Gasket: Oil-resistant 100 percent neoprene by polymer content, ASTM-D1056 grade SCE-42 with oil-resistant adhesive.

3) Piano hinges: Stainless Steel, one inch wide by 1-3/4 inches high with model pins and fasteners, two per enclosure.

4) Door handle: T-handle, One half turn, Vise Action Type, die cast zinc, matte black, polyester powder finish with stainless steel hardware, SOUTHCO catalog No. E3-10-105-50 or equal.

5) Panels, back plates, barriers and brackets: 10 gauge stainless steel as shown.

6) Hardware: Stainless steel bolts, nuts and screws; ASTM F593, size as shown.
7) For ultra-violet protection of fiberglass box, the material shall material shall contain ultra-violet inhibitor on inside and outside surfaces coated with polyurethane paint, 1.5 mils minimum dry film thickness.
8) Color: Fiberglass material, gray inside and out.
9) Open/Close Decal: Pressure sensitive weatherproof, vinyl tape with 1/4" high red on a white background. “OPEN” shall have red letters, “CLOSE” shall have green letters.
10) Nameplates: Each ETS Enclosure provided with three-ply laminated plastic, multi-layered nameplates inscribed with 1-inch lettering identifying the ETS Box Number, Supervisory Control Identification Nos. of the dc breakers being tripped. A typical example of engraving is as follows:
    a. EMERGENCY TRIP SWITCH NO.
    b. E-F07-31
    c. E-F08-41

b. Emergency pushbutton: Provide on the backplate, mushroom head trip switch with 4 NC poles similar to Square-D Cat. No. 9001-4-KA-3 with head No. 9001-KR-5R.
c. Terminal block: Provide on the backplate one 12-point terminal board similar to GE Cat. No. CR151B2 or equal.

2. ETS Relay Cabinets:
    a. Wall mounted, single door, NEMA 250, type 12, with enclosure and back panel similar to Hoffman Engineering Company or equal, as shown.
    b. Enclosure formed of minimum 14-gauge steel with sufficient structural reinforcements to ensure a plane surface, to limit vibration and to provide sufficient rigidity during shipment, installation and operation. A print pocket shall be attached to the inside of the door of enclosure.
    c. Door formed of minimum 14 gauge steel with rolled lip formed along top and sides to mate with enclosure. Provided with hasp and staple for padlocking.
    d. Back panel formed of minimum 12 gauge steel.
    e. Relays and Terminal Blocks: The cabinet shall have mounted on its back panel auxiliary relays of hinged armature construction, 125V dc rated coil and electrically held, self reset type with 2 NO and 4 NC contacts similar to GE Catalog No. 12HFA51A42H code No. 24 contact arrangement or equal. Terminal blocks with cover similar to GE Type EB shall be mounted on back panel. Quantity of relays and points on terminal blocks as shown.
    f. Name Plates and Wire Labels: In accordance with Article 2.02.C.

C. Nameplates, Tags and Wire Labels:
1. Nameplates:
    a. Three-ply, laminated phenolic plates, engraved through black face to white core, attached by stainless steel rivets or screws.
    b. Lettering: Vertical gothic using round or square cutter. V-shape groove is prohibited.
    c. Size: One-inch high with 1/2-inch high lettering.
2. Conduit and Cable Tags: Stainless steel, round, punched with cable or conduit number as shown.
3. Wire labels: Sleeve-type, heat shrinkable, flame retardant Raychem TMS product line, Type XPE or equal and conforming to UL224. Wire identification same as corresponding terminal block identification unless otherwise shown. The labels on 1000 KCMIL cable shall be clear, heat shrinkable with 1/2" height yellow lettering stamped on inside. The labels shall have reference of substation or tie-breaker

station breaker Supervisory Control ID number and cable sequence in the branch of the feeder (e.g. BRK. 32-A) at both ends.

D. Emergency Trip Station Light Fixture Type 9.
   1. Lighting Fixture: LED hazardous location warning light; model and manufacturer as specified.

2.02 ACCESSORIES:

A. Wire Connection Accessories: Spec section 16125.

B. Terminal blocks:
   1. Barriered, screw type equipped with washer head binding screws, white marking strips for terminal identifications and hinged covers; unless otherwise shown or specified.
   2. Rated 600 volts, 30 amperes per point and designed to accommodate wire sizes 19 AWG through 10 AWG inclusive.

C. Exothermic mold kit, consisting of mold and handle and Exothermic Weld Cartridge:
   1. Exothermic weld mold for making #4 AWG cable connections to the base of the composite contact rail. Erico part No. PB10QTIL84C or equal.
   2. Exothermic weld mold for making #4 cable connections to the neutral axis of the running rail, Erico part No. PB13STIL or equal.
   3. Mold handle for holding the exothermic mold to the composite contact rail and the running rail. Erico part No. PBL160 or equal.
   4. Exothermic Weld Cartridge: Consisting of welding powder, steel discs and packing material required to make an exothermic weld of #4 AWG cable to the composite contact rail and running rail. Erico part No. PB65 or equal.

D. Heat-shrinkable tubing: UL-approved, flame retardant, corrosion resistant thick wall tubing with factory-applied sealant for field insulation on inline splices and taps or wraparound type sleeve for retrofit installation on existing splices and taps to provide a watertight seal and insulating encapsulation, with the following additional properties:
   1. Material: Cross-linked polyolefin.
   2. Shrink ratio: 3 to 1 (min.)
   3. Physical properties:

Ultimate tensile strength	2350 psi	ASTM D412
Hardness, Shore D	42	ASTM 2240
Water absorption Method 6.1	0.05%	ASTM D570
Specific gravity	1.28	ASTM D792

   4. Electrical properties:
      a. Dielectric strength 450 volts ASTMD149 per mil
      b. Volume resistivity 1 x 1014 ASTMD 257 ohm cm
   5. Thermal properties:
      a. Continuous operating temp. -55C to +135C
      b. Air oven aging (7 days @ 175C):
      c. Tensile strength 2680 psi
      d. Elongation 375 %
      e. Low temp. flexibility. No cracking (4 hours @ -55C) when flexed

f. Heat shock (4 hours No cracking, @ 225C) flowing or dripping

6. Chemical properties:
   a. Corrositivity Non-corrosive MIL-I-23053/15
   b. Fungus resistance Non-nutrient ASTM G21

E. Nuts, Bolts, U-Bolts and Miscellaneous Hardware.
   1. Material
      a. All nuts, bolts, u-bolts and washers for outdoor locations including tunnels shall be Type 316 stainless steel in accordance with ASTM F593 and F594.
      b. All nuts, bolts, and flat washers for indoor locations in TBS and TPS shall be galvanized steel in accordance with ASTM A325.
      c. The dimensional data and type hardware for all nuts, bolts and miscellaneous parts shall be shown and specified; where not shown as recommended by the manufacturer.
   2. Galvanizing
      a. All parts to be galvanized shall be galvanized after manufacture. Unless otherwise specified, parts to be galvanized shall be coated in accordance with the requirements of ASTM A123. Bolts and miscellaneous hardware shown or specified to be galvanized shall be coated in accordance with ASTM A153 or alternate method in accordance with ASTM B633

F. Structural Steel Shapes:
   1. Shapes, plates and bars: ASTM A36.
   2. Structural tube: ASTM A500, Grade A, hot-dip galvanized.
   3. Galvanizing: Hot-dip galvanized after fabrication in accordance with ASTM A123, zinc coating weight two ounces per square foot, minimum.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install generally as shown and in accordance with approved shop drawings, the NEC and jurisdictional agencies.

B. Conduit, Boxes, Cabinets and Fittings:
   1. General:
      a. Use size, type, general routing, location of conduit, raceways, boxes and cabinets as shown and specified.
      b. Install metallic raceway, fittings, boxes and cabinets free from contact with reinforcing steel.
      c. Where aluminum is placed in contact with dissimilar metal or with concrete, separate contact surfaces by means of gasket, non-absorptive tape or coating to prevent corrosion.
      d. Unless specified or shown otherwise, make metallic conduit, raceways, and cable trays, electrically and mechanically continuous, and grounded in accordance with NEC and as shown.
   2. Conduit:
      a. Run exposed conduit parallel to building lines.
      b. Install exposed conduit to avoid interference with other work.
         1) Where shown and as necessary, install cable seal in accordance with the manufacturer's recommendation.
         2) Use sealing compound where approved and in accordance with manufacturer's recommendations, with the following additional requirements:

i. Before applying sealing compound, prime conduit and cable surface using primer recommended by the manufacturer.
ii. Pour or inject compound to prevent voids inside seal and to keep cable centered in conduit.

3) In empty conduit installed for future use, install blank cable seal inside conduit to prevent seepage of water.
4) Ensure conduits are free of water before conduit seals are installed.

c. Apply lead-free conductive anti-seize compound to threaded conduit joints.
d. For outdoor locations use threaded conduit hub to attach conduit to equipment enclosure. Use watertight conduit fitting for attachment of conduit to enclosure having punched or formed knockout.
e. For indoor locations use locknut and nylon-insulated bushing to attach conduit to enclosure.
f. Install suitable caps or plugs in empty conduit for future extension.
g. Thread and ream ends of field-cut conduit to remove rough edges. Use bushing at conduit entrance to boxes, cabinets and equipment enclosures.
h. Bends:
1) Unless otherwise shown or specified, install conduit bends in accordance with reference codes.
2) Bend conduit so that field made bend is free from cuts, dents and other surface damage and does not reduce cross-sectional area of conduit.
i. Support horizontal conduit 1-1/2 inches and smaller with one-hole pipe straps or individual pipe hangers.
j. Support horizontal conduit larger than 1-1/2 inches with individual pipe hangers.
k. Spring steel fasteners, clips or clamps specifically designed for supporting exposed single conduits may be used in lieu of pipe straps or pipe hangers. Use 1/4 inch minimum diameter galvanized steel rods for hanger rods with spring steel fasteners, clips and clamps.
l. Secure conduit supported on multi-hangers (trapeze) or channel inserts by fasteners suitable for such purpose.
m. Where conduit is attached to masonry surface, use malleable iron spacers with Style A pipe straps.
n. Support and secure vertical conduit spanning open areas at intervals not exceeding 10 feet.
o. Install conduit so as to drain moisture to nearest outlet or pull box.
p. Use only metallic conduit in exposed locations in tunnels and buildings.
q. Ensure waterproof conduit connection where conduit is installed in outdoor locations.
r. Use Schedule 80 PVC conduit for cable which is buried directly in ballast or at trackside locations for contact rail heater segment jumper cables.
s. Install expansion fittings in exposed conduit runs longer than 300 feet.
t. Use metallic conduit routed between control cable trays and equipment enclosures.

3. Channel Inserts and Spot Inserts:
a. Mount outlet boxes.
b. Keep number of knock-outs to minimum.
c. Clean boxes thoroughly after installation and correct damage to boxes and to finish.
d. Install covers on boxes mounted on walls and ceilings.
e. Install junction and pull boxes so that covers are readily accessible.

4. Cabinets:
a. Fasten cabinets using expansion bolts, toggle bolts or mounting ears.

b. Touch-up damaged painted finish.

5. Fasteners:
   a. Fasten equipment and devices to concrete surfaces with lag screw shields, cinch anchors, expansion bolt anchors or lead jacketed tamp-in inserts. Use bolt sizes providing a safety factor of 2.5.
   b. Fasten equipment and devices to concrete masonry units with toggle bolts.
   c. Fasten equipment, devices and supports to structural steel with beam clamps, welded studs or drilled and tapped holes no greater than 1/4 inch diameter.
6. ETS Relay Cabinet:
   a. Install as shown. Wall-mounted and fixed by expansion bolt anchors or toggle-bolts.
   b. Terminate all wires as shown, including spares.
   c. Ground DTS and ETS relay cabinets.
7. ETS Enclosures:
   a. Install as shown.
8. ETS lighting fixtures:
   a. Install as shown.
9. Filling of openings:
   a. Where conduit and raceway (including cable tray and bus duct) pass through fire-rated walls, ceilings or floors, provide approved firestops to prevent passage of fire and fumes and to maintain integrity of fire-rated structure.
   b. Close unused openings or spaces in floors, walls and ceilings. Plug or cap unused conduit and sleeves.
   c. Seal unused traction power conduits in ductbank at both ends using OZ Gedney CSBE seals or equal.
10. Cleaning of raceways:
    a. Rod and swab raceways and duct6s through which cables are to be installed. Use a mandrel with an outside diameter 3/8-inch less than the inside diameter of the duct and remove all obstructions. Install a non-metallic pull line fish wire, as approved by the Engineer in each raceway or duct immediately after rodding and swabbing and, unless cables are pulled immediately.
    b. The Contractor shall be responsible for the dewatering and removal of all dirt, rocks, track ballasts and trash from trenches, pipe, manholes, pull chambers, cable trough, surface trench, conduit and ductbank prior to and during the installation of cable, at no additional cost to the Authority.
11. Cable Troughs:
    a. Remove the trough covers, install wire and cables and reinstall the trough covers.
    b. The Contractor is specifically warned of the following conditions and potential problems with the track right-of-way cable troughs:
       1) The covers for these troughs are not of uniform length and locations of drill holes, i.e., each cover section must be replaced on the trough section from where it was removed.
    c. Apply anti-corrosion joint compound to connectors, terminal lugs and bolting pads before installation. Install lockwasher under each bolt head and nut.
    d. Install terminal fittings on multiple-conductor cable in accordance with manufacturer's recommendation. Completely seal cable from moisture.
    e. Attach contact rail cable connector assembly compression connectors to the cable with manufacturer's recommended tooling. Install a lockwasher under the head of each bolt and under each nut when bolting tongues together. Tighten bolted connections to a uniform torque of 450 inch-pounds.
    f. Prior to assembly of contact rail cable terminal lugs to composite contact rail, coat mating services with oxide-inhibiting paste, NO-OX-ID, Dearborn

Chemical, or equal. Coat all interfaces of the compression fasteners. Fasten terminal lugs to the composite compact rail using methods and equipment recommended by the rail manufacturer.

12. Exothermic Welded Connections: Make connections using exothermic mold kit and cartridge in accordance with the manufacturer's recommendations. Remove all extraneous weld metal and test connection for mechanical strength by striking twice with a two-pound hammer.
    a. The splicing of power and control cables is not permitted in manholes, ductbanks and cable troughs. However, if permitted by the Engineer, make water tight splices as approved.

C. Nameplates, Tags and Wire Labels:
    1. Nameplates: Attach nameplates to all panelboards, DTS cabinets, remove control and monitoring cabinet, ETS enclosures and ETS relay cabinets.
    2. Cable Tags: Attach cable tags to each cable at all pull boxes, manholes and terminations.
    3. Wire labels: Attach wire labels at all control, annunciation and supervisory wiring at each terminal point. Attach label to a clean, dry section of wire as close as possible to the terminal point.

3.02 FIELD QUALITY CONTROL

A. Submit test procedure for approval and perform approved tests. Do not perform tests without approved test procedure. Schedule tests through the Engineer with minimum of 14 days prior notice. Furnish the necessary equipment and perform the following tests:
    1. Test metallic conduit and boxes for electrical continuity.
    2. Load Centers: Perform insulation resistance tests of each bust section phase-to-phase and phase-to-ground for one minute using 1,000 volt megger. Insulation resistance not less than manufacturer's recommended value, two megohms minimum. Test enclosure for continuity to substation ground bus. Test circuit connections in accordance with wiring diagrams.
    3. Molded case circuit breakers: Perform pole-to-pole and pole-to-ground insulation resistance tests with a 1,000 volt megger. Insulation resistance: 50 megohms minimum.

B. Submit Certified test reports within 10 days of completion of tests.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 – GENERAL

1.01 DESCRIPTION:

A. This section specifies providing complete grounding and bonding system.

B. Related Work Specified Elsewhere:
   1. Wire, Cable And Busways: Section 16120.
   2. Stray Current And Cathodic Protection: Section 13110

C. Compensation for work specified in this section will be made in the following manner:
   1. Basic Materials: Lump Sum.
   2. Installation: Lump Sum.
   3. Additional Work: Work not included in lump sum price but required to complete work, such as replacement of cables that did not pass testing, shall be based on Unit Price Schedule.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. National Electrical Code (NEC)
   3. ANSI/IEEE 80-2000, IEEE Guide for Safety in AC Substation Grounding.
   4. UL 467, Grounding and Bonding Equipment..
   5. American Standards of Testing and Materials (ASTM) B187-00, Standard Specification for Copper Bar, Bus Bar, Rod and Shapes.
   6. ITS: Directory of ITS Listed Products.
   7. 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. Source Quality Control:
   1. Each item, except for exothermic-welded electrical connections, listed per referenced UL or ITS directory.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings.
   2. Certification.
      a. Certified test reports verifying that ground resistance of each ground grid when installed and each ground bus when connected to ground grid does not exceed specified values.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mark each item in accordance with applicable reference standard.

B. Ship each unit securely packaged and labeled for safe handling and to avoid damage.

C. Store equipment in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. Grounding and Bonding Equipment

1. General Requirements:
    a. UL 467.
2. Equipment grounding conductor:
    a. Sized in accordance with NEC Article 250-122 unless otherwise shown.
    b. Insulated equipment grounding conductor: Single-conductor cable as specified in Section 16120.
    c. Bare equipment grounding conductor integral with multiple-conductor cable: Section 16120.
3. Bonding conductor for stray current and cathodic protection and electrical continuity:
    a. Insulated or bare conductors, as shown, in accordance with the following:
        1) Insulated conductors: As specified in Section 16120 for single-conductor cable.
        2) Bare conductor: Section 16120.
    b. Size: As shown or as specified.
4. Ground connector:
    a. O-Z, Type KG or equal.
    b. Two-piece, designed for connecting grounding conductor to bus bar.
    c. Copper-alloy body and silicon-bronze bolt, nut and lock washer with interlocking clamp.

PART 3 - EXECUTION

3.01 GROUNDING:

A. Equipment Grounding Conductor: Provide insulated equipment grounding conductor for following services and as shown:
    1. Feeders.
    2. Branch circuits.

B. Grounding of Separately Derived AC System:
    1. Ground in accordance with NEC.
    2. Ground secondary neutral and enclosure of transformers to nearest ground bus or sub-bus using insulated grounding electrode conductor.
    3. For transformer located outside of building, install additional grounding connector between transformer secondary neutral/enclosure and ground bus or grid using insulated grounding electrode conductor.

C. Grounding for Personnel Safety:
    1. Passenger shelter equipped with illuminated diorama and receptacle at station platform: Provide multiple ground paths as follows:
        a. Bond and ground two separate frame columns of each shelter to nearest ground bus in electrical room or sub-bus or to 5/8-inch diameter by 10-foot long ground rod driven so that the top of rod is three inches above finished floor of under platform space using 6AWG insulated grounding conductor unless otherwise shown.
        b. Bond and ground each shelter to equipment grounding conductor in branch circuit.
    2. Illuminated diorama, station pylon equipped with light fixtures, map case and telephone enclosure: Provide multiple ground paths as follows:
        a. Bond and ground illuminated diorama frame, column of station pylon equipped with light fixtures, map case and telephone enclosure to nearest ground bus in electrical room or sub-bus or to 5/8-inch diameter by 10-foot long ground rod driven so that the top of rod is three inches above finished floor of under platform space using 6AWG insulated grounding conductor unless otherwise shown.

b. Bond and ground frame of each illuminated diorama, pylon equipped with light fixture, map case and telephone enclosure to equipment grounding conductor in branch circuit.

3. Station entrance pylon (Type B): Provide multiple ground paths as follows:
   a. Bond and ground the pylon frame using 6AWG insulated grounding conductor to 5/8-inch diameter by 10-foot long ground rod driven so that top of rod is six inches below finished grade.
   b. Bond and ground the pylon frame to equipment grounding conductor in branch circuit.
4. Exothermically weld or gas torch braze grounding and bonding connection to exposed metallic structure, metallic cable trough, galvanized steel fence, hand railing, metallic safety walk grating, map case and telephone enclosure, frame columns of shelter, pylon and diorama, and metallic cover, metallic cover frame and metallic body of handhole, manhole and junction box. Repair damaged galvanized coating in accordance with Section 02820. Repair finish of shelter, map case and telephone enclosure and diorama frame to match existing finish.

3.02 BONDING FOR STRAY CURRENT AND CATHODIC PROTECTION:

A. Metallic Pipe
   1. Bond across joint for the following pipe, pipe fittings and pipe appurtenances, except those welded or soldered joints, using 2AWG insulated conductor as shown and in accordance with Section 15205.
      a. Buried pipe, except soil pipe unless shown bonded.
      b. Pressure pipe.
      c. Pipe parallel to and within 20 feet of centerline of track.
   2. Do not bond District of Columbia, Department of Public Works (DCDPW), buried piping systems

B. Floating-Slab Expansion Joints

   1. Bond floating-slab expansion joints, using 1/0 AWG, class G Stranded bare or insulated conductor exothermic welded to longitudinal bar.

C. Separate reinforcing steel and other buried metallic structures, bonded for stray current and cathodic protection, from ground grid, grounding electrode, or exposed metallic structures grounded for personnel safety. Metallic contact or electrical bonding between the two systems is prohibited.

3.03 FIELD QUALITY CONTROL:

A. Test metallic conduits and raceways, metallic enclosures for equipment, metallic cable troughs, fences, metallic hand railings, metallic safety walk gratings, metallic structures, metallic covers, cover frames and bodies of manholes, handholes and junction boxes, frames of shelters, pylons and dioramas, map case and telephone enclosures, and poles for mounting lighting fixtures for continuity to grounding system.

B. Conduct tests in presence of Engineer.

C. Inspect and test exothermic welds as follows:
   1. Inspect finished exothermic welds for visual characteristics that are consistent with a properly made connection in accordance with the manufacturer's instructions and recommendations. Remove welds that do not meet minimum visual requirements as acknowledged by the Engineer, and reweld after cleaning the area to be welded.

   2. Test mechanical strength of exothermic weld by applying three sharp blows to the weld with a two-pound hammer using 15-inch strokes. Acceptable welds to sustain the blows without cracking the weld metal or the bond between the two connecting materials. Remove defective welds and reweld after cleaning the area to be welded.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 16120

WIRE, CABLE AND BUSWAYS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing wire, cable and busways.

B. Definitions:
   1. Cable: Cable having low smoke generating characteristics.

C. Requirements for single-conductor cable and for multiple-conductor cable as stated except as otherwise specified.

D. Related Work Specified Elsewhere:
   1. Wire connection accessories: Section 16125.
   2. Raceways, boxes and cabinets: Section 16130.

E. Compensation for work specified in this section will be made in the following manner:
   1. Basic Materials: Lump Sum.
   2. Installation: Lump Sum.
   3. Additional Work: Work not included in lump sum price but required to complete work, such as replacement of cables that did not pass testing, shall be based on Unit Price Schedule.

1.02 QUALITY ASSURANCE:

A. Qualifications: Select a manufacturer who is engaged in production of similar wire, cable and busways.

B. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. National Electrical Code (NEC).
   3. Insulated Cable Engineers Association (ICEA): S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, S-81-570.
   4. IEEE: 1202-1991 IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies, 383-1974 IEEE Standard for Type Test of Class 1E Electrical Cables, Field Splices, and Connections for Nuclear Power Generating Stations.
   5. National Electrical Manufacturers Association (NEMA): BU1, WC70, WC71, WC74.
   6. American National Standards Institute (ANSI): *C37.20.1, Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear; C37.20.2, Metal-Clad and Station-Type Cubicle Switchgear; C37.20.3, Metal-Enclosed Interrupter Switchgear; Z55.1, Gray Finishes for Industrial Apparatus and Equipment*.
   7. UL: 44, Rubber-Insulated Wires and Cables Thermoset-Insulated Wires and Cables; 62, Flexible Cord and Fixture Wire; 857, Electric Busways and Associated Fittings; and 1581, Standard for Electrical Wires, Cables, and Flexible Cords.
   8. NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems.
   9. American Standards of Testing and Materials (ASTM): B3-95, Standard Specification for Soft or Annealed Copper Wire; B8-99, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; D471-98e1, Standard Test Method for Rubber Property-Effect of Liquids, E662-97, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
   10. ITS: Directory of ITS Listed Products

C. Source Quality Control:
   1. Cable and busways: Listed or labeled per UL or ITS directory.

D. 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.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings.
   2. Samples:
      a. Smoke-density test sample for jacket material: Specified sample will become property of the Authority.
   3. Certification:
      a. Certified flame-retardancy test reports (VW-1, IEEE 383, and IEEE 1202, Article 18) and data for tests performed not more than 12 months prior to submittal, for materials which are identical to those of cable furnished. Include test reports with submittal of shop drawings.
      b. Submit smoke-density test reports and data for tests performed on the jacket material not more than 12 months prior to the submittal, for materials which are identical to those of the furnished cable. Include test reports with submittal of shop drawings.
      c. Certified test reports demonstrating that cable complies with specified requirements and those of referenced ICEA Standards. Submit test reports prior to cable shipments.
      d. Certificates from manufacturers verifying that products conform to specified requirements. Include certificate with submittal of shop drawings and with each cable shipment.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mark each single-conductor cable, each multiple-conductor cable and each busway to show label per referenced UL or ITS directory, size, voltage, manufacturer and number of conductors or phases in accordance with NEC requirements.

B. Ship each unit securely packaged and labeled for safe handling and shipment.

C. Store products in a dry and secure facility.

PART 2 – PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. General Requirements for Single-Conductor and Multiple-Conductor Cable:
   1. Type and size: As shown.
   2. Rated voltage: 600 volts.
   3. Conductors:
      a. ASTM B3 or B8 annealed copper.
      b. Size 10 AWG and smaller: Solid or Class B or Class C stranded.
      c. Size 8 AWG and larger: Class B stranded.
   4. Standards: Except as modified, wires and cable complying with the following standards:
      a. Cross-linked polyethylene (XLPE) insulated cable: ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, S-81-570.
      b. Other cable: ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, S-81-570.
   5. Non-metallic jacket for single-conductor cable and an overall covering on multiple-conductor cable:

a. Chlorosulfonated polyethylene or cross-linked polyolefin.
b. Cross-linked polyolefin complying with the following physical requirements. Properties tested in accordance with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, and S-81-570 if ethylene-propylene-rubber (EPR) insulation is used, or with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692 if cross-linked polyethylene insulation is used. Jacket material free of PVC and PVC-based compounds.
    1) Tensile strength, minimum pounds per square inch: 1,800.
    2) Elongation at rupture, minimum percent: 150.
    3) Aging requirement: After 168 hours in air oven test at 100C, plus-or-minus one degree C:
        a) Tensile strength, minimum percentage of unaged value: 100.
        b) Elongation at rupture, minimum percentage of unaged value: 80.
    4) Oil immersion: 18 hours at 121C, plus-or-minus one degree C, ASTM D471, Table 1, No. 2 oil:
        a) Tensile strength, minimum percentage of unaged value: 80.
        b) Elongation at rupture, minimum percentage of unaged value: 80.
c. Jacket materials other than cross-linked polyolefin complying with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692. Jacket material free of PVC and PVC-based compounds.

6. Flame retardancy: Single-conductor and multiple-conductor cable tested by independent agency demonstrating flame retardancy in accordance with the following:
    a. Single-conductor cable and individual conductors of multiple-conductor cable passing vertical wire (VW-1) flame test in accordance with UL1581 or ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692. Cable size for testing: 14AWG.
    b. Single-conductor cable , size 1/0 AWG and larger, passing vertical tray flame test, using ribbon gas burner in accordance with IEEE 1202 or IEEE 383. Cable size for testing: 1/0 AWG.
    c. Multiple conductor cable passing vertical tray flame test using ribbon gas burner in accordance with IEEE 383 or IEEE 1202. Cable size for testing: 7/C or 9/C with No. 12 AWG or No. 14 AWG conductors.
7. Smoke generation: Single and multiple-conductor cable jacket materials demonstrating low-smoke generation when tested in accordance with ASTM E662 by independent, nationally recognized testing agency.
    a. Conduct tests on specimens of overall jacket material for multiple-conductor cable and of jacket material for single-conductor cable.
    b. Prepare slab specimens for each material .100 inch, plus-or-minus .005-inch thick, identical to those of finished cables and meeting minimum physical requirements specified.
        1) Prior to testing, submit six-inch square portion of each specimen. Tag sample with manufacturer's jacket or insulation identification code or number.
    c. Test values for chlorosulfonated polyethylene not to exceed the following:
        1) Flaming mode:
            a) Uncorrected maximum specific optical density during first four minutes of test: 325.
            b) Uncorrected maximum specific optical density for entire 20-minute test: 400.
        2) Nonflaming mode:
            a) Uncorrected maximum specific optical density during first four minutes of test: 325.

b) Uncorrected maximum specific optical density for entire 20-minute test: 480.

d. Test values for cross-linked polyolefin not to exceed the following:
1) Flaming mode:
a) Uncorrected maximum specific optical density during first four minutes of test: 150.
b) Uncorrected maximum specific optical density for entire 20-minute test: 300.
2) Nonflaming mode:
a) Uncorrected maximum specific optical density during first four minutes of test: 150.
b) Uncorrected maximum specific optical density for entire 20-minute test: 300.

8. Applied voltage testing:
a. Single-conductor cable and individual conductors of multiple-conductor cable to be given applied ac voltage dielectric-strength test, i.e., six-hour water-immersion test.
b. For single conductors of multiple-conductor cable, conduct tests prior to assembly as multiple-conductor cable.
c. Test procedures:
1) Polyethylene-insulated conductors: In accordance with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692.
2) Other conductors: In accordance with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, S-105-692, and S-81-570.

B. Single-Conductor Cable:
1. Insulated with ethylene-propylene-rubber with non-metallic jacket as specified. UL-Labeled as Type RHW-2.
2. Color coding: In accordance with paragraphs 200-6, 200-7 and 210-5 of the NEC.

C. Multiple-Conductor Cable:
1. Individual conductors:
a. Number of conductors: As shown.
b. Construction: Complying with one of the following:
1) Insulated with ethylene-propylene-rubber, with or without non-metallic jacket.
2) Insulated with composite compound of ethylene-propylene-rubber and polyethylene, without outer jacket.
3) Insulated with filled cross-linked polyethylene without jacket.
c. Phase and neutral conductors: Individually insulated.
d. Neutral conductors: Same size as phase conductors.
e. Bare ground conductors: Sized in accordance with the NEC, unless otherwise shown.
f. UL Listed as Type RHW-2 or XHHW-2.
2. Conductors assembled with nonwicking, flame-retardant filler to form cable of circular cross section.
3. Metallic sheath:
a. Provide one of the following:
1) Size 1 AWG and larger:
a) Interlocked aluminum-tape armor.
b) Continuous corrugated aluminum sheath conforming to ICEA S-19-81, Table 4-26A.
2) Size 2 AWG and smaller: As specified for 1 AWG and larger or continuous smooth aluminum sheath conforming to ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692.
b. Metallic covering not required for multiple-conductor TC cable with overall non-metallic jacket when installed in cable tray.

4. Multiple-conductor cable provided with overall non-metallic jacket as specified.
5. Cable UL-listed as follows:
    a. Non-metallic-sheathed cable: Type TC, suitable for wet and dry locations.
    b. Metallic-sheathed cable: Type MC, suitable for wet and dry locations.
6. Color coding:
    a. Power cables: In accordance with paragraphs 200-6, 200-7 and 210-5 of the NEC.
    b. Control cables: In accordance with ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692.

D. Fixture Wire: UL 62, with the following additional requirements:
1. Type: SF-2 silicone-rubber insulated or as necessary to suit temperature rating of lighting fixture, minimum 90C.
2. Conductor: Stranded copper conductor 16AWG or larger as shown.

E. Bare Conductors: ASTM B3 or B8, annealed copper conductor; 8AWG and larger, Class B stranded, unless otherwise shown or specified.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install type cable as specified.

B. Install single-conductor cable in conduitor wireway. Install UL Type MC multiple-conductor cable and ground cable on channel inserts, cable trays, racks, trench or trough using straps and fasteners as specified in Section 16130. Install UL Type MC multiple-conductor cable in conduit where shown or required. On walls or ceilings, fasten cable directly to channel inserts, or use expansion-bolt anchors to attach to concrete and toggle bolts to attach to concrete masonry unit walls. Splice cable only when unavoidable, and only with prior WMATA approval.

C. Install motor feeders, service connections and extensions in accordance with reference codes. Install motor feeder in 18-inch minimum length liquid-tight flexible conduit at motor conduit box.

D. Use nylon straps to bundle and secure wire and cable located in panelboards, cabinets, switchboards, motor control centers and switchgear.

E. Minimum bending radius 12 times outer diameter of cable. Where shown, use shorter bending radius as permitted by NEC, ICEA S-95-658, S-96-659, S-93-639, S-94-649, S-97-682, and S-105-692, and cable manufacturer.

F. To facilitate pulling cable, use listed per UL or ITS directory lubricant recommended by cable manufacturer.

G. Use direct-burial cable only for stray current and cathodic protection.

H. In damp and dusty indoor locations, tunnel areas, manholes and outdoor locations, seal cable at conduit termination using duct-sealing compound.

I. Where shown or necessary, install cable-seal fitting specified in Section 16130 to prevent entry of water into electrical facilities. Where approved, use seal compound specified in Section 16130.

3.02 IDENTIFICATION:

A. Identify cable terminations, feeders and power circuits using non-metallic fiberboard tags or plastic labels. Attach tags to cable with slip-free plastic lacing or nylon bundling straps. Use designation shown.

3.03 FIELD QUALITY CONTROL:

A. Furnish equipment required to perform tests. Prior to insulation and high-potential tests, disconnect instruments and equipment which might be damaged during such tests. Conduct tests in presence of the Engineer.

B. Submit test procedure for approval and perform approved tests including, but not limited to, the following:
   1. Single-conductor cable and multiple-conductor cable:
      a. Test continuity of cable conductors using ohmmeter.
      b. Proof-test insulation resistance to ground and between insulated conductors for minimum of one minute using 1,000-volt megger. Insulation resistance: 200,000 ohms minimum.
      c. When cable shows unsteady insulation resistance of less than 200,000 ohms, perform high-potential test at 80 percent of factory ac test voltage or as recommended by cable manufacturer.

C. Submit certified test reports.

END OF SECTION

SECTION 16125

WIRE CONNECTION ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing wire-connection accessories, such as connectors, terminal lugs and fittings, bundling straps, insulating tape and resin.

B. Compensation for work specified in this section will be made in the following manner:
   1. Basic Materials: Lump Sum.
   2. Installation: Lump Sum.
   3. Additional Work: Work not included in lump sum price but required to complete work, such as replacement of cables that did not pass testing, shall be based on Unit Price Schedule.

1.02 QUALITY ASSURANCE:

A. Qualifications: Select a manufacturer who is engaged in production of similar wire connection accessories.

B. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. National Electrical Code (NEC).
   3. UL: 486A,Wire Connectors and Soldering Lugs for Use With Copper Conductors.
   4. American Standards of Testing and Materials (ASTM): D149-97a, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies; D257-99, Standard Test Methods for DC Resistance or Conductance of Insulating Materials; D412-98a, Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension; D570-98, Standard Test Method for Water Absorption of Plastics; D638-00, Standard Test Method for Tensile Properties of Plastic; D696-98, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer; D792-00, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement; D1000-99, Standard Test Method for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications; D1518-85(1998)e1, Standard Test Method for Thermal Transmittance of Textile Materials; D5034-95, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test); D5035-95, Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method); D2240-00, Standard Test Method for Rubber Property-Durometer Hardness; and G21-96, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
   5. American National Standards Institute (ANSI): C119.1, Sealed Insulated Underground Connector System 600V
   6. ITS: Directory of ITS Listed Products.

C. Source Quality Control:
   1. Connectors, terminal lugs and fittings listed, per referenced UL or ITS directory.
   2. Factory testing: Submit certified copies of test report for cable splice and tap-insulation/sealing kits as specified.

D. 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.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings.
   2. Certification.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mark each item in accordance with applicable reference standard.

B. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage.

C. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. Connectors, Terminal Lugs and Fittings:
   1. In accordance with UL 486A.
   2. For 10AWG and smaller conductor cable: Tin-plated copper pressure connectors with nonflammable, self-extinguishing insulation grip with temperature rating equal to that of conductor insulation.
   3. For 8AWG to 4/0 AWG conductor cable: Tin-plated copper compression connectors and terminal lugs with nylon insulating sleeve for insulation grip.
   4. For 250 KCMIL and larger conductor cable: Long-barrel, double-compression tin-plated copper connectors and terminal lugs with two-hole pad.
   5. For multiple-conductor cable: Watertight aluminum fittings with stainless-steel pressure ring and set screws or compression cone for grounding of aluminum sheath of MC cable.

B. Bundling Straps:
   1. Self-locking steel barb on one end, with tapered strap of self-extinguishing nylon, temperature rating minus 40F to plus 185F.
   2. For outdoor use: Ultraviolet-resistant.

C. Insulating Tape:
   1. Plastic tape: Vinyl plastic tape with rubber-based pressure-sensitive adhesive, pliable at zero degree F with the following minimum properties when tested in accordance with ASTM D1000-99:
      a. Thickness: 8.5 mils.
      b. Breaking strength: 20 pounds per inch width.
      c. Elongation: 200 percent.
      d. Dielectric breakdown: 10,000 volts.
      e. Insulation resistance, indirect method of electrolytic corrosion: 1,000,000 megohms.
   2. Rubber tape: Silicone-rubber tape with silicone pressure-sensitive adhesive, with the following minimum properties when tested in accordance with ASTM D1000-99:
      a. Thickness: 12 mils.
      b. Breaking strength: 13 pounds per inch width.
      c. Elongation: 525 percent.
      d. Dielectric breakdown: 13,000 volts.
      e. Insulation resistance, indirect method of electrolytic corrosion: 1,000,000 megohms.
   3. Arcproof tape: Flexible, coated one side with flame-retardant flexible elastomer, self-extinguishing, non-combustible, with the following minimum properties:
      a. Thickness, ASTM D1000: 30 mils.

b. Breaking strength, ASTM D5034-95 and D5035-95: 50 pounds per inch width.
c. Thermal conductivity, ASTM D1518-85: 0.0478 BTU per hour per square foot per degree F.
d. Electrical arc resistance: Withstand 200 amperes arc for 30 seconds.

4. Glass tape: Woven-glass fabric tape with pressure-sensitive thermosetting adhesive, with the following minimum properties when tested in accordance with ASTM D1000-99:
   a. Nominal width: 3/4 inch.
   b. Thickness: Seven mils.
   c. Breaking strength: 170 pounds per inch width.
   d. Elongation: Five percent.
   e. Dielectric breakdown: 2,500 volts.
   f. Insulation resistance, indirect method of electrolytic corrosion: 5,000 megohms.

D. Epoxy Resin: Suitable for insulating and moisture sealing cable splices, with the following minimum properties:
1. Dielectric strength, ASTM D149-97a: 400 volts per mil.
2. Volume resistance, ASTM D257-99: 2.8×10^{15} ohm per centimeter cube at 30C.
3. Water absorption, ASTM D570-98:
   a. 0.193 percent in 24 hours at 23C.
   b. 0.62 percent in 24 hours at 53C.
4. Tensile strength, ASTM D638-00: 8,000 psi.
5. Elongation, ASTM D638-00: 2.4 percent.
6. Coefficient of expansion, ASTM D696-98: 6.8 X 10-5 inch per inch per degree C.

E. Cable splice and tap-insulation/sealing kit: Suitable for use on 600-volt, 90C cables, material compatible with cable insulation and jacket, meeting the seal test requirements of ANSI C119.1.
1. Heat-shrinkable tubing or wraparound heat-shrinkable sleeve: approved per referenced UL or ITS directory, flame-retardant, corrosion-resistant thick-wall tubing with factory-applied sealant for field insulation on in-line splices and taps or wraparound-type sleeve for retrofit installation on existing splices and taps to provide a watertight seal and insulating encapsulation, with the following additional requirements:
   a. Material: Cross-linked polyolefin.
   b. Shrink ratio: 3 to 1 minimum.
   c. Physical properties:
      1) Ultimate tensile strength: 2,350 psi, ASTM D412-98a.
      2) Ultimate elongation: 350 percent, ASTM D412-98a.
      3) Hardness, Shore D: 42, ASTM D2240-00.
      4) Water absorption: 0.050 percent, ASTM D570-98, Method 6.1.
      5) Specific gravity: 1.28, ASTM D792-00.
   d. Electrical properties:
      1) Dielectric strength: 450 volts per mil, ASTM D412-98a.
      2) Volume resistivity: $1 \times 10^{14\ \text{ohm}}$ cm, ASTM D257-99.
   e. Thermal properties:
      1) Continuous operating temp.: -55C to +135C.
      2) Air oven aging (14 days at 175C):
         a) Tensile strength: 2,680 psi.
         b) Elongation: 375 percent.
      3) Low temp. flexibility (4 hours at -55C): No cracking when flexed.
      4) Heat shock (4 hours at 250C): No cracking, flowing or dripping.

f. Chemical properties:
   1) Corrosivity: Non-corrosive.
   2) Fungus resistance: Non-nutrient, ASTM G21-96.
   3) Flammability: Self-extinguishing.

PART 3 - EXECUTION

3.01 SPLICES AND TERMINATIONS:

A. Make wire and cable splices in outlet, junction or pull boxes, in cable troughs or in equipment cabinets. Splices in conduit are prohibited.

B. Secure connectors or terminal lugs to conductor so as to engage all strands equally.

C. Do not rupture insulation nor expose bare conductors.

D. Install compression connectors and terminal lugs using tools and pressure recommended by manufacturer. Indent mark connectors and terminal lugs with number of die used for installation.

E. Apply anti-corrosion joint compound to connectors, terminal lugs and bolting pads before installation.

F. Wrap ½-lapped layer of arcproof tape, glass tape overall on cable splices installed in air tunnels, ducts and shafts.

G. Install terminal fittings on multiple-conductor cable in accordance with manufacturer's recommendation. Completely seal cable from moisture.

H. On cable splices, taps and terminations in manhole handhole and outdoor junction and pull boxes, cover connectors with electrical putty, wrapped with three layers of plastic tape or final layer of rubber tape and then install watertight encapsulation as follows and under the supervision of kit manufacturer's representative or using a factory-certified installation technician, proficient in field installation of heat-shrinkable sealing kits.
   1. Use heat-shrinkable tubing for encapsulation of new splices, taps and terminations.
   2. Use wraparound-type heat-shrinkable sleeve for encapsulation of existing splices, taps and terminations.

3.02 CATHODIC PROTECTION SPLICES AND TERMINATIONS:

A. For splices made in aboveground cable, use compression connectors covered with electrical putty, wrapped with three layers of plastic tape and final layer of rubber tape.

B. Install compression terminal lugs using tools and pressure recommended by manufacturer. Indent mark terminal lugs with number of die used for installation.

C. For splices made in direct-burial cable, use thermit weld sealed with cast epoxy-resin encapsulation.

3.03 INSPECTION:

A. Have splices in direct-burial cable for stray current and cathodic protection inspected by the Engineer before backfilling.

B. Have splices and taps in manholes, handholes and outdoor junction and pull boxes inspected by the Engineer or the manufacturer's representative, when available.

END OF SECTION

SECTION 16130

RACEWAYS, BOXES AND CABINETS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing conduit, raceways, cable trays, boxes and cabinets to form raceway and support system for power, communication and control cables.

B. Related Work Specified Elsewhere:
   1. Grounding and bonding: Section 16060.

C. Compensation for work specified in this section will be made in the following manner:
   1. Basic Materials: Lump Sum.
   2. Installation: Lump Sum.
   3. Additional Work: Work not included in lump sum price but required to complete work, such as replacement of cables that did not pass testing, shall be based on Unit Price Schedule.

1.02 QUALITY ASSURANCE:

A. Qualifications: Select a manufacturer who is engaged in production of similar raceways, boxes and cabinets.

B. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. National Electrical Code (NEC).
   3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum); VE 1, Metallic Cable Tray Systems; TC-2, Electrical Polyvinyl Cloride (PVC) Tubing and Conduit.
   4. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc Coated; C80.5, Aluminum Rigid Conduit - (ARC); and Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
   5. UL: 5, Surface Metal Raceways and Fittings; 6, Rigid Metal Conduit; 50, Enclosures for Electrical Equipment; 94, Test for Flammability of Plastic Materials for Parts in Devices and Applicances; 360, Liquid Tight Flexible Steel Conduit; 514A, Metallic Outlet Boxes; 514B, Fittings for Conduit and Outlet Boxes; 514C, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers; 651, Schedule 40 and 80 Rigid PVC Conduit; 884, Underfloor Raceways and Fittings; and 1684, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   6. Federal Specifications (FS): FF-S-325C, FF-S-760, TT-S-227.
   7. American Standards of Testing and Materials (ASTM): A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings; A123/A123M-00, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; A185-97, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement; A276-00a, Standard Specification for Stainless Steel Bars and Shapes; A507-00, Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled; A532/A532M-93a(1999)e1, Standard Specification for Abrasion-Resistant Cast Irons; A536-84(1999)e1, Standard Specification for Ductile Iron Castings; A615/A615M-00, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; A653/A653M-00, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; B138-96, Standard Specification for Manganese Bronze Rod, Bar and Shapes; B455-96, Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes; B584-00, Standard Specification for Copper Alloy Sand Castings for General Applications; B633-98, Standard Specification for

Electrodeposited Coatings of Zinc on Iron and Steel; C109/C109M-99, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens); C173-94ae1, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; C231-97e1, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method; D149-97a, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies; D495-99, Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation; D570-98, Standard Test Method for Water Absorption of Plastics; D638-00, Standard Test Method for Tensile Properties of Plastics; D648-00a, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position; and D790-00, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

8. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges (SSHB).
9. ITS: Directory of ITS listed products.

C. The following items to be listed or labeled per referenced UL or ITS directory:
   1. Conduit and fittings.
   2. Surface raceways and fittings.
   3. Boxes.
   4. Cabinets.

D. 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.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings.
   2. Certification.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mark each item in accordance with applicable reference standard.

B. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.

C. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. General Requirements for Conduit, Raceways, Cable Trays, Boxes, Cabinets and Fittings:
   1. Size: As shown, minimum conduit size 3/4 inch.
   2. Materials:
      a. Steel sheet: ASTM A507-00.
      b. Zinc-coated steel sheet: ASTM A653/A653M-00.
      c. Cast iron: ASTM A532/532M-93a(1999)e1.
      d. Ductile iron: ASTM A536-84(1999)e1.
      e. Malleable iron: ASTM A47/A47M-99.
      f. Bronze extrusion: ASTM B455-96, Alloy C38500.
      g. Bronze casting: ASTM B584-00, Alloy C83600.
      h. Rigid fiberglass reinforced epoxy: UL 1684.
      i. Stainless steel: ASTM A276-00a, Type 304.

   3. Zinc coating:

a. Hot-dip galvanizing: ASTM A123/A123M-00.
b. Electro galvanizing: ASTM B633-98.

B. Galvanized-Steel Rigid Conduit and Fittings: UL 6 and ANSI C80.1, zinc coating tested in accordance with reference test in appendix.

C. Liquid-Tight Flexible Conduit and Fittings:
1. Applicable requirements of UL 360.
2. Flexible galvanized-steel core with extruded liquid-tight neoprene or PVC jacket overall.
3. Sizes up to 1-1/4 inch provided with continuous copper bonding conductor, spiral wound between convolutions.
4. Sizes 1-1/2 inch and above provided with separate grounding conductor.

D. Conduit Expansion Fittings and Expansion and Deflection Fittings:
1. Materials:
a. For galvanized-steel rigid conduit:
1) Expansion fittings: Steel or malleable iron, hot-dip galvanized.
2) Expansion/deflection fittings: Bronze or ductile iron end couplings, neoprene sleeve and stainless steel clamping bands.
b. For PVC conduit: Rigid metal expansion/deflection fitting with galvanized rigid steel to PVC conduit adapters at each end.
2. Conduit expansion fitting: Weatherproof.
3. Conduit expansion and deflection fitting: Watertight.
4. Metallic fittings equipped with bonding jumper cable to provide electrical continuity.

E. Conduit Connector Fittings:
1. UL 514B, material and finish similar to that of conduit with which they are to be used.
2. For enclosures, cabinets, boxes and gutters in electrical rooms and aboveground indoor locations: Threaded nylon-insulated bushing and locknuts.
3. For enclosure, cabinets, boxes and gutters with hub in outdoor, tunnel and underground locations, except electrical rooms: Threaded watertight hub fitting with gasket.
4. For enclosure having punched or formed knockout for conduit entry in outdoor and underground locations, except electrical rooms: Threaded watertight fitting with gasket, nylon-insulated throat and sealing locknut.

F. Conduit and Cable-Seal Fittings:
1. Conduit seal:
a. To provide watertight seal between concrete and conduit where it penetrates wall, floor or ceiling.
b. Size as shown or necessary.
c. Materials: Body and pressure clamp of malleable or cast iron with a neoprene sealing grommet and PVC-coated or galvanized-steel pressure rings, oversized sleeve of FRE or galvanized steel.
d. Seal between conduit and concrete to withstand pressure from 50-foot head of water without leakage.
2. Cable seal:
a. To provide watertight seal between cable and conduit for use with single-conductor or multiple-conductor cable as necessary.
b. Size as necessary, drilled to accommodate cable.
c. Pressure discs of PVC-coated steel and sealing ring of neoprene.
d. Seal between cable and conduit to withstand water pressure of 50 psi without leakage.

3. Seal compound:

a. FS TT-S-227, two-component, fast-setting, polymeric sealing compound to provide watertight seal between concrete and conduit, between cable and conduit.
b. Pour-type for horizontal and gun-grade for vertical or overhead application.
c. When cured, sealant to have rubber-like flexibility allowing minimum movement of conduit and cable in temperature range of minus 40F to plus 150F without loss of watertight seal.
d. Pot life: 15 minutes.
e. Minimum ambient temperature for application: 35F.
f. Initial cure: 15 minutes.
g. Final cure: Seven days.
h. Hardness, Durometer A: 20-35.
i. Seal between conduit and concrete to withstand pressure from 50-foot head of water without leakage.
j. Seal between conduit and single-conductor or multiple-conductor cable to withstand water pressure of 70 psi without leakage.
k. Fox Industries, Type FX-571G or approved equal.

G. Conduit and Cable Supports:
1. Retaining straps and fasteners: FS FF-S-760, with the following additional requirements:
a. Type, style and size: As necessary.
b. Material and finish: Stainless steel, Type 316, or approved equal. Provide alternate for type FRE non-metallic cable supports.
c. For separating conduit from masonry surface: Hot-dip galvanized malleable-iron spacer assembled with Style A strap.
d. For vertical run of metallic-sheath cable: Basket-weave cable support.
e. For fastening conduit or cable to channel inserts: Stainless steel, Type 304, or approved equal.
2. Multiple pipe hangers (trapeze-type): Consisting of two or more hanger rods, horizontal member, U-bolt clamp and other attachment necessary for securing hanger rods and conduit, with the following additional requirements:
a. Material and finish: Stainless steel, Type 304, or approved equal.
b. Hanger rod: Not smaller than 3/8-inch diameter, threaded for sufficient distance at each end to permit at least 1-1/2 inches of adjustment.
c. Horizontal member: Channel, 1-1/2 inches square or 1-5/8 inches square by 12 gauge or heavier. Weld two or more channels together for greater strength if necessary.
d. Design: Capable of supporting load equal to sum of weights of conduit, cable and hanger plus 200 pounds. At design load, stress at root of thread on hanger rod 9,500-psi maximum; stress in horizontal member 12,500-psi maximum.
3. Stainless Steel Channel Struts:
a. Size and shape as shown, 12-gauge or heavier stainless steel, type 316, with 7/8 inch wide continuous slot, 9/16 inch base slot, two inches on center or solid base with field drilled holes as required with minimum pull out load rating of 1,000 pounds per linear foot.
b. Fittings and accessories compatible with associated channel struts and having same material and finish.

H. Boxes and Cabinets:
1. Outlet boxes:
a. UL 514A, capable of accommodating conduit as shown.
b. Material and finish:
1) Steel, malleable iron, cast iron or ductile iron.
2) Hot-dip galvanized or electro galvanized after fabrication.

c. For aboveground indoor locations and electrical rooms: Punched or formed knockouts.
d. For outdoor and underground locations, except electrical rooms:
    1) Threaded-conduit entrance hub.
    2) Threaded watertight fitting with gasket, nylon-insulated throat and sealing locknuts for enclosures having punched or formed knockouts for conduit entry.
e. For wall receptacles and switches, single or double devices: Outlet boxes 4-11/16 inch square by 1-1/2 inch deep.
f. For floor receptacles: Watertight cast-iron outlet boxes, four inches diameter, of suitable depth and complete with the following:
    1) Adjustment screws for final leveling.
    2) Bronze floor plate with flush-mounted screw plug, without exposed fastener, M32 finish.
    3) Screw plug attached to outlet-box assembly by chain or other means, M32 finish.
    4) Bronze floor plate flange, five inches in diameter, extending beyond box 1/2-inch above finished floor, M32 finish.
    5) One special screw-plug removal tool with every 10 receptacles.
g. For recessed wall-mounted receptacles: Watertight cast-iron outlet box, three-inch diameter, of suitable depth and complete with the following:
    1) Bronze faceplate with flush-mounted screw plug, without exposed fasteners, M32 finish.
    2) Screw plug attached to outlet-box assembly by chain or other approved means, M32 finish.
    3) Bronze faceplate flange, five inches in diameter, extending beyond box, M32 finish.
    4) One special screw-plug removal tool with every 10 receptacles.

2. Junction and pull boxes:
    a. Internal volume up to 100 cubic inches, metallic boxes: UL 514A, non-metallic boxes: UL514C; internal volume above 100 cubic inches, UL 50.
    b. Flush-mounted or surface-mounted as shown.
    c. Size: Suitable to accommodate conduit, raceways, ducts, number of cables and splices shown.
    d. Material and finish:
        1) Metallic boxes:
            a) Steel, malleable iron, cast iron or ductile iron.
            b) Hot-dip galvanized or electro galvanized after fabrication.
            c) Stainless steel in tunnel areas.
        2) Non-metallic boxes:
            a) Precast concrete: Compressive strength 3,500 psi; air entrainment six-percent minimum, ASTM C173-94ae1 or C231-97e1; Section 03300 and Section 03400 and in accordance with the following:
                1) Box: Concrete formed with closed bottom and sides and recess at top of box or at edge of cover to provide mating surfaces to prevent lateral movement of flush-mounted cover. Knockouts provided to accommodate conduits as shown.
                2) Cover:
                (a) Material same as for box. Use of metallic cover and cover frame prohibited.
                (b) Metro Type "B" logo with 3-1/8 inch by 4-inch envelope and service designation recessed in center of cover.

(c) Non-protruding provisions provided for lifting.

3) Reinforcement:
   (a) Sidewalk and landscape locations: Welded wire fabric, ASTM A185-97.
   (b) Areas subject to vehicular traffic: Deformed steel bars, ASTM A615/A615M-00.
4) Loading:
   (a) Sidewalk and landscape locations: AASHTO ‘s SSHB H15-44.
   (b) Areas subject to vehicular traffic: AASHTO‘s SSHB H20-44.
   (c) Hardware: Stainless steel.
   (d) Size: As shown or next available larger size.

b) Composite material: Sand and gravel bound together with a polymer and reinforced with continuous woven glass strands and in accordance with the following:

Physical Properties	Values	Method
Compressive strength	11,000 psi	ASTM C109
Tensile strength	1,700 psi	ASTM D638
Flexural strength	7,500 psi	ASTM D790
Water Absorption (24 hours)	0.5 percent	ASTM D570

1) Box: Gray-color material formed with closed bottom and sides and flange with recess at top of box to accommodate flush-mounted cover.
2) Cover:
   (a) Material same as for box.
   (b) Skid-resistant top surface with minimum 0.5 coefficient of friction.
   (c) Metro Type "B" logo with 3-1/8 inch by 4-inch envelope and service designation recessed in center of cover.
   (d) Secured to box with bolts.
   (e) Non-protruding provisions provided for lifting.
3) Loading:
   (a) Sidewalk and landscape locations: AASHTO’s SSHB H15-44.
   (b) Areas subject to vehicular traffic: AASHTO’s SSHB H20-44.
4) Hardware: Stainless steel.
5) Size: As shown or next available larger size.

c) Molded fiberglass-reinforced polyester 1/8-inch thickness, minimum, and in accordance with the following requirements:

Physical Properties	Values	Method
Flexural strength	17,000 psi	ASTM D790
Deflection temperature	400F	ASTM D648
Water absorption (24 hours)	0.5 percent	ASTM D570
Tensile strength	6,500 psi	ASTM D638
Specific gravity	1.8	ASTM D794
Flammability	94-5V	UL 94
Dielectric strength	400 volts per mil	ASTM D149
Arc resistance	180 seconds	ASTM D495

1) Ultraviolet protection: Fiberglass material containing ultraviolet-inhibitor, or coated with polyurethane paint, 1.5 mils minimum dry-film thickness on both inside and outside surfaces.
2) Color: Fiberglass material, gray inside and outside.

d) Molded polyvinyl chloride 1/8-inch thickness, minimum.

e. For aboveground indoor locations and electrical rooms: Punched or formed knockouts.
f. For outdoor and underground locations, except electrical rooms:
1) Threaded conduit entrance hub.
2) Threaded watertight fitting with gasket, nylon-insulated throat and sealing locknuts for boxes having punched or formed knockouts for conduit entry.

3. Cabinets:
a. UL 50, fabricated from galvanized steel.
b. Surface-mounted, unless otherwise shown.
c. Backplate of reinforced steel for mounting interior components and to ensure rigid support and accurate alignment.
d. Provision for cabinet grounding.
e. Provide latch and handle in accordance with UL 50; screw fastenings will not be accepted in lieu of latch.
f. Finish: Metallic surface thoroughly cleaned, degreased, primed with zinc primer and coated after fabrication with light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.

I. Expansion Bolt Anchors: FS FF-S-325C Group II, stainless steel, Type 304, or approved equal.

J. Fiberglass Conduit and Fittings:

1. Rigid fiberglass reinforced epoxy conduit, UL 1684, IPS (Iron Pipe Size) based conduit.
2. Conduit shall be manufactured by using filament winding process with minimum fiberglass content of 65 percent by weight and no fillers.
3. IPS based conduit with nominal wall thickness of 0.09 inches for five-inch nominal conduit size.
4. Conduits, elbows and fittings manufactured from the same material and using the same manufacturing process.
5. Conduit sections formed with integral bell and spigot type couplings. Rubber sealing gasket at bell end is prohibited.
6. Conduits, elbows and fittings provided with protection from exposure to sunlight by pigmentation uniformly dispersed through resin material.
7. Adhesive as recommended by conduit manufacturer.
8. Conduits, elbows and fittings are specified for use throughout a temperature range of -40°F to 230°F, and they are to be protected from exposure to sunlight by pigmentation uniformly dispersed through the resin material.
9. Conduits, elbows and fittings shall be suitable for encasement in concrete below grade and conform to UL 1684, and listed and labeled by UL meeting the requirements of NEC Article 347 for Rigid Nonmetallic Conduit and its use.
10. Each piece of the straight length conduit and each piece of the elbow and other bend made from and for use with such conduit is to be labeled with the following information, mark clearly legible and durable every 10 feet or as recommended by the manufacturer.
    a. "Reinforced Thermosetting Resin Conduit", "RTRC"; "Fiberglass Reinforced Epoxy Conduit", "FREC"; or equivalent, as applicable.
    b. Normal Size: (IPS)
    c. Manufacturer's name and trademark.
    d. Temperature range for conduit application.
    e. "Above Ground", "AG", "Below Ground", "BG", or equivalent wording, as applicable.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:
1. Use size, type, general routing, location of conduit, raceways, boxes and cabinets as shown and specified.
2. Install metallic raceway, fittings, boxes and cabinets free from contact with reinforcing steel.
3. Where aluminum is placed in contact with dissimilar metal or with concrete, separate contact surfaces by means of gasket, nonabsorptive tape or coating to prevent corrosion.
4. Make metallic conduit, raceways, ducts and cable trays, electrically and mechanically continuous and ground them in accordance with Section 16060.
5. Install FRE conduit where conduit runs are embedded in concrete and where conduit is shown as direct-burial.

B. Conduit:
1. Run exposed conduit parallel to building lines.
2. Install exposed conduit to avoid interference with other work.
3. Apply lead-free conductive anti-seize compound to threaded-conduit joints.
4. In outdoor and underground locations, except electrical rooms, use threaded-conduit hub to attach conduit to equipment enclosure. Use watertight conduit fitting with gasket, nylon-insulated throat and sealing locknuts for attachment of conduit to enclosure having punched or formed knockout.
5. In aboveground indoor locations and electrical rooms, use locknut and nylon-insulated bushing to attach conduit to enclosure.

6. Install suitable caps or plugs in empty conduit for future extension. Leave approved nylon or polyester pull line in each conduit.
7. Thread and ream ends of field-cut conduit to remove rough edges. Use bushing at conduit entrance to boxes, cabinets and equipment enclosures.
8. Bends:
    a. Unless otherwise shown or specified, install conduit bends in accordance with reference codes.
    b. Install bends in buried conduit in accordance with the following:

Size of Conduit (in inches)	Minimum Radius of Factory-Bend (in inches)	Minimum Radius of Field-Bend (in inches)
3	18	24
4	24	30
5	48	48
6	48	48

    c. Total bends in each conduit run for traction-power cable: 225 degrees maximum.
    d. Bend conduit so that field-made bend is free from cuts, dents and other surface damage.
9. Support conduit during construction to prevent distortion and to ensure independent support.
10. Support horizontal conduit with one-hole pipe straps or individual pipe hangers.
11. Secure conduit supported on multiple-hangers (trapeze) or channel inserts by fasteners suitable for such purpose.
12. Where conduit is attached to masonry surface, use malleable-iron spacers with Style A pipe straps.
13. Support and secure vertical conduit spanning open areas at intervals not exceeding 10 feet.
14. Support conduit above suspended ceiling using applicable specified methods.
15. Install conduit so as to drain moisture to nearest outlet or pull box.
16. Use minimum of 18-inch long liquid-tight flexible-conduit connection for equipment enclosure subject to vibration.
17. Do not use wire for support of conduit and cable.
18. Install expansion fitting in exposed conduit runs longer than 300 feet and where shown. Install expansion/deflection fittings where embedded conduits cross structural expansion joints. Where embedded conduits cross a structural contraction joint, paint the external surface of conduit with linseed oil or other compatible bond breaker for two feet on each side of contraction joint.
19. Use metallic conduit or above ground FRE conduit in exposed locations.
20. Conduit installed in outdoor location: Waterproof conduit connection.

C. Outlet, Junction and Pull Boxes:
1. Mount outlet boxes as shown.
2. Arrange front of box or attached plaster cover flush with finished wall or ceiling.
3. Keep number of knock-outs to minimum.
4. Clean boxes thoroughly after installation and correct damage to boxes and to finish.
5. Install covers on boxes mounted on walls and ceilings.
6. Measure height of wall-mounted outlet box from finished floor to horizontal centerline of cover plate.
7. Fasten floor boxes securely in place.
8. Install junction and pull boxes so that covers are readily accessible.

9. Do not install boxes above suspended ceilings except where ceilings are removable or definite provision is made for access to boxes.
10. Use stainless steel (Type 304) mounting channels, retaining straps and fasteners, pipe hangers for conduits and cables; expansion bolt anchors, junction boxes, outlet boxes, cover plates for receptacles, enclosures for load centers in tunnel environment which includes vent and fan shafts and underplatform areas.
11. Use non-metallic boxes as follows:
    a. Buried with cover flush-mounted with finish grade: Precast concrete or composite material junction and pull boxes within AASHTO load designations as specified.
    b. For indoor and outdoor locations not subject to pedestrian or vehicular traffic: Molded fiberglass-reinforced polyester junction and pull boxes.
    c. For outdoor locations but not for burial: Molded polyvinyl chloride junction and pull boxes.

D. Cabinets:
1. Fasten cabinet securely using expansion bolts, toggle bolts or mounting ears.
2. Touch-up damaged painted finish.

E. Use expansion-bolt anchors to secure equipment to concrete surfaces.

F. Attachments to Prestressed-Concrete Girders:
1. Attach pipes, conduits, boxes or similar items to prestressed girders by welding to embedded plates or bolting to embedded fittings. Drilling into prestressed girders is prohibited, except for track fasteners and appurtenances as shown.

3.02 FILLING OF OPENINGS:

A. Where conduit and raceway pass through fire-rated walls, ceilings or floors, provide seals to prevent passage of fire and fumes and to maintain integrity of fire-rated structure in accordance with Section 07481.

B. Where openings are provided for passage of conduit and raceways in walls, ceilings or floors, use fire-resistant fibrous-glass safing or similar material to seal unused openings to prevent passage of fire and fumes in accordance with Section 07841.

C. Close unused openings or spaces in floors, walls and ceilings. Plug or cap unused conduit and sleeves.

3.03 IDENTIFICATION:

A. At end of each run, use stainless steel or aluminum tags, minimum 1-1/2 inch diameter, with stamped markings, minimum 1/4-inch high lettering, and tag holders attached to conduit using a stainless steel band with worm screw clamping device to establish identification of conduits and raceways in accordance with designations shown. Where conduits are terminated flush with concrete structure, install three-ply laminated phenolic plate, engraved through black face to white core and attached adjacent to conduits' entrance by means of non-metallic screws. Engrave conduits' designations within circles arranged in pattern similar to that of conduits.

B. Identify by red painted color code and by marking EMERGENCY SYSTEM on all boxes and enclosures for emergency circuits to identify them as part of an emergency system in accordance with the NEC.

3.04 FIELD QUALITY CONTROL:

A. Arrange with the Engineer for inspection and approval of embedded conduit and boxes prior to concrete placement.

B. Arrange with the Engineer for inspection by electrical utility company representative of incoming-service conduit prior to placing concrete.

C. Test metallic conduit and boxes for electrical continuity. Conduct tests in presence of Engineer.

D. Test not less than 0.5 percent of total installed channel inserts and spot inserts as directed for compliance with specified pullout-load rating. Replace and retest inserts which fail. Conduct tests in presence of Engineer.

E. Arrange with the Engineer for inspection and approval of direct-buried conduits for future train control circuits prior to backfilling.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 16145

WIRING AND CONTROL DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing switches, cover plates, limit switches, occupancy sensors, receptacles, plugs, magnetic contactors, automatic transfer switches, photoelectric controls and time switches.

B. Related Work Specified Elsewhere:

1. Wire connection accessories: Section 16125.

2. Grounding and bonding: Section 16060.

3. Raceways, boxes and cabinets: Section 16130.

C. Compensation for work specified in this section will be made in the following manner:

1. Basic Materials: Lump Sum.

2. Installation: Lump Sum.

3. Additional Work: Work not included in lump sum price but required to complete work, such as replacement of cables that did not pass testing, shall be based on Unit Price Schedule.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of the jurisdictional authorities.

2. National Electrical Code (NEC).

3. National Electrical Manufacturers Association (NEMA):WD1, General Color Requirements for Wiring Devices*;* KS1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum); ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; ICS 12, Profiles of Networked Industrial Devices--Part 1: General Rules; NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

4. American National Standards Institute (ANSI): Z55.1, Gray Finishes for Industrial Apparatus and Equipment.

5. UL: 98, Enclosed and Dead-Front Switches; 198D, Class K Fuses; 198E, Class R Fuses; 508, Industrial Control Equipment; 773, Plug-In Locking-Type Photocontrols for Use With Area Lighting; 1008, Transfer Switch Equipment.

6. American Standards of Testing and Materials (ASTM): A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings; A276-00a, Standard Specification for Stainless Steel Bars and Shapes; and A507-00, Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled.

7. ITS: Directory of ITS Listed Products

B. Source Quality Control:

1. Following items listed per referenced UL or ITS directory:

a. Snap switches.

b. Disconnect switches.

c. Receptacles and plugs.

C. 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.

D. Qualifications: Select a manufacturer who is regularly engaged in the production of automatic transfer switches.

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. Catalog cut sheets.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mark each item in accordance with applicable reference standard.

B. Ship each unit securely packaged and labeled for safe handling and to avoid damage

C. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

1.05 PRODUCTS AND MATERIALS:

A. Snap Switches:

1. NEMA WD1, specification grade.

2. Rating:

a. Twenty amperes at 120-277 volts ac.

b. Horsepower-rated when used as disconnecting device for motor circuit.

3. Body and base: Fully enclosed, brown, fire-resistant, non-absorptive thermosetting urea or nylon.

4. Contacts: Silver alloy.

5. Mounting yoke: Corrosion-resistant metal with plaster ears.

6. Poles: Single-pole, double-pole, three-way or four-way as shown.

B. Disconnect (Safety) Switches:

1. UL 98, NEMA KS1, heavy-duty, fusible or non-fusible as shown.

2. Voltage rating: 240 volts ac, 480 volts ac or 250 volts dc as shown and as necessary.

3. Number of poles and current rating: As shown and as necessary.

4. Fuses:

   a. UL 198D.

   b. For fused disconnect switch associated with motor load: UL Class RK5 with time delay or as shown.

   c. For fused disconnect switch associated with other loads: UL Class RK1 or as shown.

   d. Current rating: As shown.

5. Enclosure: (NEMA 250)

   a. Type:

      1) For aboveground indoor locations and electrical rooms: Type 1.

      2) For tunnel and underground locations, except electrical rooms: Type 4.

      3) For outdoor locations: Type 3R.

   b. Materials:

      1) Steel sheet: ASTM A507-00.

      2) Malleable iron: ASTM A47/A47M-99.

   c. Finish: Metallic surface cleaned, degreased, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.

6. Quick-make/quick-break switching mechanism with operating handle external to enclosure with positions labeled ON/OFF and capable of being padlocked in OFF position, defeatable interlock to prevent opening of enclosure door when switch is closed.

C. Receptacles and Plugs:

1. NEMA WD1, specification grade.

2. Rating: 20 amperes at 125 or 250 volts as shown.

3. Base and body: Brown, fire-resistant, non-absorptive thermosetting urea or nylon.

4. Receptacles:

   a. Outlet: Single or duplex as shown.

   b. Mounting yoke: Corrosion-resistant metal with plaster ears.

c. Configuration:

Rating	NEMA Configuration
Two-pole, three-wire, 20 amps, 125 volts	5-20 R
Two-pole, three-wire, 20 amps, 250 volts	6-20 R

d. For use in restroom; water service room; locker room; wash rooms; elevator machine room, pit and hoistway; and outdoor locations: Equipped with solid-state ground-fault circuit interrupter with five-milliampere trip level.

5. Plugs:

a. Configuration and design: As follows unless otherwise shown:

Rating		NEMA Configuration
Two-pole, three-wire, 20 amps, 125 volts	Urea or neoprene with cord grip	5-20 P
Two-pole, three-wire, 20 amps, 250 volts	Armored cap with cord grip	6-20 P

D. Cover Plates:

1. Wall plates:

a. NEMA WD1, suitable for specified receptacles and switches, size suitable for recess-mounted or surface-mounted associated outlet box, stainless steel, ASTM A276-00a, Type 304, or approved equal.

b. For use in indoor public areas: Bronze, with M32 medium satin finish as specified in Section 05700.

c. For above ground indoor service areas and electrical rooms: Steel, stainless steel or aluminum plate, as standard with the manufacturer.

d. For receptacles in outdoor and underground locations, except electrical rooms: Stainless steel, ASTM A276-00a, Type 304, wall plate with gasketed spring-loaded hinged cover.

2. Floor plates: Section 16130.

PART 3 - EXECUTION

1.06 INSTALLATION:

A. Install switches, receptacles, lighting contactor, photoelectric controls and time switches as shown and in accordance with referenced codes and standards in Article 1.2, and manufacturer's instructions.

B. Install cover plate on switch and receptacle.

C. Install cover plate with gasketed spring-loaded cover, on each receptacle in outdoor and underground locations except electrical rooms.

D. Ground disconnect switches, receptacles, snap switches, in accordance with Section 16060.

E. Make power cable connections to snap switches, plugs, receptacles, by means of integral mechanical connectors. If such items are not furnished with integral mechanical connectors, make connections using compression connectors in accordance with Section 16125.

F. Make power cable connections to snap switches and receptacles using their side screw wiring connection terminals.

G. Apply matching touch-up paint as necessary.

1.07 FIELD QUALITY CONTROL:

A. Furnish necessary test equipment and perform the following in the presence of the Engineer, in accordance with approved procedures:

1. Test receptacles for connection in accordance with wiring diagram.

2. Test equipment enclosure for continuity to grounding system.

3. Check tightness of cable connections of snap switches, receptacles, time switches, occupancy sensors, disconnect switches, automatic transfer switches, lighting contactors, photoelectric controls and limit switches.

4. Test operations of circuits of switches and receptacles.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 16440

CIRCUIT BREAKERS, PANELBOARDS AND LOAD CENTERS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies furnishing, installing, connecting and testing of load centers.

B. Related Work Specified Elsewhere:

1. Raceways, boxes and cabinets: Section 16130.
2. Wire, cable and busways: Section 16120.
3. Wire connection accessories: Section 16125.
4. Grounding and bonding: Section 16060.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of the jurisdictional authorities.
2. NEC.
3. NEMA: AB1, PB1, ST20, 250.
4. ANSI: Z55.1.
5. UL: 50, 67, 198C, 489, 891, Electrical Construction Materials Directory.
6. ASTM: A276, B187.
7. ITS: Directory of ITS Listed Products.

B. Source Quality Control:

1. Each item listed per referenced UL or ITS directory.

C. 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.

1.03 SUBMITTALS:

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

1. Shop Drawings.
2. Certification.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mark each circuit breaker, panelboard and transformer in accordance with applicable reference standard.

B. Ship each unit securely packaged and labeled for safe handling and to avoid damage or distortion.

C. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. General Requirements:

1. Interchangeability: Components of the same type, size, rating, functional characteristics and make are to be interchangeable.

2. Finish for enclosures for load centers:

a. Clean and degrease metallic surfaces.

b. Prime with zinc primer.

c. Finish with one coat of light-gray enamel, ANSI Z55.1, Color 61. Minimum dry-film thickness: Two mils.

B. Load Centers:

1. Enclosure:

a. UL 891, stainless steel, ASTM A276, Type 316, NEMA 250 type 4X or approved equal.

b. Type:

1) Underground locations, except electrical rooms and tunnel areas: Non-ventilated outdoor.

2) Outdoor locations and tunnel areas: Non-ventilated outdoor.

2. Transformer:

a. NEMA ST20, dry, self-cooled, epoxy-encapsulated, double-wound with insulated copper conductor with 185C-insulation system capable of withstanding full-wave impulse voltage of 10KV.

b. Five kVa load center: Single-phase, 60 Hertz, 480 volts primary to 120/240 volts secondary.

c. Nine kVA load center: Three-phase, 60 Hertz, 480 volts primary to 120/208Y volts secondary.

d. Fifteen kVa load center: Three-phase, 60 Hertz, 480 volts primary to 120/208Y volts secondary.

e. Maximum allowable temperature rise under continuous full load above ambient temperature of 30C and 40C maximum:

1) By winding resistance: 115C.

2) By hottest spot in winding: 145C.

3. Circuit breaker:

    a. Bolt-on or plug-in, as specified.

    b. Primary circuit breaker: 480 volts, bolt-on, 14,000-rms symmetrical amperes interrupting capacity, 100-ampere frame, with the following additional requirements:

        1) For five kVa load center: Two-pole breaker with 20-ampere trip setting.

        2) For nine kVa load center: Three-pole breaker with 25-ampere trip setting.

        3) For 15 kVa load center: Three-pole breaker with 40-ampere trip setting.

    c. Secondary main circuit breaker:

        1) Bolt-on, two or three poles as shown, 240 volts, 10,000-rms symmetrical amperes interrupting capacity with trip setting as follows:

            a) For five kVa load center: 25 amperes.

            b) For nine kVa load center: 30 amperes.

            c) For 15 kVa load center: 50 amperes.

    d. Branch circuit breaker:

        1) Single-pole, plug-in, 120 volts, 10,000-rms symmetrical amperes interrupting capacity.

            a) For five kVa load center: Four breakers, each with 20-ampere trip setting.

            b) For nine kVa load center: Six breakers, each with 20-ampere trip setting.

            c) For 15 kVa load center: Twelve breakers, each with 20-ampere trip setting.

    e. Nameplate: Laminated plastic, one-inch high, attached by means of stainless-steel rivets or screws, showing load-center number in 1/2-inch high white characters engraved on black background.

    f. Neutral and ground bus bar equipped with mechanical connectors.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install panelboards at locations shown, with bottom not less than 12 inches above floor. Use multiple-section panelboards to meet such spacings if necessary.

B. Mount panelboards and load centers with front straight and plumb.

C. When feeder serves more than one panelboard or panelboard section, install separate junction box or provide adequate gutter area for termination of feeders and bus taps.

D. Install single and/or multiple-conductor cable in accordance with Section 16120. Connect branch circuit wires as shown. Connect neutral wire of branch circuit to neutral bar in panelboard.

E. Install load centers where shown.

F. Make conduit connections in accordance with Section 16130.

G. Make power cable connections to circuit breakers, integrally fused circuit breakers, fused switch units, neutral and ground bus bars in panelboard and load centers and enclosed circuit breakers by means of integral mechanical connectors. If such items are not furnished with integral mechanical connectors, make connections using compression connectors in accordance with Section 16125.

H. Ground panelboards, load centers and enclosed circuit-breaker enclosures in accordance with Section 16060 and the NEC.

I. Apply matching touch-up paint where necessary.

3.02 DIRECTORY OF CIRCUITS:

A. Furnish each panelboard and load center with legibly printed circuit directory located on inside of enclosure.

3.03 FIELD QUALITY CONTROL:

A. Furnish necessary equipment and perform the following tests:

1. Load centers: Perform insulation-resistance tests of each bus section phase-to-phase and phase-to-ground for one minute using 1,000V megger. Insulation resistance to be not less than manufacturer's recommended minimum or two megohms minimum.

2. Test circuit connections in accordance with wiring diagram.

3. Test load-center enclosures for continuity to grounding system.

4. Check cable connections to circuit breakers and fused switch unit for tightness.

5. Check setting of adjustable magnetic trips for compliance with approved coordination study.

B. Submit certified test reports.

END OF SECTION

SECTION 16525

LIGHTING FIXTURES AND MOUNTING POLES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing lighting fixtures and mounting poles.

B. Related Work Specified Elsewhere:

1. Grounding and bonding: Section 16060.
2. Wire, cable and busways: Section 16120.
3. Wire connection accessories: Section 16125.
4. Raceways, boxes and cabinets: Section 16130.
5. Wiring and control devices: Section 16145.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of jurisdictional authorities.
2. NEC.
3. UL: 496, 542, 1029, 1570, 1571, 1572, Electrical Construction Materials Directory.
4. FS: FF-B-588, FF-P-395, FF-S-325C.
5. MS: MIL-C-450.
6. FED STD: 595.
7. PEI: 1001.
8. SSPC: SP-8, SP-10.
9. ASTM: A53, A167, A276, A123, A507, A575, B26, B85, B117, B136, B137, B209, B221, B244, D635, D1056, D1400, D2240.
10. AASHTO: M314, LTS-3.
11. ITS: Directory of ITS Listed Products.
12. AA: Standard finishes as designated by the Aluminum Association and referenced in NAAMM Metal Finishes Manual.
13. ANSI/IEEE: C62.41.
14. IEEE Publication 587.
15. ANSI Standards.
16. FCC Rules and Regulations, Part 15, Part 18.

17. NEMA 1

18. AISI.

19. IES: RP-20

B. Each lighting fixture to be labeled or listed per referenced UL or ITS directory.

C. 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.

1.03 SUBMITTALS:

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

1. Shop Drawings:

a. Include photometric curves.

2. Samples: One of each type of fixture.

3. Certification:

a. Verification that each fixture is in compliance with applicable codes, regulations, reference standards and specifications for the location at which it is to be used. Indicate requirements that each fixture meets.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.

B. Store lighting fixtures and mounting poles in secure and dry storage facility.

1.05 WARRANTY:

A. Globes and Diffusers: In addition to warranty requirements of the General Provisions, furnish warranty against discoloration and distortion for a total of four years.

B. Lamps: Warrant the life of lamps for periods specified.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. General Requirements for Lighting Fixtures:

1. Interchangeability: Components of same type, size, rating, functional characteristics and make are to be interchangeable.

2. In accordance with UL 1570, UL 1571 and UL 1572.

3. Materials:

a. Steel:

1) Sheet: ASTM A507, 22-gauge minimum.

2) Bar: ASTM A575.

b. Steel pipe: ASTM A53, Type S.

c. Stainless steel:

1) Sheet: ASTM A167, 22-gauge minimum.

2) Bar: ASTM A276, Type 316.

3) Finish: AISI Alloy S30400, NAAMM Finish No. 4, unless otherwise shown.

d. Aluminum: Alloy as recommended by manufacturer, unless otherwise shown or specified.

1) Sheet and plate: ASTM B209.

2) Extrusion: ASTM B221, 0.109-inch minimum thickness, unless otherwise shown.

3) Cast:

a) Die cast: ASTM B85, 0.1875-inch minimum thickness, unless otherwise shown.

b) Sand cast: ASTM B26, 0.1875-inch minimum thickness, unless otherwise shown.

c) Color-anodized cast: Kalcolor Casting Alloy No. 2 or equal.

4. Lamps:

a. In accordance with applicable ANSI Standards.

b. Fluorescent:

1) Wattage and size: As shown or specified.

2) Color: Warm white.

3) Type:

a) PL7 compact, PL13 compact.

b) F6T5/CW and F20T12WW, Preheat start.

c) F32T8/WW, F48T12/WW/SHO, F72T12/WW/SHO, and F96T12/WW/SHO: Rapid start.

4) Rated life:

a) Super-high output (SHO), very-high output (VHO) and high output (HO) lamps: 12,000 hours.

b) F32T8/WW: 20,000 hours.

c) PL compact lamps: 10,000 hours.

5) Base:

a) Super-high output (SHO), very-high output (VHO) and high output (HO) lamps: Recessed double contact.

b) F32T8/WW: Medium bi-pin.

c) PL7 medium.

c. LED: As specified.

5. Lampholders:

a. Fluorescent:

1) In accordance with UL 542.

2) Rated 660 watts, 600 volts.

3) Integral starter holder for preheat-type lamps, with starter.

4) White, thermosetting phenolic-compound base and body, silver-plated phosphorous-bronze contacts, self-aligning neoprene gasket face.

6. Ballasts:

a. Fluorescent lamps:

1) FCC part 15 subpart J, UL listed Class P.

2) Operable on 120-volt or 277-volt, 60 Hertz, as shown or necessary, type and load rating suitable for associated lamps.

3) Capable of starting lamps at ambient temperature as follows:

a) F32T8/WW lamps: Zero degree F.

b) F48T12/WW/SHO, F72T12/WW/SHO, and F96T12/ WW/SHO lamps: Minus 20F.

4) Sound rating:

a) For use with F32T8/WW lamps installed in office areas: A.

b) For use with F32T8/WW lamps installed in ancillary areas: B or better.

c) For use with F48T12/WW/SHO, F72T12/WW/SHO, and F96T12/WW/SHO lamps: D or better.

5) Maximum utilization of two-lamp ballasts in public-area lighting fixtures.

6) Equipped with individual fuse protection, installed in the fixture wiring channel.

7. Fixture body and housing: Shape, size and material as shown.

8. Reflector: Shape, size and material as shown. Aluminum or stainless steel polished to mirror finish unless otherwise shown. Minimum thickness 22 gauge unless otherwise shown.

9. Diffusers:

    a. Shape and size as shown, one-piece molded or extruded clear virgin acrylic or polycarbonate plastic having the following properties:

        1) Interior diffusing with smooth exterior surface.

        2) Self-extinguishing, in accordance with ASTM D635.

        3) No material color change when used with 4500K fluorescent lamp.

        4) No apparent yellowing after 500 hours exposure to fluorescent-lamp source under conditions similar to those existing in the lighting fixture.

        5) No alteration to optical properties of the fixture when finished diffuser treated with anti-static wax.

    b. Formed by carefully controlled processes so that the finished piece retains its design contours and dimensions at normal operating temperature.

    c. Resistance to shrinking, warping, crazing, cracking, or discoloring, either in service or when stored in the manufacturer's standard shipping containers under normal conditions.

10. Globes:

    a. Clear seamless polycarbonate or high-impact heat-resistant glass as shown.

    b. Shape and size: As shown.

    c. Minimum thickness: 0.125 inch, surface free from visible mold seam.

    d. Reduction in strength: 10-percent maximum after five years.

    e. Maximum haze: Two percent.

    f. Minimum light transmittance: 88 percent.

11. Lenses:

    a. Plastic lenses: Clear polycarbonate as shown, minimum thickness 0.06 inch.

    b. Glass lenses: 1/4-inch tempered glass, laminated glass, or 1/8-inch double-strength clear glass as shown, capable of absorbing ultraviolet rays when used with mercury-vapor or metal-halide lamps.

    c. Refracted lenses: Heat-resistant, annealed, clear borosilicate glass, with the following additional requirements:

        1) Initial lumen distribution on horizontal plane evenly from zero to 90 degrees: 55 to 60 percent.

        2) Minimum efficiency: 85 percent.

12. Fixture wire: Section 16120.

13. Gasket:

    a. Keyed gasket: One-piece, extruded solid neoprene having Type A durometer hardness of 30 plus-or-minus five when tested in accordance with ASTM D2240.

    b. Self-retaining gasket:

        1) One-piece, closed-cell sponge neoprene, soft or medium density.

        2) Resistant to aging, heat, ultra-violet light, water, oil, weathering and setting as determined by ASTM D1056.

        3) Cemented to component with resilient neoprene sealing compound compatible with finish. Adhesive not applied to diffuser.

    c. Silicone gasket equal to neoprene, at Contractor's option.

14. Hardware:

    a. Latches, catches, release mechanisms, hinges, screws, bolts, studs, nuts, rivets, washers and springs. Heavy-duty stainless steel or bronze, as shown.

    b. Latches and catches: Captive-type.

    c. Operating hardware: Self-retaining type.

15. Construction:

    a. Fixture body, reflectors, wiring channels, end caps and castings formed so as to prevent buckling or distortion.

    b. Minimum of two wire clips provided in wiring channel to support wiring. Self-cleaning air filter provided on breather ports.

    c. Seams and joints continuously welded and ground smooth.

    d. When aluminum will be in contact with dissimilar metal, separate contact surfaces with gasket, nonabsorptive tape, or coating to prevent corrosion.

16. Finish:

    a. Baked enamel: Nonspecular finish consisting of six-stage hot-cleaning wash, phosphate coat, prime coat, and finish coat of sprayed white or other color acrylic enamel as shown, baked at 350F for a minimum of 30 minutes, with the following additional requirements:

        1) Dry-film thickness (DFT) per ASTM D1400: 1.25 mils minimum.

        2) Undercutting of enamel film from scored line after exposing to 10-percent salt spray for 1,500 hours, per ASTM B117: 0.067-inch maximum.

        3) Baked white enamel after 100 hours exposure to fadeometer: 86-percent minimum reflectance factors, no appreciable visual color change.

4) Bronze color: FED STD 595, Color No. 20040.

b. Porcelain enamel: Opaque, fused vitreous surface finish, 88-percent average reflectance factor, in accordance with the following standards:

1) On steel: PEI 1001.

2) On aluminum alloy: PEI 1001.

c. Specular anodized coating: 14-stage process for permanently sealed specular or semispecular finish, as shown, in accordance with patented electrolytic process, Alzak or equal. When shown dark-bronze color, match Duranodic 313 Dark Bronze.

d. Clear anodic coating: AA-M22C22-A41, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot-water seal overall, tested in accordance with the following requirements:

1) Coating weight: ASTM B137.

2) Coating thickness: ASTM B244.

3) Sealing test: ASTM B136.

4) Undercutting of anodic film from scored line after exposing to 10-percent salt spray for 1,500 hours, in accordance with ASTM B117: 0.067-inch maximum.

e. Color-anodized finish: NAAMM AA-M22-C22A42, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot-water seal overall, tested in accordance with the following requirements:

1) Coating weight: ASTM B137.

2) Coating thickness: ASTM B244.

3) Sealing test: ASTM B136.

4) Color: Dark Bronze. Kaiser Aluminum Color, Statuary Bronze; Alcoa Color, Dark Bronze, Duranodic 313.

f. Zinc coating: ASTM A123.

g. Factory-painting: Prepare surfaces by pickling in accordance with SSPC SP-8. Apply coating of 7.0-mil total DFT as follows:

1) First coat: Inorganic zinc-silicate primer, 2.5-mil DFT.

2) Second coat: High-build epoxy primer, 3.0-mil DFT.

3) Third coat: Aliphatic polyurethane, 1.5-mil DFT, FED STD 595, Color No. 20040.

h. Field painting: Section 09920.

i. Electrostatic-powder coating: Prepare surfaces by sandblast cleaning complying with SSPC SP-10 near-white blast cleaning, applying coating promptly after cleaning. Ground material to be coated. Apply coating as

electrostatically-charged dry powder using electrostatic spray gun to produce DFT of six mils plus-or-minus two mils. Cure by heat treatment.

17. Mark each fixture and its components in accordance with applicable reference standard.

18. Conduit: Section 16130.

19. Connectors: Section 16125.

20. Fasteners: Size and type shown or best suited to use.

    a. Expansion anchors: FS FF-S-325C, Group II, Type 3, Class 1, stainless steel, Type 303.

    b. Toggle bolts: FS FF-B-588.

    c. Powder-actuated: FS FF-P-395.

    d. Finish: Where exposed, custom finish exposed parts to match surface being fastened.

2.02 LIGHTING FIXTURES:

A. Tunnel and Ancillary-Space Lighting Fixtures: Types as shown.

B. Other Lighting Fixtures: Types as shown, with materials and finishes shown and specified.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install lighting fixtures of types shown at locations shown as follows:

1. Mount fixtures rigidly in place. Use expansion anchors and machine screws for concrete surfaces and toggle bolts for hollow concrete-masonry surfaces. Use appropriate fasteners for attachment to other surfaces. Support lighting fixtures independent of suspended acoustical-panel ceiling systems.

2. Where aluminum contacts concrete or dissimilar metal, separate contact surfaces with gasket, nonabsorptive tape or bituminous coating to prevent corrosion. Use stainless-steel fasteners.

3. Mount fixtures plumb, level and in straight lines. Install stems of suspended fixtures plumb. Group-mounted fluorescent fixtures to appear as one unit.

4. Install 12-inch minimum length of liquid-tight flexible conduit for connection between fixture and outlet box unless otherwise shown in accordance with Section 16130. Use fixture wire from outlet box in branch circuit to lighting fixture in accordance with Section 16120, and connect fixtures to branch circuit in accordance with Section 16125

5. Install chase nipple where fluorescent fixtures are installed in continuous groups. Clean lamps, diffusers, globes, reflectors and exposed-to-view surfaces of fixtures after aiming and adjusting has been approved.

3.02 FIELD QUALITY CONTROL:

A. Testing:

1. Furnish necessary personnel and equipment and perform tests and adjustments in the presence of the Engineer. Schedule adjustment of exterior installations to occur during hours of darkness.

2. Test lighting circuits for continuity and operation.

3. Test fixtures and mounting poles for continuity of grounding system.

4. Aim and adjust fixtures to provide distribution pattern approximately as shown and as approved.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 16565

FLASHER AND DIMMER CONTROL SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing flasher and dimmer control system for platform-edge lights.

B. Related Work Specified Elsewhere:

1. Grounding and bonding: Section 16060.
2. Wire, cable and busways: Section 16120.
3. Wire connection accessories: Section 16125.
4. Raceways, boxes and cabinets: Section 16130.
5. Lighting Fixtures and Mounting Poles Section 16525

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

1. Comply with codes and regulations of jurisdictional authorities.
2. NEC.
3. NEMA: ICS2, AB1, 250.
4. ANSI: Z55.1.
5. UL: 50, Electrical Construction Materials Directory.
6. ITS: Directory of ITS Listed Products.

B. Source Quality Control:

1. Each item listed per referenced UL or ITS directory.

1.03 SUBMITTALS:

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

1. Shop Drawings:
    a. Drawing showing outline dimensions, cross section showing internal construction and weights.
    b. Internal wiring diagram.
    c. Characteristic data of 24-volt dc coil in flasher and dimmer control system.
2. Certification.
3. Operation and Maintenance Manuals.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage.

B. Store products in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. General Requirements:

1. Provide product compatible with platform edge lights being supplied.

2. Components of the same type, size, rating, and functional characteristics to be interchangeable.

3. Furnish similar items such as flasher and dimmer control unit, time switch and selector switch and associated components as products of single manufacturer.

B. Flasher and Dimmer Control System: Rated to operate on 120/208-volt three-phase four-wire supply with continuous output of six kilowatts, guaranteed life of 10,000,000 flash cycles, all the lamps flashing simultaneously; having suitable protection device, compatible with fixtures provided at platform edge, with the following additional requirements:

1. Flasher:

a. Solid-state design.

b. Flash rate: 60 flashes per minute, plus-or-minus five percent.

c. Flash-mode intensity: Adjustable from 50 to 100 percent of lamp brightness.

d. Control relay coil:

1) Nominal coil voltage: 24 volts dc.

2) Coil pick-up voltage: 85 percent of nominal voltage, minimum.

3) Coil resistance: 150 ohms, minimum.

4) Suppression network adequate to limit inductive voltage to 250 volts and load to 15 volt-amperes maximum.

e. No interaction between intensity control and rate of flashing.

2. Dimmer:

a. Solid-state design.

b. Continuous output: Six kilowatts.

c. Capable of operating within ambient temperature range of zero degree C to 40C and relative humidity of 20 percent to 90 percent.

d. Capable of varying lamp intensity from 50 to 100 percent.

e. Capable of withstanding current inrush to incandescent lamps when switched from zero-volt condition to 120-volt supply.

f. Designed to prevent false triggering of silicon-controlled rectifiers, interaction with other dimmer system and objectionable radio-frequency interference with communication and signal equipment.

g. Maximum voltage drop at full load: Three volts.

h. Output-voltage variation with input-voltage variation between 95 and 135 volts: One-volt maximum.

i. Equipped with filter choke to eliminate spurious harmonics and lamp-filament singing.

3. Time switch:

a. Seven-day and 24-hour calibration for each day time switch, UL-listed, heavy-duty, suitable for controlling LED lighting fixtures when fed via flasher and dimmer control system.

b. Three-pole single-throw switch capable of switching a continuous load of 20 amperes at 208Y/120-volt system.

c. Seven-day and 24-hour dial dial with day and night zones and 24-hour calibration for each day clearly marked.

d. Providing up to four automatic ON/OFF operations each day.

e. Adjustable ON/OFF actuators designed for minimum ON period of one hour and minimum two-hour period between one OFF operation and next ON operation.

f. Provision for manual ON/OVERRIDE/OFF operation of switch without disturbing weekly preset schedule.

g. Provision for omitting operation of switch on selected days.

h. Spring-driven reserve power suitable for operation of switch for minimum of 16 hours after failure of power. On restoration of power, switch transfers to synchronous motor drive and automatically rewinds spring.

i. Terminals designed to accommodate up to 8AWG conductor cable.

j. Operation at 208Y/120 volts, 60 Hertz and within temperature range of zero degree F to plus 140F.

4. Enclosure:

a. NEMA 250, Type 1, galvanized steel, surface-mounted.

b. Hinged, flush front door with latch and handle in accordance with UL 50; screw fastenings will not be accepted in lieu of latch.

c. Finish: Metallic surfaces cleaned, degreased, primed with zinc primer and finished with light-gray enamel, ANSI Z55.1, Color 61; minimum dry-film thickness, two mils.

5. Selector switch:

    a. NEMA ICS2-216, UL-listed, heavy-duty rotary switch suitable for controlling incandescent lighting fixtures.

    b. One three-pole switch or three single-pole switches capable of switching continuous load of 20 amperes at 208 volts.

    c. Knob for manual operation of the switch to three positions labeled AUTO/OFF/ON. AUTO position provides for controlling the light by time switch through flasher and dimmer control unit, OFF position disconnects the power; ON position bypasses the time switch and turns lights on through flasher and dimmer control unit.

    d. Selector switch furnished as an integral part of the time switch.

6. Controls: Following controls provided on door:

    a. Dimmer control: To vary lamp intensity from 50 to 100 percent, with scale marking.

    b. Flash-mode intensity control: To vary flash-mode intensity from 50 to 100 percent, with scale marking.

    c. Two-position selector switch marked MANUAL for manual operation of flasher for testing and AUTO for automatic operation of flasher by dc signal.

    d. Flasher and dimmer control unit ON/OFF switch.

7. Indicator lights: Following lights provided and identified on door:

    a. Red light to indicate unit is ENERGIZED.

    b. Green light to indicate dimmer is ON.

    c. Amber light to indicate flasher is ON.

8. Circuit Breaker: Three-pole, 20-ampere, molded-case, having interrupting capacity of 10,000 amperes conforming to NEMA AB1 provided on outgoing feeder.

9. Nameplate:

    a. Three-ply, laminated phenolic plate, engraved through black face to white core and attached by means of stainless-steel rivets or screws on each flasher and dimmer control system and its components. Lettering to be vertical gothic using round or square cutter. V-shaped groove not acceptable.

        1) Each flasher and dimmer control system labeled with nameplate 1-1/2 inches high inscribed in letters one-inch high: FLASHER AND DIMMER CONTROL SYSTEM.

        2) Each major component of flasher and dimmer control system labeled with nameplate one-inch high inscribed in letters ½-inch high: FLASHER AND DIMMER CONTROL SYSTEM or TIME SWITCH, as appropriate.

3) In addition to other information normally displayed on equipment, provide one-inch nameplate showing in letters ½-inch high switch positions, meaning of indicator lamp and other pertinent information.

b. On each flasher and dimmer control unit and on each time switch, provide nameplate with manufacturer's name, brand designation, reference standard, type, class and rating as applicable.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install flasher and dimmer control system at locations shown and in accordance with the NEC.

B. Install conduit, as shown and as necessary, in accordance with Section 16130.

C. Install and connect wire and cable as shown and as necessary, in accordance with Sections 16120 and 16125.

D. Connect and adjust time switch so that it turns on flasher and dimmer control unit for seven-day time schedule as directed.

E. Connect dc control coil in flasher and dimmer control unit to DTS-cabinet terminals or as required for outbound-train signal or inbound-train signal as directed.

F. Ground enclosure of flasher and dimmer control system in accordance with Section 16060.

G. Set dimmer control at 50-percent and flasher-mode intensity control at 100-percent intensity of platform-edge lights.

H. Apply touch-up paint where necessary.

3.02 DIRECTORY OF CIRCUITS:

A. Furnish each selector and time switch, flasher and dimmer control unit with legible circuit directory located on an accessible spot inside enclosure.

3.03 FIELD QUALITY CONTROL:

A. Furnish necessary equipment and perform the following tests:

1. Test circuits for connections in accordance with the wiring diagram.

2. Test cable in accordance with the requirements of Section 16120.

3. Test flasher and dimmer control-system enclosure for continuity of the grounding system.

4. Test operation of time switch for Automatic and OFF of ac power to flasher and dimmer control unit, and ON for manual bypass of time switch.

5. Test operation of flasher and dimmer control unit in conjunction with the time switch with flasher controlled by 24-volt dc signal.

B. Submit certified test reports.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 16721

COMMUNICATIONS TELEPHONE CABLING SYSTEM

PART 1 - GENERAL

1.01 SECTION DESCRIPTION AND BASIC REQUIREMENTS

A. The Telephone Cabling System is part of the WMATA telecommunications network. Its purpose is to provide telephone and LAN/WAN service to WMATA personnel in selected locations within, and associated with, the Yard Buildings.

B. The Contractor shall install printed labels for all cables and cords, distribution frames, and outlet locations. No labels shall be written by hand. Machine labeling shall be used on all information outlets, patch panels, punch blocks, feed cables, etc.

C. The Emergency Trip Station telephones are grouped into circuits. Inbound and outbound Emergency Trip Station telephones at the same location are wired to the same group circuit. No more than four Emergency Trip Station telephones are wired to any one circuit.

D. In the event of an emergency, the ETS telephone instrument in the vicinity of the incident will be used to contact the Operations Control Center. Depressing the "0" button shall be recognized by the Rolm CBX as an Emergency Trip Station Emergency Communications call. The call is automatically switched by the Rolm CBX to a telephone instrument in the Operations Control Center assigned to respond to that specific area of the rapid rail system.

1.02 SECTION INCLUDES

A. Telephone instruments in Emergency Trip Station (ETS) enclosures along the right-of-way.

B. Replacement of 25-Pair communication cable between ETSs and from ETSs to the Communications Equipment Room in each station.

1.03 REFERENCES

A. National Electrical Manufactures Association (NEMA) Standard Publication 250-1997, Enclosures for Electrical Equipment (1000 Volts Maximum)

B. National Electric Code

C. ANSI/EIA/TIA-568-B Commercial Building Wiring Standard

D. ANSI/EIA/TIA-568-B.2-1 Commercial Building telecommunications

E. Cabling Standard Twisted pair Components Addendum1 -

F. ANSI/EIA/TIA-568-B.2-6 Commercial Building telecommunications

G. Cabling Standard Twisted pair Components Addendum 6 - Related Components Test Procedure.

1.04 SUBMITTALS

A. Proposed Product List:

1. Within 30 days after date of Notice to Proceed, submit list of major products

proposed for use, with name of manufacturer, trade name, and model number of each product.

2. If “equal” products are proposed by the Contractor, he shall insure that the proposed products will interface and operate properly with other Contractor-supplied products, subsystems and systems, and with existing communications products, subsystems, and systems.

B. Shop Drawings - Indicate physical dimensions, electrical characteristics and connection requirements, including system wiring diagram.

C. Product Data - Provide manufacturer’s cut sheets and drawings showing dimensions, materials, electrical characteristics and connection requirements for each component.

D. Manufacturer's Installation Instructions - Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.05 QUALIFICATIONS

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

B. Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.

C. Installer: Service facilities within 50 Miles of Project.

1.06 SYSTEM DESCRIPTION

A. Emergency Trip Station telephones are grouped into circuits. Inbound and outbound Emergency Trip Station telephones at the same location are wired to the same group circuit. No more than four Emergency Trip Station telephones are wired to any one circuit.

1.07 SYSTEM PERFORMANCE REQUIREMENTS

B. The following overall system performance objectives are applicable to WMATA’s existing Telephone System, and shall be maintained when performing the work in this Contract.

1. Frequency Response: (end-to-end) 300 Hz to 3000 Hz, maximum 6 dB at 3000 Hz.

2. Maximum Loss: shall not exceed 8.5 dB at 1000 Hz (from Communications Equipment Room to telephone instrument).

3. Noise Objective: 20 dBrnC with 30 dBrnC maximum noise terminated into 900-ohm impedance.

4. Loop Resistance: shall not exceed 1300 ohms (terminated into a short circuit).

5. Loop dc Current: not less than 23 mA.

6. Balance Ratio: not less than -50 dB.

PART 2 - PRODUCTS

2.01 EMERGENCY TRIP STATION TELEPHONE INSTRUMENT

A. Manufacturer:

1. Gai-Tronics Model No. 240 (or approved equal).

B. Face plate of heavy gauge steel, corrosion resistant, dustproof.

C. Handset: Cradle of cast aluminum with nylon coating with heavy duty handset cord of appropriate length to fit into enclosure.

D. With 4-position terminal block and gas discharge tube surge protector.

E. With protector blocks and Weidmuller AKZ 2.5 terminal blocks (or approved equal), as required.

F. Compatible with the Emergency Trip Station enclosures..

G. Ratings:

1. Type: Analog Telephone Instrument with electronic ringer

2. Keypad Type: DTMF covered with protective seal.

2.02 25 PAIR/22 AWG TIE CABLE

2.03 MANUFACTURER:

1. Superior Model TEL G 194 (or approved equal).

2.04 RATINGS:

1. Size: 25 pair.

2. Gauge: 22-AWG.

3. Conductors: Solid, bare copper conductors, solid high-density polyethylene insulation with standard telephone color code, twisted into pairs.

4. Core filling: ETPR compound.

5. Core covering: Non-hygroscopic dielectric tape.

6. Shield: .008 inch corrugated, copolymer coated aluminum.

7. Armor: Corrugated bare 6 or 7-mil copper alloy 194 tape (TEL G194) applied longitudinally over the core.

8. Jacket: Black polyethylene.

9. Conforms to ANSI/ICEA S-84-608-1994 and Code of Federal Regulations, Title 7, Subtitle B, Chapter XVII, Part 1755, Section 1755.390.

2.05 CABLE LADDERS

A. Cable ladders shall be prefabricated aluminum, open ladder type, approximately three (3) inches in depth and shall conform to NEMA Standard VE-1. The width of cable ladders shall be determined by the Contractor to support cables in cable vault or mounted on wall when conduit is not available or conduit is not suitable for installation.

2.06 STAINLESS STEEL CORROSION RESISTANT HARDWARE

A. Except as otherwise specified, equipment enclosures, cabinets, boxes and hardware of all types in tunnels, tunnel crossovers, along the surface right-of-way, and in all ancillary structures that are open to tunnels (vent shafts, fan shafts, pumping stations, etc. - excluding rooms within these areas that are heated/air conditioned) shall consist of stainless steel 316 material. Also, except as otherwise specified, equipment enclosures, cabinets, boxes and hardware of all types; shall consist of stainless steel 316 material.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL

1. All cable plant installed by the Contractor shall be fully tested in accordance with the applicable certifying agency testing practices and procedures prior to acceptance.

2. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire, miscellaneous grounding and support hardware, etc. necessary to facilitate the installation of this project.

3. It shall be the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the project. This may include, but is not limited to, tools for terminating cables, testing and splicing equipment f for copper/fiber cables, communication devices, jack stands for cable reels, or cable wenches.

4. The Contractor shall be responsible for printed labels for all cables and cords, distribution frames, and outlet locations, at the time of delivery. No labels will be written by hand. Machine labeling shall be used on all information outlets, patch panels, punch blocks, feed cables, etc.

5. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

6. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.

7. All Cables/fibers will be connected in numerical order in the MDF .

B. TELEPHONE CABLE INSTALLATION IN TUNNELS

1. Unless otherwise directed, cables shall be installed along the tunnel walls in an organized fashion within the area allotted for communications cables. Cable crosses shall be kept to a minimum.

2. Channel inserts have been provided by others, mounted on approximately four-foot centers, in the tunnel walls. Stainless steel type fasteners or mounting devices shall be provided to secure the cables to the channel inserts. Cables shall be individually mounted to the channel inserts. Cable shall be secured to each channel insert. The fasteners or mounting devices shall be properly sized to the cable, or shall be adjustable to the proper size to support the cable without undue compression. Prior to cable installation, the channel inserts shall be cleaned and foreign material shall be removed, where necessary.

3. Unless otherwise specified, cables shall be installed on the channel inserts in the space allocated for communications cables.

4. In those areas where the specified locations for cables within the tunnels do not coincide with the channel inserts provided by others, or when channel inserts are not available for communications cables, appropriate type cable ladder with hardware, cement anchors, fasteners, and mounting devices, shall be provided to secure cables to the tunnel structure. Appropriate type cement anchors, fasteners, and mounting devices, shall also be provided to secure cables to the tunnel structure when routed to equipment, equipment housings, junction boxes, terminals, and conduits.

5. Sufficient slack shall be provided in the cables between fasteners and mounting devices to allow for expansion and contraction of the cables without damage to the cables or the fasteners and mounting devices.

6. The Authority is installing Tunnel Ventilation Barriers in the tunnels between passenger stations in the vicinity of some fan shafts. The Contractor shall install communications cables running along the tunnel walls through the cable openings that are provided in the Tunnel Ventilation Barrier structures. Openings are either provided on the side near the cable runs or at the top near the ceiling area of the tunnel.

C. CIRCUIT IDENTIFICATION

1. The Contractor shall tag all telephone cables.

3.02 DEMONSTRATION

A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of Substantial Completion.

B. Demonstrate Project equipment by a qualified person who is knowledgeable about the Project.

C. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.

D. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at equipment location.

E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

F. Demonstrate system operation.

G. Conduct walking tour of Project and briefly describe function, operation, and maintenance of each component.

H. Demonstrate testing procedure.

END OF SECTION

THIS PAGE LEFT BLANK INTENTIONALLY

SECTION 07426

METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior cladding consisting of formed metal composite material (MCM) sheet, secondary supports, and anchors to structure, attached to solid backup.

B. Matching flashing and trim.

1.02 RELATED REQUIREMENTS

A. Section 07600 – Flashing and Sheet Metal: Metal flashing components integrated with this wall system.

1.03 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2012.

B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.

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

D. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes; 2013a.

E. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2013.

F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2013.

G. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.

H. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2010.

I. ASTM D523 - Standard Test Method for Specular Gloss; 2008.

J. ASTM D1781 - Standard Test Method for Climbing Drum Peel for Adhesives; 1998 (Reapproved 2012).

K. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2013a.

L. ASTM D2244 - Standard Practice for Calculation of Color Differences from Instrumentally Measured Color Coordinates; 2011.

M. ASTM D4145 - Standard Test Method for Coating Flexibility of Prepainted Sheet; 2010.

N. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films; 2007.

O. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2013a.

P. 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 (Reapproved 2012).

Q. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014.

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

S. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2012.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Meeting: Convene one week before starting work of this section to verify project requirements, co-ordinate with installers of other work, establish condition and completeness of building substrate, and review manufacturers' installation instructions and warranty requirements.
   1. Require attendance by the installer and relevant sub-contractors.
   2. Include MCM sheet manufacturer’s representative and wall system manufacturer’s representative to review storage and handling procedures.
   3. Review in detail truck transportation, parking, vertical transportation, schedule, personnel, installation of adjacent materials and substrate.
   4. Review procedures for protection of work and other construction.
   5. Review safety precautions.

1.05 SUBMITTALS

A. Wall System Manufacturer Qualifications.

B. Product Data - MCM Sheets: Manufacturer's data sheets on each product to be used, including thickness, physical characteristics, and finish, and:
   1. Finish manufacturer's data sheet showing physical and performance characteristics.
   2. Storage and handling requirements and recommendations.
   3. Fabrication instructions and recommendations.
   4. Specimen warranty for finish, as specified herein.

C. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
   1. Physical characteristics of components shown on shop drawings.
   2. Storage and handling requirements and recommendations.
   3. Installation instructions and recommendations.
   4. Specimen warranty for wall system, as specified herein.

D. Shop Drawings: Show layout and elevations, dimensions and thickness of panels, connections, details and location of joints, sealants and gaskets, method of anchorage, number of anchors, supports, reinforcement, trim, flashings, and accessories.
   1. Indicate panel numbering system.
   2. Differentiate between shop and field fabrication.
   3. Indicate substrates and adjacent work with which the wall system must be coordinated.
   4. Include large-scale details of anchorages and connecting elements.
   5. Include large-scale details or schematic, exploded or isometric diagrams to fully explain flashing at a scale of not less than 1-1/2 inches per 12 inches (1:10).
   6. Include design engineer's stamp or seal on shop drawings for attachments and anchors.

E. Design Data: Submit structural calculations stamped by design engineer, for AR's information and project record.

F. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.

G. Verification Samples: For each finish product specified, minimum size 12 inches (305 mm) square, representing actual product in color and texture.

H. Test Report: Submit report of full-size mock-up tests for air infiltration, water penetration, and wind performance.

I. Test Report: Submit report of full-size mock-up test for NFPA 285 fire performance.

J. Installer's Qualifications.

K. Certificate: Certify that the work results of this section meet or exceed specified requirements.

L. Manufacturer's Field Reports: Provide within 48 hours of field review. State what was observed and what changes, if any, were requested or required.

M. Maintenance Data: Care of finishes and warranty requirements.

N. Executed Warranty: Submit warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Design Engineer's Qualifications: Design structural supports and anchorages under direct supervision of a Structural Engineer experienced in design of this type of Work and licensed in the State in which the Project is located.

B. Wall System Manufacturer Qualifications: Company specializing in manufacturing products specified in this section.
   1. With not less than three years of documented experience.
   2. Approved by MCM sheet manufacturer.
   3. Submit contact names and phone numbers for at least three references connected with successful past projects.

C. Installer Qualifications: Company specializing in performing work of the type specified in this section.
   1. With minimum 3 years of documented experience.
   2. Approved by wall system manufacturer.
   3. Submit contact names and phone numbers for at least three references connected with successful past projects.

D. Testing Agency Qualifications: Independent agency experienced in testing assemblies of the type required for this project and having the necessary facilities for full-size mock-up testing of the type specified.

E. Mock-Up: Provide a mock-up for evaluation of fabrication workmanship.
   1. Locate where directed.
   2. Provide panels finished as specified.
   3. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.
   1. Protect finishes by applying heavy duty removable plastic film during production.
   2. Package for protection against transportation damage.
   3. Provide markings to identify components consistently with drawings.
   4. Exercise care in unloading, storing and installing panels to prevent bending, warping, twisting and surface damage.

B. Store products protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
   1. Store in well ventilated space out of direct sunlight.
   2. Protect from moisture and condensation with tarpaulins or other suitable weather tight covering installed to provide ventilation.
   3. Store at a slope to ensure positive drainage of any accumulated water.
   4. Do not store in any enclosed space where ambient temperature can exceed 120 degrees F (49 degrees C).
   5. Avoid contact with any other materials that might cause staining, denting, or other surface damage.

1.08 WARRANTY

A. Wall System Warranty: Provide joint written warranty by manufacturer and installer, agreeing to correct defects in manufacturing or installation within a two year period after Date of Substantial Completion.

B. MCM Sheet Manufacturer's Finish Warranty: Provide manufacturer's written warranty stating that the finish will perform as follows for minimum of 5 years:
   1. Chalking: No more than that represented by a No.8 rating based on ASTM D4214.
   2. Color Retention: No fading or color change in excess of 5 Hunter color difference units, calculated in accordance with ASTM D2244.
   3. Gloss Retention: Minimum of 30 percent gloss retention, when tested in accordance with ASTM D523.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Composite Material Sheet Manufacturers:
   1. North Clad Rainscreen Solutions: www.northclad.com.
   2. Or approved equal.

B. Wall Panel System Manufacturers:
   1. North Clad Rainscreen Solutions: northclad.com.
   2. Or approved equal.

2.02 WALL PANEL SYSTEM

A. Wall Panel System: Metal panels, fasteners, and anchors designed to be supported by framing or other substrate provided by others; provide installed panel system capable of maintaining specified performance without defects, damage or failure.
   1. Provide structural design by or under direct supervision of a Structural Engineer licensed in the State in which the Project is located.
   2. Provide panel jointing and weatherseal using reveal joints and gaskets but no sealant.
   3. Anchor panels to supporting framing without exposed fasteners.

B. Performance Requirements:
   1. All tests are to be on full-size mock-ups; tests performed previously for other projects are acceptable provided tested assemblies are truly equivalent to those to be used on this project, unless otherwise indicated.
   2. Thermal Movement: Provide for free and noiseless vertical and horizontal thermal movement due to expansion and contraction under material temperature range of minus 20 degrees F (minus 29 degrees C) to 180 degrees F (82 degrees C) without buckling, opening of joints, undue stress on fasteners, or other detrimental effects; allow for ambient temperature at time of fabrication, assembly, and erection procedures.

3. Wind Performance: Provide system tested in accordance with ASTM E330/E330M without permanent deformation or failures of structural members.
4. Air Infiltration: 0.06 cfm/sq ft (0.003 L/s/sq m) of wall area, maximum, when tested at 1.57 psf (0.075 kPa) in accordance with ASTM E283.
5. Water Penetration: No water penetration under static pressure when tested in accordance with ASTM E331 at a differential of 10 percent of inward acting design load, 6.24 psf (0.299 kPa) minimum, after 15 minutes.
   a. Water penetration is defined as the appearance of uncontrolled water on the interior face of the wall.
   b. Design to drain leakage and condensation to the exterior face of the wall.
6. Fire Performance: Tested in accordance with, and complying with the acceptance criteria of, NFPA 285; testing must be performed specifically for this project.

C. Panels: One inch (2.5 mm) deep pans formed of metal composite material sheet by routing back edges of sheet, removing corners, and folding edges.
   1. Reinforce corners with riveted aluminum angles.
   2. Provide concealed attachment to supporting structure by adhering attachment members to back of panel; attachment members may also function as stiffeners.
   3. Maintain maximum panel bow of 0.8 percent of panel dimension in width and length; provide stiffeners of sufficient size and strength to maintain panel flatness without showing local stresses or read-through on panel face.
   4. Reinforce panels with metal angle braces 24 inches (610 mm) on center in short direction.
   5. Secure members to back face of panels using structural silicone sealant approved by MCM sheet manufacturer.
   6. Fabricate panels under controlled shop conditions.
   7. Where final dimensions cannot be established by field measurement before commencement of manufacturing, make allowance for field adjustments without requiring field fabrication of panels.
   8. Fabricate as indicated on drawings and as recommended by MCM sheet manufacturer.
      a. Make panel lines, breaks, and angles sharp and true.
      b. Keep plane surfaces free from warp or buckle.
      c. Keep panel surfaces free of scratches or marks caused during fabrication.
   9. Provide joint details providing a watertight and structurally sound wall panel system that allows no uncontrolled water penetration on inside face of panel system.
   10. For "dry" jointing, secure extrusions to returned pan edges with stainless steel rivets; provide means of concealed drainage with baffles and weeps for water that might accumulate in members of system.

2.03 MATERIALS

A. Metal Composite Material (MCM) Sheet: Two sheets of aluminum sandwiching a solid core of extruded thermoplastic material formed in a continuous process with no glues or adhesives between dissimilar materials; core material free of voids and spaces; no foamed insulation material content.
   1. Overall Sheet Thickness: 4 mm.
   2. Face Sheet Thickness: 0.019 inches (0.50 mm), minimum.
   3. Alloy: Manufacturer's standard, selected for best appearance and finish durability.
   4. Bond and Peel Strength: No adhesive failure of the bond between the core and the skin nor cohesive failure of the core itself below 22.4 inch-pound/inch (100 N-mm/mm) with no degradation in bond performance, when tested in accordance with ASTM D1781, simulating resistance to panel delamination, after 8 hours of submersion in boiling water and after 21 days of immersion in water at 70 degrees F (21 degrees C).

5. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
6. Flammability: Self-ignition temperature of 650 degrees F (343 degrees C) or greater, when tested in accordance with ASTM D1929.
7. Factory Finish: One coat fluoropolymer resin coating, approved by the coating manufacturer for the length of warranty specified for the project, and applied by coil manufacturing facility that specializes in coil applied finishes.
   a. Coating Flexibility: Pass ASTM D4145 minimum 1T-bend, at time of manufacturing.
   b. Long-Term Performance: Not less than that specified under WARRANTY in PART 1.
8. Color/Texture: As selected by AR from manufacturer's standard range.

B. Metal Framing Members: Include all sub-girts, zee-clips, base and sill angles and channels, hat-shaped and rigid channels, and furring channels required for complete installation.
   1. Provide material strength, dimensions, configuration as required to meet the applied loads applied and in compliance with applicable building code.
   2. Sheet Steel Components: ASTM A653/A653M galvanized to G90/Z275 or zinc-iron alloy-coated to A60/ZF180; or ASTM A792/A792M aluminum-zinc coated to AZ60/AZM180.
   3. Stainless Steel Sheet Components: ASTM A480/A480M.

C. Flashing: Sheet aluminum; 0.040 inch (1.0 mm) thick, minimum; finish and color to match MCM sheet.

D. Anchors, Clips and Accessories: Use one of the following:
   1. Stainless steel complying with ASTM A480/A480M, ASTM A276 or ASTM A666.
   2. Steel complying with ASTM A36/A36M and hot-dipped galvanized to ASTM A153/A153M.
   3. Steel complying with ASTM A36/A36M and hot-dipped galvanized to ASTM A123/A123M Coating Grade 10.

E. Fasteners:
   1. Exposed fasteners: Stainless steel; permitted only where absolutely unavoidable and subject to prior approval of the AR.
   2. Screws: Self-drilling or self-tapping Type 410 stainless steel or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
   3. Bolts: Stainless steel.
   4. Fasteners for Flashing and Trim: Blind fasteners of high-strength aluminum or stainless steel.

F. Joint Sealer: As specified in Section 07 9005, subject to MCM sheet manufacturer's approval.

G. Provide panel system manufacturer's and installer’s standard corrosion resistant accessories, including fasteners, clips, anchorage devices and attachments.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and interfaces with other work.

B. Verify substrate on-site to determine that conditions are acceptable for product installation in accordance with manufacturers written instructions.

C. If substrate preparation is the responsibility of another installer, notify AR of unsatisfactory preparation before proceeding.

D. Notify AR in writing of conditions detrimental to proper and timely completion of work. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protect adjacent work areas and finish surfaces from damage during installation.

3.03 INSTALLATION

A. Do not install products that are defective, including warped, bowed, dented, and broken members, and members with damaged finishes.

B. Comply with instructions and recommendations of MCM sheet manufacturer and wall system manufacturer, as well as with approved shop drawings.

C. Install wall system securely allowing for necessary thermal and structural movement; comply with wall system manufacturer's instructions for installation of concealed fasteners.

D. Do not handle or tool products during erection in manner that damages finish, decreases strength, or results in visual imperfection or failure in performance. Return component parts that require alteration to shop for refabrication, if possible, or for replacement with new parts.

E. Do not form panels in field unless required by wall system manufacturer and approved by the AR; comply with MCM sheet manufacturer's instructions and recommendations for field forming.

F. Separate dissimilar metals; use gasket fasteners, isolation shims, or isolation tape where needed to eliminate possibility of electrolytic action between metals.

G. Install flashings as indicated on shop drawings At flashing butt joints, provide a lap strap under flashing and seal lapped surfaces with a full bed of non-hardening sealant.

H. Install square, plumb, straight, and true, accurately fitted, with tight joints and intersections maintaining the following installation tolerances:
   1. Variation From Plane or Location: 1/2 inch in 30 feet (10 mm in 10 m) of length and up to 3/4 inch in 300 feet (20 mm in 100 m), maximum.
   2. Deviation of Vertical Member From True Line: 0.1 inch in 25 feet (3 mm in 9 m) run, maximum.
   3. Deviation of Horizontal Member From True Line: 0.1 inch in 25 feet (3 mm in 9 m) run, maximum.
   4. Offset From True Alignment Between Two Adjacent Members Abutting End To End, In Line: 0.03 inch (0.75 mm), maximum.

I. Replace damaged products.
   1. Exception: Field repairs of minor damage to finishes are permitted only when approved in writing by AR, panel manufacturer, and fabricator.
   2. Field Repairs to Finishes: Using materials and methods sufficient that repairs are not discernible when viewed at distance of 10 feet (3000 mm) under all typical light conditions experienced at the project.

3.04 FIELD QUALITY CONTROL

A. Wall System Manufacturer's Field Services: Provide field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with instructions.

3.05 CLEANING

A. Ensure weep holes and drainage channels are unobstructed and free of dirt and sealants.

B. Remove protective film after installation of joint sealers, after cleaning of adjacent materials, and immediately prior to completion of work.

C. Remove temporary coverings and protection of adjacent work areas.

D. Clean installed products in accordance with manufacturer's instructions.

3.06 PROTECTION

A. Protect installed panel system from damage during construction.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

SECTION 07542

THERMOPLASTIC-POLYOLEFIN ROOFING (TPO)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Thermoplastic membrane roofing system, including all components specified.

B. Disposal of demolition debris and construction waste is the responsibility of Contractor. Perform disposal in manner complying with all applicable federal, state, and local regulations.

C. Comply with the published recommendations and instructions of the roofing membrane manufacturer.

D. Commencement of work by Contractor shall constitute acknowledgement by Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. No modification of the Contract Sum will be made for failure to adequately examine the Contract Documents or the project conditions.

1.02 RELATED REQUIREMENTS

A. Section 06100 - Rough Carpentry: Wood nailers associated with roofing and roof insulation.

B. Section 08630 - Metal Framed Skylights.

C. Section 15205 – Piping Systems: Scupper drains

1.03 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 for definition of terms related to roofing work not otherwise defined in the section.

1.04 REFERENCE STANDARDS

A. ASTM C208 - Standard Specification for Cellulosic Fiber Insulating Board; 2012.

B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2014.

C. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer; 2009.

D. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2010.

E. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting; 2009.

F. ASTM D1079 - Standard Terminology Relating to Roofing and Waterproofing; 2013.

G. ASTM D6878/D6878M - Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing; 2011a.

H. PS 1 - Structural Plywood; 2009.

I. PS 20 - American Softwood Lumber Standard; 2010.

J. SPRI ES-1 - Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems; 2003. (ANSI/SPRI ES-1)

1.05 ADMINISTRATIVE REQUIREMENTS

A. Pre-Installation Conference: Before start of roofing work, Contractor shall hold a meeting to discuss the proper installation of materials and requirements to achieve the warranty.
   1. Require attendance with all parties directly influencing the quality of roofing work or affected by the performance of roofing work.

1.06 SUBMITTALS

A. Product Data:
   1. Provide membrane manufacturer's printed data sufficient to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the membrane manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with roofing membrane.

B. Samples: Submit samples of each product to be used.

C. Shop Drawings: Provide:
   1. The roof membrane manufacturer's standard details customized for this project for all relevant conditions, including flashings, base tie-ins, roof edges, terminations, expansion joints, penetrations, and drains.
   2. For tapered insulation, provide project-specific layout and dimensions for each board.

D. Specimen Warranty: Submit prior to starting work.

E. Installer Qualifications: Letter from manufacturer attesting that the roofing installer meets the specified qualifications.

F. Pre-Installation Notice: Copy to show that manufacturer's required Pre Installation Notice (PIN) has been accepted and approved by the manufacturer.

G. Executed Warranty.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Roofing installer shall have the following:
   1. Fully staffed office within 100 miles of the job site.
   2. At least ten years of experience in installing specified system, with five years minimum for each member of the installation crew.
   3. Capability to provide payment and performance bond to building owner.
   4. Capability to provide a payment performance bond.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.

B. Store materials clear of ground and moisture with weather protective covering.

C. Keep combustible materials away from ignition sources.

1.09 WARRANTY

A. Comply with all warranty procedures required by manufacturer, including notifications, scheduling, and inspections.

B. Warranty: Limited Warranty covering membrane, roof insulation, and other indicated components of the system, for the term indicated.
   1. Limit of Liability: No dollar limitation.
   2. Scope of Coverage: Repair leaks in the roofing system caused by:
      a. Ordinary wear and tear of the elements.
      b. Manufacturing defect in materials.
      c. Defective workmanship used to install these materials.
      d. Damage due to winds up to 55 mph (88 km/h).

C. Metal Roof Edging with Exposed Decorative Fascia: Provide 20 year warranty for painted finish covering color fade, chalk, and film integrity.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of design Manufacturer - Roofing System: Firestone Building Products LLC, Carmel, IN.
   1. Roofing systems manufactured by others, WMATA Architecture- Approved, are acceptable provided the roofing system is completely equivalent in materials and warranty conditions and the manufacturer meets the following qualifications:
      a. Specializing in manufacturing the roofing system to be provided.
      b. Minimum ten years of experience manufacturing the roofing system to be provided.
      c. Able to provide a no dollar limit, single source roof system warranty that is backed by corporate assets in excess of one billion dollars.
      d. ISO 9002 certified.

B. Manufacturer of Insulation and Cover Boards: Same manufacturer as roof membrane.

C. Manufacturer of Metal Roof Edging: Same manufacturer as roof membrane.
   1. Metal roof edging products by other manufacturers are not acceptable.
   2. Field- or shop-fabricated metal roof edgings are not acceptable.

2.02 ROOFING SYSTEM DESCRIPTION

A. Roofing System: Thermoplastic olefin (TPO) single-ply membrane.
   1. Membrane Attachment: Fully adhered.
   2. Warranty: Full system warranty; 30 year Limited Warranty covering membrane, roof insulation, and membrane accessories.
   3. Comply with applicable local building code requirements.
   4. Provide assembly having Underwriters Laboratories, Inc. (UL) Class A Fire Hazard Classification.

B. Roofing System Components: Listed in order from the top of the roof down:
   1. Membrane: Thickness as specified.
   2. Base Sheet Over Insulation: Cold adhesive attached.
   3. Insulation:
      a. Maximum Board Thickness: 3 inches (75 mm); use as many layers as necessary; stagger joints in adjacent layers.
      b. Tapered: Slope as indicated.
      c. Maximum Thickness: match existing conditions.
      d. Crickets: Tapered insulation of same type as specified for top layer; slope as indicated.
   4. Deck Cover Board: Wood fiber board, 0.5 inch (13 mm) thick; loose-laid, no attachment.

2.03 MEMBRANE MATERIALS

A. Membrane: Flexible, heat weldable sheet composed of thermoplastic polyolefin polymer and ethylene propylene rubber; complying with ASTM D6878, with polyester weft inserted reinforcement and the following additional characteristics:
   1. Thickness: 0.080 inch (2.03 mm) plus/minus 10 percent, with coating thickness over reinforcement of 0.030 inch (0.76 mm) plus/minus 10 percent.
   2. Sheet Width: Provide sheets of width necessary to accommodate batten spacing required by manufacturer for project conditions.
   3. Puncture Resistance: 415 lbf (1868 N), minimum, when tested in accordance FTM 101C Method 2031.
   4. Solar Reflectance: 0.79, minimum, when tested in accordance with ASTM C1549.
   5. Color: White.
   6. Acceptable Product: UltraPly Platinum TPO by Firestone.

B. Membrane Fasteners: Type and size as required by roof membrane manufacturer for roofing system and warranty to be provided; use only fasteners furnished by roof membrane manufacturer.

C. Curb and Parapet Flashing: Same material as membrane, with encapsulated edge which eliminates need for seam sealing the flashing-to-roof splice; precut to 18 inches (457 mm) wide minimum.

D. Formable Flashing: Non-reinforced, flexible, heat weldable sheet, composed of thermoplastic polyolefin polymer and ethylene propylene rubber.
   1. Thickness: 0.060 inch (1.52 mm) plus/minus 10 percent.
   2. Tensile Strength: 1550 psi (10.7 MPa), minimum, when tested in accordance with ASTM D638 after heat aging.
   3. Elongation at Break: 650 percent, minimum, when tested in accordance with ASTM D638 after heat aging.
   4. Tearing Strength: 12 lbf (53 N), minimum, when tested in accordance with ASTM D1004 after heat aging.
   5. Color: Same as membrane.
   6. Acceptable Product: UltraPly TPO Flashing by Firestone.

E. Tape Flashing: 5-1/2 inch (140 mm) nominal wide TPO membrane laminated to cured rubber polymer seaming tape, overall thickness 0.065 inch (1.6 mm) nominal; TPO QuickSeam Flashing by Firestone.

F. Bonding Adhesive: Neoprene and SBR rubber blend, formulated for compatibility with the membrane other substrate materials, including masonry, wood, and insulation facings; UltraPly Bonding Adhesive by Firestone.

G. Pourable Sealer: Two-part polyurethane, two-color for reliable mixing.

H. Seam Plates: Steel with barbs and Galvalume coating; corrosion-resistance complying with FM 4470.

I. Termination Bars: Aluminum bars with integral caulk ledge; 1.3 inches (33 mm) wide by 0.10 inch (2.5 mm) thick..

J. Cut Edge Sealant: Synthetic rubber-based, for use where membrane reinforcement is exposed.

K. General Purpose Sealant: EPDM-based, one part, white general purpose sealant.

L. Molded Flashing Accessories: Unreinforced TPO membrane pre-molded to suit a variety of flashing details, including pipe boots, inside corners, outside corners, etc.

2.04 ROOF INSULATION AND COVER BOARDS

A. Polyisocyanurate Board Insulation: Closed cell polyisocyanurate foam with black glass reinforced mat laminated to faces, complying with ASTM C1289 Type II Class 1, with the following additional characteristics:
   1. Thickness: As indicated elsewhere.
   2. Size: 48 inches (1220 mm) by 96 inches (2440 mm), nominal.
      a. Exception: Insulation to be attached using adhesive or asphalt may be no larger than 48 inches (1220 mm) by 48 inches (1220 mm), nominal.
   3. Compressive Strength: 20 psi (138 kPa) when tested in accordance with ASTM C1289.
   4. Ozone Depletion Potential: Zero; made without CFC or HCFC blowing agents.
   5. Recycled Content: 19 percent post-consumer and 15 percent post-industrial, average.

B. Wood Fiber Cover Board: Cellulosic fiber insulating board complying with ASTM C208 Grade 2, surfaced with non-asphaltic coating to reduce asphalt absorption, and with the following additional characteristics:
   1. Size: 48 inches (1220 mm) by 96 inches (2440 mm), nominal.
      a. Exception: Board to be attached using adhesive or asphalt may be no larger than 48 inches (1220 mm) by 48 inches (1220 mm), nominal.
   2. Thickness: As indicated elsewhere.
   3. Spanning Capability: Recommended by manufacturer for following minimum flute spans:
      a. 0.5 inch (12 mm) Thickness: 1.6 inches (40.6 mm), minimum.
      b. 1 inch (25 mm) Thickness: 2.7 inches (68.8 mm), minimum.
   4. Recycled Content: 50 percent post-consumer, minimum.

C. Adhesive for Insulation Attachment: Type as required by roof membrane manufacturer for roofing system and warranty to be provided; use only adhesives furnished by roof membrane manufacturer.

2.05 METAL ACCESSORIES

A. Metal Roof Edging and Fascia: Continuous metal edge member serving as termination of roof membrane and retainer for metal fascia; watertight with no exposed fasteners; mounted to roof edge nailer.
   1. Wind Performance:
      a. Membrane Pull-Off Resistance: 100 lbs/ft (1460 N/m), minimum, when tested in accordance with ANSI/SPRI ES-1 Test Method RE-1, current edition.
      b. Fascia Pull-Off Resistance: At least the minimum required when tested in accordance with ANSI/SPRI ES-1 Test Method RE-2, current edition.
      c. Provide product listed in current Factory Mutual Research Corporation Approval Guide with at least FM 1-270 rating.
   2. Fascia Face Height: as indicated on drawings.
   3. Edge Member Height Above Nailer: 1-1/4 inches (31 mm).
   4. Fascia Material and Finish: 0.040 inch (1.0 mm) thick formed aluminum, color to be selected; matching concealed joint splice plates; factory-installed protective plastic film.
   5. Length: 144 inches (3650 mm).
   6. Functional Characteristics: Fascia retainer supports while allowing for free thermal cycling of fascia.
   7. Aluminum Bar: Continuous 6063-T6 alloy aluminum extrusion with pre-punched slotted holes; miters welded; injection molded EPDM splices to allow thermal expansion.
   8. Anchor Bar Cleat: 20 gage, 0.036 inch (0.9 mm) G90 coated commercial type galvanized steel with pre-punched holes.
   9. Fasteners: Factory-provided corrosion resistant fasteners, with drivers; no exposed fasteners permitted.

10. Special Shaped Components: Provide factory-fabricated pieces necessary for complete installation, including miters, scuppers, and end caps; minimum 14 inch (355 mm) long legs on corner pieces.
11. Scuppers: Welded watertight.
12. Accessories: Provide matching brick wall cap, downspout, extenders, and other special fabrications as shown on the drawings.

B. Parapet Copings: Formed metal coping with galvanized steel anchor/support cleats for capping any parapet wall; watertight, maintenance free, without exposed fasteners; butt type joints with concealed splice plates; mechanically fastened as indicated; Firestone PTCF.
   1. Wind Performance:
      a. At least the minimum required when tested in accordance with ANSI/SPRI ES-1 Test Method RE-3, current edition.
      b. Provide product listed in current Factory Mutual Research Corporation Approval Guide with at least FM 1-90 rating.
   2. Description: Coping sections allowed to expand and contract freely while locked in place on anchor cleats by mechanical pressure from hardened stainless steel springs factory attached to anchor cleats; 8 inch (200 mm) wide splice plates with factory applied dual non-curing sealant strips capable of providing watertight seal.
   3. Dimensions:
      a. Wall Width: As indicated on the drawings.
      b. Piece Length: Minimum 144 inches (3650 mm).
   4. Anchor/Support Cleats: 20 gage, 0.036 inch (0.9 mm) thick pre-punched galvanized cleat with 12 inch (305 mm) wide stainless steel spring mechanically locked to cleat at 72 inches (1820 mm) on center.
   5. Special Shaped Components: Provide factory-fabricated pieces necessary for complete installation, including miters, corners, intersections, curves, pier caps, and end caps; minimum 14 inch (355 mm) long legs on corner, intersection, and end pieces.
   6. Fasteners: Factory-furnished; electrolytically compatible; minimum pull out resistance of 240 pounds (109 kg) for actual substrate used; no exposed fasteners.

2.06 ACCESSORY MATERIALS

A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
   1. Width: 3-1/2 inches (90 mm), nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.
   2. Thickness: Same as thickness of roof insulation.

B. Cant Strips and Tapered Edge Strips: 45 degree face slope and minimum 5 inch (127 mm) face dimension; provide at all angle changes between vertical and horizontal planes that exceed 45 degrees.
   1. Type: Wood fiber, complying with ASTM C208.
   2. Install using roofing mastic, or mechanically fastened using fasteners and plates approved by roofing manufacturer.

C. Simulated Standing Seams: Provide 1 1/2" wide by 1 1/4" high by 10' long at 24" O.C. standing seam profiles. Install with pressure sensitive adhesive and release liner. Color to match roofing color.

PART 3 INSTALLATION

3.01 GENERAL

A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for the specified roofing system. Where manufacturer provides no instructions or recommendations, follow good roofing practices and industry standards. Comply with federal, state, and local regulations.

B. Obtain all relevant instructions and maintain copies at project site for duration of installation period.

C. Do not start work until Pre-Installation Notice has been submitted to manufacturer as notification that this project requires a manufacturer's warranty.

D. Perform work using competent and properly equipped personnel.

E. Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.

F. Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice; do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application; consult manufacturer for recommended procedures during cold weather. Do not work with sealants and adhesives when material temperature is outside the range of 60 to 80 degrees F (15 to 25 degrees C).

G. Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.
   1. Protect from spills and overspray from bitumen, adhesives, sealants and coatings.
   2. Particularly protect metal, glass, plastic, and painted surfaces from bitumen, adhesives, and sealants within the range of wind-borne overspray.
   3. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trades.

H. Until ready for use, keep materials in their original containers as labeled by the manufacturer.

I. Consult membrane manufacturer's instructions, container labels, and Material Safety Data Sheets (MSDS) for specific safety instructions. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.

3.02 EXAMINATION

A. Examine roof deck to determine that it is sufficiently rigid to support installers and their mechanical equipment and that deflection will not strain or rupture roof components or deform deck.

B. Verify that surfaces and site conditions are ready to receive work. Correct defects in the substrate before commencing with roofing work.

C. Examine roof substrate to verify that it is properly sloped to drains.

D. Verify that the specifications and drawing details are workable and not in conflict with the roofing manufacturer's recommendations and instructions; start of work constitutes acceptable of project conditions and requirements.

3.03 PREPARATION

A. Remove all of the existing roof system down to the roof deck. Dispose of all materials properly. Perform asbestos removal in accordance with federal, state and local regulations and dispose of waste in legal manner.

1. At penetrations, remove all existing flashings, including lead, asphalt, mastic, etc.
2. At walls, curbs, and other vertical and sloped surfaces, remove loose and unsecured flashings; remove mineral surfaced and coated flashings; remove excessive asphalt to provide a smooth, sound surface for new flashings.

B. Prior to proceeding, prepare roof surface so that it is clean, dry, and smooth, and free of sharp edges, fins, roughened surfaces, loose or foreign materials, oil, grease and other materials that may damage the membrane.

C. Fill all surface voids in the immediate substrate that are greater than 1/4 inch (6 mm) wide with fill material acceptable insulation to membrane manufacturer.

D. Seal, grout, or tape deck joints, where needed, to prevent bitumen seepage into building.

3.04 INSULATION AND COVER BOARD INSTALLATION

A. Install insulation in configuration and with attachment method(s) specified in PART 2, under Roofing System.

B. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.

C. Lay roof insulation in courses parallel to roof edges.

D. Neatly and tightly fit insulation to all penetrations, projections, and nailers, with gaps not greater than 1/4 inch (6 mm). Fill gaps greater than 1/4 inch (6 mm) with acceptable insulation. Do not leave the roofing membrane unsupported over a space greater than 1/4 inch (6 mm).

E. Cold Adhesive Attachment: Apply in accordance with membrane manufacturer's instructions and recommendations; "walk-in" individual roof insulation boards to obtain maximum adhesive contact.

3.05 SINGLE-PLY MEMBRANE INSTALLATION

A. Beginning at low point of roof, place membrane without stretching over substrate and allow to relax at least 30 minutes before attachment or splicing; in colder weather allow for longer relax time.

B. Lay out the membrane pieces so that field and flashing splices are installed to shed water.

C. Install membrane without wrinkles and without gaps or fishmouths in seams; bond and test seams and laps in accordance with membrane manufacturer's instructions and details.

D. Install membrane adhered to the substrate, with edge securement as specified.

E. Adhered Membrane: Bond membrane sheet to substrate using membrane manufacturer's recommended bonding material, application rate, and procedures.

F. Edge Securement: Secure membrane at all locations where membrane terminates or goes through an angle change greater than 2 in 12 inches (1:6) using mechanically fastened reinforced perimeter fastening strips, plates, or metal edging as indicated or as recommended by roofing manufacturer.
1. Exceptions: Round pipe penetrations less than 18 inches (460 mm) in diameter and square penetrations less than 4 inches (200 mm) square.
2. Metal edging is not merely decorative; ensure anchorage of membrane as intended by roofing manufacturer.

3.06 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's recommendations and details.

B. Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.
   1. Follow roofing manufacturer's instructions.
   2. Remove protective plastic surface film immediately before installation.
   3. Install water block sealant under the membrane anchorage leg.
   4. Flash with manufacturer's recommended flashing sheet unless otherwise indicated.
   5. Where single application of flashing will not completely cover the metal flange, install additional piece of flashing to cover the metal edge.
   6. If the roof edge includes a gravel stop and sealant is not applied between the laps in the metal edging, install an additional piece of self-adhesive flashing membrane over the metal lap to the top of the gravel stop; apply seam edge treatment at the intersections of the two flashing sections.
   7. When the roof slope is greater than 1:12, apply seam edge treatment along the back edge of the flashing.

C. Scuppers: Set in sealant and secure to structure; flash as recommended by manufacturer.

D. Roofing Expansion Joints: Install as recommended by roofing manufacturer.

E. Flashing at Walls, Curbs, and Other Vertical and Sloped Surfaces: Install weather-tight flashing at all walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces that the roofing membrane abuts to; extend flashing at least 8 inches (200 mm) high above membrane surface.
   1. Use the longest practical flashing pieces.
   2. Evaluate the substrate and overlay and adjust installation procedure in accordance with membrane manufacturer's recommendations.
   3. Complete the splice between flashing and the main roof sheet with specified splice adhesive before adhering flashing to the vertical surface.
   4. Provide termination directly to the vertical substrate as shown on roof drawings.

F. Scupper Drains:
   1. Existing Drains: Remove all existing flashings, drain leads, roofing materials and cement from the drain; remove clamping ring.
   2. Taper insulation around drain to provide smooth transition from roof surface to drain. Use specified pre-manufactured tapered insulation with facer or suitable bonding surface to achieve slope; slope not to exceed manufacturer's recommendations.
   3. Position membrane, then cut a hole for roof drain to allow 1/2 to 3/4 inch (12 to 19 mm) of membrane to extend inside clamping ring past drain bolts.
   4. Make round holes in membrane to align with clamping bolts; do not cut membrane back to bolt holes.
   5. Apply sealant on top of drain bowl where clamping ring seats below the membrane
   6. Install scupper drain clamping ring and clamping bolts; tighten clamping bolts to achieve constant compression.

G. Simulated Standing Seams: Install in accordance with manufacturers written instructions.

3.07 FIELD QUALITY CONTROL

A. Inspection by Manufacturer: Provide final inspection of the roofing system by a Technical Representative employed by roofing system manufacturer specifically to inspect installation for warranty purposes (i.e. not a sales person).

B. Perform all corrections necessary for issuance of warranty.

3.08 CLEANING

A. Clean all contaminants generated by roofing work from building and surrounding areas, including bitumen, adhesives, sealants, and coatings.

B. Repair or replace building components and finished surfaces damaged or defaced due to the work of this section; comply with recommendations of manufacturers of components and surfaces.

C. Remove leftover materials, trash, debris, equipment from project site and surrounding areas.

3.09 PROTECTION

A. Where construction traffic must continue over finished roof membrane, provide durable protection and replace or repair damaged roofing to original condition.

END OF SECTION

SECTION 08630

METAL-FRAMED SKYLIGHTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum skylight framing system. The scope of work for the project is to raise the existing skylight as indicated on the drawings and provide a new transitional piece to tie the raised system to the existing system. At the Contractor's Option, he may provide a new system in lieu of raising the existing system.

B. Skylight glazing.

C. Fasteners, anchors, reinforcement, and flashings.

1.02 RELATED REQUIREMENTS

A. Section 05501 - Miscellaneous Metal: Fabricated steel attachment devices.

B. Section 07600 – Flashing and Sheet Metal: Skylight counterflashing.

1.03 REFERENCE STANDARDS

A. AAMA 501.2 - Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage; American Architectural Manufacturers Association; 2009.

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association; 2012.

C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2012.

D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2013.

E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.

F. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.

G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2013.

H. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; 2013.

I. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.

J. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2006a (Reapproved 2013).

K. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2005 (Reapproved 2010).

L. ASTM D4479/D4479M - Standard Specification for Asphalt Roof Coatings - Asbestos-Free; 2007 (Reapproved 2012)e1.

M. 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 (Reapproved 2012).

N. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014.

O. 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. Product Data: Provide manufacturer's specifications, standard details, and installation requirements.

B. Shop Drawings: Indicate framed opening requirements and tolerances, spacing of all members, anticipated deflection under load, affected related work, expansion and contraction joint locations and details, and sizes and locations for field welding.
   1. Show field measurements on shop drawings.

C. Selection Samples: Submit full range of aluminum finish samples for Architect's color selection.

D. Samples: Submit two samples, not less than 12 x 12 inch (300 x 300 mm) in size illustrating appearance of prefinished aluminum and specified glazing system, including glazed edge and corner.

E. Test Reports: Submit results of full-size mock-up testing. Reports of tests previously performed on the same design are acceptable.

F. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations.

G. Structural Glazing Adhesive: Submit product data and calculations showing compliance with performance requirements.

H. Report of field testing for water leakage

.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Design skylight system under direct supervision of a professional structural engineer experienced in design of work of the type specified in this section and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not fewer than three years of documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with not fewer than three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide wrapping to protect prefinished aluminum surfaces. Do not use adhesive papers or spray coatings that bond when exposed to sunlight or weather.

1.07 WARRANTY

A. Correct defective work, including leaks, discoloration, failure of seal at insulated glazing units, and excessive thermal or structural movement, within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal-Framed Skylights: Provide manufacturer that is best able to match the existing conditions and seamless installation.

2.02 METAL-FRAMED SKYLIGHTS

A. Metal Framed Skylights: Factory-fabricated, glazed.
   1. Frame: Extruded aluminum structural members with integral condensation collection and guttering system thermally separated from exterior pressure bar.
   2. Glazing System: Pressure glazing bar system for sloped joints and structural adhesive glazing for horizontal joints.
   3. Glazing: Non-insulating glass. Match style and thickness of existing wired glass.
   4. Aluminum Finish: Color anodized. Match existing

B. Performance Requirements:
   1. Design and size components to withstand the loading requirements without damage or permanent set in accordance with the International Building Code.
   2. Maximum allowable deflection of any glazing support member: 1/180 of span.
   3. Design system to limit stress on structural glazing adhesive to 20 percent of tested tensile adhesion and maximum compression or elongation to 25 percent of neutral dimension.
   4. Design system to accommodate thermal expansion and contraction over ambient temperature range of 100 degrees F (56 degrees C), dynamic loading and release of loads, creep of concrete structural members, and deflection of structural support framing without damage to skylight system components or loss of weathertightness.
   5. Limit air infiltration through assembly to 0.06 cu ft/min/sq ft (0.3 L/s/sq m) for glazed area, measured at a reference differential pressure across assembly of 1.57 psf (75 Pa) in accordance with ASTM E283.
   6. Water Leakage: None, when measured in accordance with ASTM E331 at a test pressure difference of 2.86 lbf/sq ft (140 Pa).
   7. Design and fabricate to prevent harmonic vibration, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elem

   ents, loosening, weakening, or fracturing of attachments or components of system.

2.03 MATERIALS

A. Aluminum Extrusions: 6063-T5, 6063-T6, or 6061-T6 members complying with ASTM B221 (ASTM B221M). Minimum thickness 0.125 inch (3 mm) for structural members and 0.062 inch (1.5 mm) for non-structural members.

B. Formed Aluminum: Sheet material of alloy 5052, 5005, or 6061-T651 complying with ASTM B209 (ASTM B209M). Minimum thickness: 0.125 inch for structural members and 0.062 inches (1.5 mm) for non-structural members.

C. Internal Reinforcement: ASTM A36/A36M; Steel shapes as required for strength and mullion size limitations, hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.

D. Glass: Single pane of clear transparent, wired glass.

E. Glazing Accessories: As recommended by manufacturer of skylight system.

F. Structural Glazing Adhesive: Silicone, ASTM C920, Class 25, Grade NS, neutral cure; maximum hardness of 40, when tested in accordance with ASTM D2240 using Type A durometer; minimum tensile strength of 250 psi (1725 kPa), when tested in accordance with ASTM D412.

G. Weatherseal Sealant: Silicone, same type as glazing adhesive.

H. Touch-Up Primer for Galvanized Steel Surfaces: Zinc rich type.

I. Protective Back Coating: Asphaltic mastic, ASTM D4479 Type I.

J. Fasteners: Stainless steel.

K. Flashings: 0.063 inch (1.5 mm) thick aluminum, same finish as system components; secured with concealed fastening method.

L. Anchorage Devices: Type recommended by manufacturer, exposed to view.

2.04 FABRICATION

A. Rigidly fit and secure joints and corners with screw and spline. Make joints rigid, with connections that are flush, hairline, and weatherproof.

B. Fabricate components to allow for expansion and contraction with minimum clearance and shim spacing around perimeter of assembly.

C. Drain to exterior any water entering exterior joints, condensation occurring in glazing channels, or migrating moisture occurring within system.

D. Prepare components to receive concealed anchorage devices. Ensure that fasteners and anchorage devices will be concealed upon completion of installation.

E. Adhere glass to glazing frames with structural adhesive and cure under controlled conditions in shop. Field glazing of frames to glass is not acceptable.

2.05 FINISHES

A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick; dark bronze; exterior surfaces only.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that structural curb is ready to receive skylight system. Coordinate installation of roofing and other adjacent work to ensure weathertight construction.

3.02 PREPARATION

A. Apply 1 coat of protective coating to concealed aluminum and steel surfaces in contact with dissimilar materials.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set skylight structure plumb, level, and true to line, without warp or rack of frames or glazing panels. Anchor securely in place in accordance with approved shop drawings.

C. Maintain assembly dimensional tolerances, aligning with adjacent work.

D. Install sill flashings.

E. Touch up damaged finishes so repair is imperceptible from 6 feet (2 meters). Remove and replace components that cannot be satisfactorily touched up.

3.04 TOLERANCES

A. Maximum Variation from Plumb, Level, or Line: 1/8 inch per 10 feet (1 mm/m), or 3/8 inch (10 mm) total in overall dimension.

B. Alignment of Two Adjoining Members Abutting in Plane: Within 1/16 inches (1.6 mm).

3.05 FIELD QUALITY CONTROL

A. Test installed skylight for water leakage in accordance with AAMA 501.2.

3.06 CLEANING

A. Remove protective material from prefinished aluminum surfaces.

B. Wash down exposed surfaces; wipe surfaces clean.

C. Remove excess sealant by methods recommended by skylight manufacturer.

END OF SECTION

THIS PAGE IS INTENTIONALLY LEFT BLANK