



**Track Deck Slab and Ceiling Panel Rehabilitation at  
Rhode Island Ave Station**

**For**

**Washington Metropolitan Area Transit Authority**

**Contract Number FQ 18086**

**VOLUME 1, DIVISIONS 2-3, 5-7, 9 AND 16**

**Technical Specifications**

**February 9, 2018**

**Final Submittal**

**Gannett Fleming/Parsons Joint Venture  
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**WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY**

**Track Deck Slab and Ceiling Panel Rehabilitation at  
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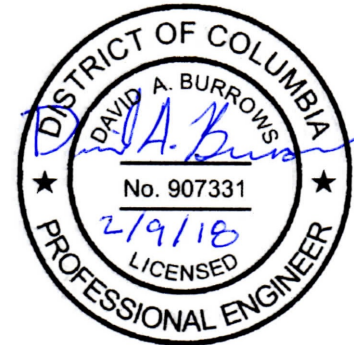
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**SECTION 02205  
REMOVAL AND RESTORATION OF EXISTING FACILITIES**

**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 Rhode Island Ave 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 03720 - Repair of Existing 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. Definitions pertaining to trees, shrubs and other plants: ANSI Z60.1.
  - 3. Salvage: To remove and store material and equipment for reuse in this or other Authority contracts.
- D. Salvage:
  - 1. Clean salvaged items of foreign material 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:
  - 1. New materials, unless otherwise approved, confirming 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 restore 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 structure track deck and ceiling panel elements for alteration purposes excluding removal of hazardous materials and toxic substances.

**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
    - 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:
  - 1. Submit demolition plan as specified by OSHA and local authorities.
  - 2. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences.
  - 3. Identify demolition firm and submit qualifications.
  - 4. Include a summary of safety procedures.
- D. Project Record Documents:
  - 1. 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.
- C. Codes, Regulations, Reference Standards and Specifications:
  - 1. Comply with codes and regulations of the jurisdictional authorities.

## **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.

### **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 temporary 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.
- J. Prevent damage to pipes, conduits, wires, cables and structures above and below ground which are not designated for removal. Repair or replace damaged items.

### **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 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.

### **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 02250  
SHORING**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. This work shall consist of providing the necessary labor, materials, equipment and supervision for the installation of shoring to support structural elements during execution of the work, as shown in the Contract Drawing.

**1.02 SUBMITTALS**

- A. Contractor shall submit shop drawings for the temporary shoring shown in the Contract Drawings
- B. Temporary Shoring Plans: Temporary shoring plans shall be submitted with design calculations and supporting data for review and approval by the AR and Quality Control Engineer. Shop drawings and calculations shall be sealed by a Professional Engineer, licensed in Washington DC. Shop drawings shall include all details and components required to construct the temporary shoring, design loadings, specifications, required inspection and testing, material specifications and procedures for erection.

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Contractor shall submit shop drawings for the temporary shoring shown in the Contract Drawings
- B. Temporary Shoring Plans: Temporary shoring plans shall be submitted with design calculations and supporting data for review and approval by the AR and Quality Control Engineer. Shop drawings and calculations shall be sealed by a Professional Engineer, licensed in Washington DC. Shop drawings shall include all details and components required to construct the temporary shoring, design loadings, specifications, required inspection and testing, material specifications and procedures for erection.

**PART 3 EXECUTION**

**3.01 SHORING INSTALLATION**

- A. Shoring shall be installed in accordance with the Contract Drawings or the shop drawing submittals produced under Section 3.2. The shoring design in the Contract Drawings assumes a construction live load of 50 psf. If construction equipment, construction sequence, or Contractor means and methods produce a construction live load in excess of 50 psf, shoring shall be designed by the Contractor under Section 3.02. No demolition shall proceed prior to review and approval of the shoring installation by the Quality Control Engineer and the AR.

**3.02 SHORING DESIGN REQUIREMENTS – TEMPORARY SHORING SYSTEMS**

- A. Design of Shoring components shall conform to accepted engineering practice. The minimum construction live load shall be 50 psf. Higher construction live loads shall be used if warranted by construction equipment, sequence, means and/or methods. If multiple level shoring is required, it shall be supplied and installed at no additional cost to the Authority. The work area size shall be adjusted as required so as not to exceed the maximum number

of parking spaces which can be taken out of service at any one time as indicated in the Contract Drawings.

- B. Design calculations shall be included for portions of the existing structure that will either directly or indirectly support the temporary shoring. As-built dimensions, materials, and conditions shall be based on the original plans and field verification by Contractor.
- C. If the temporary shoring is to be directly supported by the existing structure, connections shall be made by direct bearing or the use of suitable anchors. If mechanical anchors (wedge anchors, sleeve anchors, expansion shields, or similar proprietary anchors) or adhesive or epoxy resin anchors are used in the shoring, installation of the anchors shall be monitored by the Quality Control Engineer. Inspection instructions shall be included in the submittal.
- D. Special Shoring: Special shoring required to support demolition equipment loads shall also be designed and submitted in accordance with this section.
- E. The Designer of the Alternate shoring system shall attend a site meeting to be attended by the AR, Quality Control Engineer and Contractor to review the alternate shoring system requirements with the parties.

### **3.03 SHORING INSTALLATION CERTIFICATION – TEMPORARY SHORING SYSTEMS**

- A. Professional Engineer registered in Washington DC shall be retained by the Contractor and shall inspect the alternate shoring systems during and after installation in each work area or phase of construction and shall submit a written certification that the shoring has been installed in accordance with the approved shop drawings. If the shoring system is to be modified at various phases of the work, certification is required for each phase. No demolition shall proceed prior to review and approval of the certification by the AR

### **3.04 ACCESS**

- A. Drive Lanes:
  - 1. Contractor shall provide warning devices, signs and guards for shoring components to protect shoring components from vehicle impact.

### **3.05 REMOVAL OF SHORING**

- A. Upon completion of the work, the Contractor shall remove all shoring materials from Authority property. Shoring may be removed when field cured concrete test specimens reach a compressive strength of 4,000 psi. Concrete shall be tested in accordance with Specifications Section 03300 as applicable.
- B. Anchor bolts and/or other connections to existing components shall be removed and all holes repaired in accordance with Section 03300.

**END OF SECTION**

**SECTION 03100  
CONCRETE FORMWORK**

**PART 1 GENERAL**

**1.01 DESCRIPTION**

- A. This section specifies reinforcement 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
- C. 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 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
  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. 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:**

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 2.

Structural Member	Minimum Percentage of	
	Schedule 1	Schedule 2
Track Deck Overhang Slab (Cantilevers)	90	75

- 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 03200  
CONCRETE REINFORCEMENT**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

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

**1.02 1.2 RELATED SECTIONS**

- A. Section 03300: Cast-in-Place Concrete

**1.03 1.3 REFERENCES**

- A. American Concrete Institute (ACI):
  - 1. ACI 315: Details and Detailing of Concrete Reinforcement.
  - 2. ACI 318: Building Code Requirements for Structural Concrete and Commentary.
- B. American Welding Society (AWS):
  - 1. AWS D1.4: Structural Welding Code – Reinforcing Steel.
- C. ASTM International (ASTM):
  - 1. ASTM A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
  - 2. ASTM A663: Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
  - 3. ASTM A706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
  - 4. ASTM A1064: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- D. Concrete Reinforcing Steel Institute (CRSI):
  - 1. CRSI Manual of Standard Practice.

**1.04 SUBMITTALS**

- A. Shop Drawings and Product Data:
  - 1. Prepare shop drawings of concrete reinforcement in accordance with ACI 315.
  - 2. Provide drawings showing all fabrication dimensions and locations for placing reinforcement and bar supports; indicate bending diagrams, splicing and lap of rods, shapes, dimensions and details of bar reinforcing, and accessories.
  - 3. Product Data: Submit manufacturer's descriptive product data and current specification for each product specified herein, include installation instructions.
- B. Test Reports:
  - 1. Submit copies of reports showing the results of tests, conducted in accordance with ASTM Specifications.
  - 2. Test Requirements may be waived based upon certified copies of mill test reports.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Storage of Materials:
  - 1. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.

- a. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
- b. Cover reinforcement and accessories.
2. Identify bundles of reinforcing steel with tags wired to steel.
3. Protect reinforcement from deforming, bending, kinking, and other injury.

## 1.06 PROJECT CONDITIONS

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

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Reinforcing Steel:
  1. Reinforcement Bars: ASTM A615, Grade 60, deformed steel.
  2. Epoxy-Coated Reinforcement Bars: ASTM A775
  3. Weldable reinforcement bars: ASTM A706.
  4. Wire: ASTM A1064.
  5. Epoxy Coated Welded Wire Reinforcement: ASTM A185.
  6. Metal Accessories: CRSI Manual of Standard Practice.
- B. Rebar Splicing Coupler: Make splices in accordance with ACI 318 with a capacity not less than 125 percent of minimum yield strength of the rebar.
  1. Internal Coupler Protector: Provide coupler manufacturer's plastic internal coupler protector where couplers are provided for anticipated future additions.
  2. Use Rebar Splicing Coupler only where shown on Drawings or where approved by the Engineer.
  3. Acceptable Manufacturers:
    - a. Lenton Lock Shear Bolt Mechanical Coupler Coated by Erico
    - b. Or approved equal.
- C. Slab Joint Dowel System for Expansion and Contraction Joints:
  1. Two-piece system consisting of a closed end plastic sleeve and smooth dowel bar, size as indicated on drawings.
    - a. Dowel Bar:
      - 1) Plain round bar conforming to requirements of ASTM A663, Grade 70, 75, or 80 which is not burred, roughened, or deformed out-of-round so slippage is not hindered.
    - b. Acceptable Manufacturers:
      - 1) Greenstreak: Speed Dowel System
      - 2) Or approved equal.
  2. Dowel Bar with Bondless Surface:
    - a. Plain round bar conforming to requirements of ASTM A663, Grade 70, 75, or 80 which is not burred, roughened, or deformed out-of-round to slippage is not hindered.
    - b. Coat with curing compound to render surface bondless.
      - 1) Curing compound: Section 03300.
- D. Deformed Bar Anchors: Deformed anchor conforming to ASTM A1064 with minimum yield strength of 70 ksi and minimum ultimate tensile strength of 80 ksi. Bar anchor shall be low

carbon steel with the following properties C -0.23 max, Mn – 0.90 max, P – 0.040 max, and S – 0.050 max.

1. Anchors shall be similar to Nelson, flux-filled deformed bar anchor, Type D2L, by Nelson Stud Welding or equal.
- E. Fiber Concrete Reinforcement: First quality, 100% virgin polypropylene fibers containing no reprocessed olefin materials such as Fibermesh as manufactured by SI Concrete Systems, or equal.
1. Fiber material shall be mixed at rate of 1.5 pounds of fiber to 1 cubic yard of concrete.
  2. Add fibrous reinforcement to concrete material at the time concrete is cast. Mix concrete in strict accordance with fiber reinforcement manufacturer's instructions in order to achieve uniform three-dimensional distribution.
- F. Metal Accessories:
1. Provide metal accessories in accordance with the requirements of the CRSI Manual of Standard Practice.

## 2.02 FABRICATION

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

## 2.03 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein.
  2. The Testing and Inspection Agency (Approved Agency) will perform the source testing specified in this Paragraph, unless the testing is not required as specified.
    - a. The tests specified in Subparagraphs 2.03.A.3 through 2.08.A.9 may be waived if certified copies of mill test reports are submitted showing complete compliance with the specified requirements.
    - b. If the certified mill test reports are not submitted the Testing and Inspection Agency must perform the specified tests.
  3. Deformed Steel Reinforcement Tests:
    - a. Test Procedure:
      - 1) The following properties of the deformed steel bar reinforcement will be determined using the methods specified in ASTM A615:
        - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
        - b) The tensile strength, yield strength, and percentage elongation.
      - 2) The bend test will be performed on the deformed steel bar reinforcement using the methods specified in ASTM A615.
    - b. Acceptance Criteria:

- 1) Deformed steel bar reinforcement that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A615, and that pass the bend test for the bar size, as specified in ASTM A615 are acceptable.
4. Deformed Weldable Reinforcement Tests:
  - a. Test Procedure:
    - 1) The following properties of the low-alloy steel deformed bar reinforcement will be determined using the methods specified in ASTM A706:
      - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
      - b) The tensile strength, yield strength, and percentage elongation.
    - 2) The bend test will be performed on the low-alloy steel deformed bar reinforcement using the methods specified in ASTM A706.
  - b. Acceptance Criteria:
    - 1) Low-alloy steel deformed bar reinforcement that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified, and that pass the bend test for the bar size, as specified in ASTM A706 are acceptable.
5. Steel Welded Wire Reinforcement Tests:
  - a. Test Procedure:
    - 1) The tensile strength, yield strength, and percent reduction of area will be determined, and the bend test for steel welded wire reinforcement will be performed in accordance with the methods specified in ASTM A1064.
  - b. Acceptance Criteria:
    - 1) Steel wire used to fabricate the steel welded wire reinforcement that exhibits the tensile strength, yield strength, and percent reduction of area within the ranges specified, and that passes the bend test for the wire size as specified in ASTM A1064 are acceptable.
6. Deformed Bar Anchor Tests:
  - a. Test Procedure:
    - 1) The tensile strength and yield strength will be determined, and the bend test for steel deformed bar anchors will be performed in accordance with the methods specified in ASTM A1064.
  - b. Acceptance Criteria:
    - 1) Deformed bar anchors exhibiting the tensile strength and yield strength within the ranges specified in Subparagraph 2.01.E are acceptable.
7. Rebar Splicing Coupler:
  - a. Test Procedure:
    - 1) The following properties of the dowel bar used to fabricate the rebar splicer components will be determined using the methods specified in ASTM A615
      - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
      - b) The tensile strength, yield strength, and percentage elongation.

- 2) The bend test will be performed on the dowel bar used to fabricate the dowel bar splicer components using the methods specified in ASTM A615.
- b. Acceptance Criteria:
  - 1) Rebar splicer components that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A615, and pass the bend test for the bar size as specified in ASTM A615 are acceptable.
8. Slab Joint Dowel Bar Tests:
  - a. Test Procedure:
    - 1) The chemical composition, tensile strength, yield point, and percent elongation of slab joint dowel bars will be determined in accordance with the methods specified in ASTM A663
  - b. Acceptance Criteria:
    - 1) Dowel bars exhibiting the tensile strengths, yield points, and percents elongation within the ranges as specified in ASTM A663 for the Grade of bar tested are acceptable.
9. Non-Conforming Work:
  - a. Do not use concrete reinforcement that fails the testing.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Placing Concrete Reinforcement:
  1. Place metal concrete reinforcement accurately and in accordance with ACI 318.
    - a. Do not lay metal reinforcement on formwork.
    - b. Terminate reinforcement 2 inches from the face of expansion joints.
    - c. Continue reinforcement across or through construction joints except for keyed control joints in slab-on-grade.
    - d. Place additional concrete reinforcement around openings in slabs and walls as detailed on the Contract Drawings.
    - e. Provide reinforcing accessories to securely brace the reinforcement against displacement outside of permitted tolerances.
  2. Slab Reinforcement Placement:
    - a. Install welded wire reinforcement (flat sheets or mats) as indicated, lapping joints eight inches with the overlap being measured between the outermost cross wires of each reinforcement sheet and securely wiring the joints together.
    - b. Extend welded wire reinforcement to within 2 inches of sides and ends of slabs.
    - c. To support slab reinforcement from the ground, place the reinforcement on concrete blocks of the correct height and having a compressive strength equal to or greater than the specified compressive strength of the concrete being placed.
      - 1) Use concrete blocks not larger than 3 inches by 3 inches and of a height equal to required bottom steel cover.
    - d. To support slab reinforcement from formwork, place the reinforcement on bar chairs made of plastic or metal.
      - 1) If the slab surface is exposed to view, provide supports with legs protected by plastic or stainless steel.



3. Field weld deformed bar anchors to slab edge steel bent plate as shown on the Contract Drawings.
- B. Concrete Reinforcement Field Bends:
  1. Do not field bend bars partially embedded in concrete.
  2. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcement around it
    - a. Do not bend the reinforcement to clear the obstructions.
- C. Shortening Concrete Reinforcement:
  1. Shorten (trim) concrete reinforcement, if required, by shearing or sawing.
  2. Shortening concrete reinforcement using an acetylene torch may be acceptable, but only if the location of the shortening is approved by the Engineer in writing in advance.
- D. Welding Concrete Reinforcement:
  1. Do not weld concrete reinforcement except when using ASTM A706 weldable reinforcement, and only where indicated on the Contract Documents or approved in writing by the Engineer.
  2. Select proper filler materials, preheat temperatures, and performance/procedures in accordance with the requirements specified in AWS D1.4.
- E. Splicing Concrete Reinforcement:
  1. Splice reinforcement in accordance with ACI 318 and as indicated on the Contract Drawings.
  2. Secure reinforcement at intersections with not less than 16-gauge annealed wire or appropriately sized clips.
    - a. Where bar spacing is less than 12 inches, tie alternate intersections.
    - b. Do not tack-weld crossing bars.
- F. Slab Joint Dowel Bar Installation:
  1. Install one-half the length of the coated bar dowel into the slab to be poured.

### **3.02 SITE QUALITY CONTROL**

- A. A Testing and Inspection Agency (Approved Agency) shall be engaged by Owner to perform code-required special inspections.
  1. Written reports on all tests and inspections shall be provided immediately after work is performed. The reports shall state test specimens either comply with requirements or deviate from them.
- B. Inspections:
  1. Notify the Engineer at least 10 days prior to scheduled concrete placement operations so the placement of reinforcement can be inspected.
  2. Prior to placing concrete, inspect the reinforcement size, location, spacing, clear distance between bars, and to the outside face of the concrete, and the reinforcement will not be displaced during the placement of concrete.
    - a. Verify the rebar splicer system is installed at the approved locations, is the correct type, and is installed in accordance with the manufacturer's guidelines.

### **3.03 CLEANING**

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

**3.04 PROTECTION**

- A. Provide protection for concrete reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Contract Drawings.
- B. Protect in-place reinforcement from excessive construction traffic and other work.

**END OF SECTION**

**SECTION 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.

**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, C1105, C1107, C1293, 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 shall not exceed 0.35. Refer to 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 03300.2.1.P 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
  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 C94.
  5. Appearance:
    - a. Cured concrete exposed to public view shall be uniform in color, texture and finish with no discernible form or patch marks, grain imprint, joint irregularities or discoloration. Use only manufacturer approved chemically reactive release agents on HDO plywood forms.
    - b. Final selection and approval for color shall be made by the Engineer.
- D. Method of Proportioning:
1. Proportion mixes as described in ACI 211.1.
  2. Approximate mixing-water and air-content requirements for mixes of different slumps and nominal maximum sizes of aggregates as specified in ACI 211.1, Table 5.3.3.
  3. Do not vary proportions of ingredients of approved mixes without written approval.
- E. Ready-Mixed Concrete: ASTM C94.

### 1.03 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 mix report in submittal form as shown at the end of this specification:
    - 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.
- 6) Each mix design shall include:
  - a) Source and type of each cement including results of chemical and physical test.
  - b) Complete identification of source supply of each type of aggregate
  - c) Results of tests of aggregate for compliance with specified requirements.
  - d) Scale weight of each aggregate
  - e) Absorbed water in each aggregate
  - f) Brand, type and amount per cubic yard of each admixture used.
  - g) Amount of free water used per cubic yard.
  - h) Proportions of each material per cubic yard.
  - i) Gross weight per cubic feet.
  - j) Measured slump
  - k) Water/cementitious materials ratio, by weight.
  - l) Total air content, by percent.
  - m) Water soluble ion chloride content, percent by weight of cement.
  - n) Compressive strength at 3 days, 7days and 28 days
  - o) Complete standard deviation analysis or trial mix test data.
4. Concrete admixtures.
5. Submit current Approved ICC Evaluation Reports for adhesive anchors.
6. Submit anchor installer's certification of training completion.
7. 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. Protective Coating for use at track deck slab. As required by the manufacturer.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS:**

- A. Cementitious Materials:
1. Portland Cement: ASTM C150, Types I & II
    - a. Use Type II only for underground structures.
    - b. 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 311 and ASTM C618, Class F
1. Alkali content for fly ash shall not exceed 5.0 percent unless tested per ASTM C1567.
  2. Loss on ignition not to exceed 4 percent.
  3. Uniform color when used in concrete exposed to public view.
- D. Silica Fume: ASTM C1240.
1. Loss on ignition not to exceed 6 percent.
  2. Alkali content for silica fume shall not exceed 1.5 percent unless tested per ASTM C1567.
- E. 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.
  2. 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, Metaquartzite, 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.
3. 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, Metaquartzite, 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.
4. 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.
- a. 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.
          - (3) If ASTM C1260 expansion is greater than 0.40 percent at 16 days then the aggregate shall not be used.
    - b. 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.
        - a) ASTM C1105 Testing: Expansion greater than 0.25 percent at 6 months is unacceptable.
          - (1) ASTM C1293 Testing: See ASTM C1293 testing and acceptance criterion above.
          - (2) ASTM C1567 Testing: See ASTM C1567 testing and acceptance criterion above.
          - (3) 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.
- F. Water:
  5. Natural potable water with no pronounced taste or odor.
  6. 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.
  7. pH: Not less than five.
  8. 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.
- G. Admixtures: The following admixtures (or equivalents accepted by Authority's Representative) shall be permitted.
  1. Air-entraining, conforming to ASTM C-260; "Air Mix" or "AEA-92" by the Euclid Chemical company, "Daravair-M" by W.R. Grace & Co. or approval equal.
  2. Water reducing, conforming to ASTM C-494 Type A; "Eucon NW" or "Eucon WR- 91" by the Euclide Chemical Company, "WRDA-64" or "WRDA-79" by W.R. Grace & Co, or approved equal.

4. Non-chloride and non-corrosive accelerator conforming to ASTM C-494 Type C; "Accelguard 80/90 or NCA" by the Euclid Chemical Company, "Daraset" by W.R. Grace & Co., or approved equal
  5. Water-reducing, retarding conforming to ASTM C-494 Type D; "Eucon Retarder 75 or Eucon DS" by the Euclid Chemical Company, "Daratard-17" by
  6. W.R. Grace & Co., or approved equal
  7. High-range, water-reducing conforming to ASTM C-494 Type F; "Eucon 37" or "Eucon SPJ" or "Plastol Series" by the Euclid Chemical Company, "Daracem-100" or "AdvaFlow Series" by W.R. Grace & Co., or approved equal.
  8. Corrosion inhibiting, calcium nitrite based compound; "Eucon CIA" by the Euclid Chemical Company, "DCI Corrosion Inhibitor" by W.R. Grace & Co., or approved equal.
  9. 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.
  10. Meeting requirements of reference standards or documented to have five-year minimum history of demonstrably satisfactory performance for similar structures under equivalent conditions.
- H. 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 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.
- I. 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.
- J. Ready-Mixed Concrete: ASTM C94, Option C.
- K. 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
<u>US Standard Square Mesh</u>	<u>Passing Individual Sieves</u>
3/8 inch	—
Size 4	100
Size 8	90 - 100
Size 16	75 - 90
Size 30	45 - 60
Size 50	15 - 25
Size 100	10 - 20

3. If recommended by manufacturer and approved, in lieu of the above gradation use lower percentage of aggregate passing Size 100 sieve.
- L. Abrasive Aggregate: 60 to 75 percent silicon-carbide abrasive, bonded by vitreous ceramic material, black, graded from 12 to 30.
- M. Curing Materials:
  1. Plastic sheeting: Polyethylene, ASTM C171.
  2. Curing sheet: Type 1.1.1 and 1.1.2.
  3. Vapor barrier: Clear 10-mils thickness.
  4. Burlap sheet: AASHTO M182, Class 3 or 4.
  5. Tarpaulin: FS K-P-146.
  6. Blanket insulation: FS HH-I-521.
  7. Membrane-forming curing compound: ASTM C309, Type 1-D, 100 resin with fugitive dye, and Type 2.

- N. Epoxy Mortar:
1. Epoxy: ASTM C881, Type III-C, grey.
  2. Sand: Clean, dry, well-graded particles, passing Size 16 sieve, with the following additional requirements:

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

- O. Chairs for Reinforcement: Plastic or stainless steel.
- P. 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.
- Q. 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.
- R. 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](http://www.hilti.com).
    - b. Hilti HIT-HY 150 MAX-SD, [www.hilti.com](http://www.hilti.com).
    - c. Simpson Strong Tie SET-XP, [www.simpsonanchors.com](http://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 7000.
  - 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: 25-percent of the total weight of the Portland cement and fly-ash mixture.
  - d. Maximum allowable silica fume: 10 percent of total weight of the Portland cement and silica fume mixture.
  - e. Total cement replacement shall not exceed 50 percent when fly ash, slag and silica fume are used. Total cement replacement shall not exceed 35 percent when only fly ash and silica fume are used.
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 as follows:

Class of Concrete	Minimum Cement Factor Bags Per Cubic Yard Of Concrete
7,000	7.50
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 air content shall meet ACI 318, Chapter 4 Durability Requirement.
- 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.
  - b. 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.
    - 1) 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.
    - 2) Perform slump tests, unit weight and air content tests with no less frequency than that of strength-specimen sets.
  2. 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
    - c. Prepare printout in duplicate and submit one copy with its corresponding concrete ticket at the
    - 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. 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 55° F and falling. Do not place concrete unless the form temperature at the time of placement is at least 40° F.
- B. When ambient temperature is 40° F and falling, carry out one of the following procedures to protect placed concrete:
  1. Heating:
    - a. Enclose forms or structures and heat to maintain concrete and air within enclosure at not less than 55° F for seven days after placement.
    - b. Maintain relative humidity at not less than 40 percent during curing period when heat is applied to enclosures. Arrange stoves, salamanders or heaters so as to provide uniform distribution of heat. Vent combustion gases to outside air. Do not let hot air blow across concrete surfaces.

- c. After seven-day curing period, reduce temperature within enclosure gradually at maximum rate of 20° F per day until outside temperature has been reached.
- d. Provide continuous and adequate fire protection and watchmen when heating units are in operation.
- 2. Form insulation:
  - a. Insulate forms with blanket insulation of approved type and thickness to maintain concrete at 55° F minimum for seven days.
  - b. Protect top of placed concrete by tarpaulins or other approved waterproof material over insulation.
- C. Do not allow concrete to freeze in a saturated condition prior to achieving a strength of 5,000 psi.

### 3.07 HOT WEATHER CONCRETING:

- A. When temperature in forms is 75° 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 90° 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.

### **3.010 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.

**3.011 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.

**3.012 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.

**3.013 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.

**3.014 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 65° 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 200° F with final surface temperature below 105° 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 60° F minimum until mortar is hard.
  2. Initiate post-curing of four hours minimum at surface temperature of 90° F minimum, 110° 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.

### **3.015 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.

### **3.016 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.

**3.017 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
  - 1. 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. 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. (Inches)	3/8	1/2	5/8	3/4	7/8	1
Embedment Depth (Inches)	4	5	6	7	8	10

**3.018 SECTION 03300 APPENDIX – CONCRETE MIX DESIGN SUBMITTAL FORM**

Project: \_\_\_\_\_  
City: \_\_\_\_\_  
General Contractor: \_\_\_\_\_  
Concrete Contractor: \_\_\_\_\_  
Contact Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
Phone Number: \_\_\_\_\_  
Main Plant Location: \_\_\_\_\_  
Miles from Project Site: \_\_\_\_\_  
Date: \_\_\_\_\_

**Design Characteristics**

Use (describe): \_\_\_\_\_  
Strength: \_\_\_\_\_ psi at \_\_\_\_\_ days  
Density: \_\_\_\_\_ pcf  
Air: \_\_\_\_\_ %                      Water/cementitious ratio: \_\_\_\_\_

**Design Mix Information – check one**

Based on Standard Deviation Analysis of Trial Mixes or Field Experience.  
No. of test cylinders: \_\_\_\_\_ Avg. Strength: \_\_\_\_\_ psi  
Standard deviation: \_\_\_\_\_ f'cr: \_\_\_\_\_ psi  
f'cr = f'c + 1.34s or f'cr = f'c' + 2.33s - 500  
Refer to ACI 318 Sec. 5.3.1 for standard deviation factor if less than 30 tests

Based on Trial Mix Test Data.  
f'cr: \_\_\_\_\_ psi  
f'cr = f'c + 1200 psi, for up to 5000 psi  
f'cr = 1.10 f'c + 700 psi, for greater than 5000 psi

**Materials**

	Type/Source	Specific Gravity	Weight Lbs.	Absolute Vol. Cu. Ft.
Cement				
Flyash				
Microsilica				
Fine Aggregate				
Coarse Aggregate				
Water				
Air				
Other				
<b>Total</b>				<b>27.0 cu. ft.</b>

**Admixtures**

	Manufacturer	Dosage Oz/Cwt
Water Reducer		
Air Entraining Agent		
High Range Water Reducer		
Non-Corrosive Accelerator		
Other		

Slump before HRWR \_\_\_\_\_ inches

Slump after HRWR \_\_\_\_\_ inches

**Required Attachment Checklist**

- Combined aggregate gradation report  
 Note: 8%-18% aggregate required to be retained on each side sieve except the top size and #100.
- Standard deviation analysis summary or trial mixture test data
- Admixture compatibility certification letters

END OF SECTION 03300 APPENDIX

**END OF SECTION**

**SECTION 03700  
EMBEDDED GALVANIC ANODES**

**PART 1 GENERAL**

**1.01 DESCRIPTION**

- A. This Section includes furnishing all labor, tools, materials, equipment and services necessary to properly install embedded galvanic anodes. Embedded galvanic anodes are designed to provide localized corrosion protection. When placed at the appropriate spacing along the perimeter of concrete patches or along the interface between new/existing concrete, the anodes mitigate active corrosion and the formation of new corrosion sites in the adjacent existing concrete.
- 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 REFERENCES**

- A. ACI/ICRI Concrete Repair Manual
- B. ACI Guideline No. 222 – Corrosion of Metals in Concrete
- C. ACI Repair Application Procedure (RAP) Bulletin 8 – Installation of Embedded Galvanic Anodes (2010)
- D. ICRI Guideline 310.1R-2008 Guide for Surface Preparation for the Repair of Deteriorated Concrete resulting from Reinforcing Steel Corrosion
- E. ASTM A615/A615M Standard Specification for Deformed and Plain Billet-Steel Bar for Concrete Reinforcement
- F. ASTM B418-12 – Standard Specification for Cast and Wrought Galvanic Zinc Anodes

**1.03 QUALITY ASSURANCE**

- A. Manufacturer's extended limited warranty:
  - 1. Contractor shall provide a Limited Warranty with a notarized signature from a corporate officer of the anode manufacturer.
  - 2. The Limited Warranty shall state the following:
    - a. The published anode spacing guidelines for anode size and spacing are based on an estimated 10-20 year anode service life.
    - b. The galvanic anodes will remain electrochemically active and produce galvanic current in relation to the environment in which it is installed for a minimum of 5 years from the date of anode installation.
    - c. The anode unit, including its constituents, does not include substances that may cause adverse effects to concrete or reinforcing steel and will not contribute to reinforcing steel corrosion damage over the life of the structure.
    - d. The galvanic anodes meet all building and repair code requirements.
    - e. All galvanic anodes, galvanic anode accessory parts and materials, shall originate from a single manufacturer.
- B. 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.
- C. Manufacturer corrosion technician:

1. The contractor will enlist and pay for a technical representative employed by the galvanic anode manufacturer to provide training and on-site technical assistance during the initial installation of the galvanic anodes. The technical representative shall be a NACE-qualified corrosion technician (Cathodic Protection Technician—CP2 or higher).
  2. The qualified corrosion technician shall have verifiable experience in the installation and testing of embedded galvanic protection systems for reinforced concrete structures.
  3. The contractor shall coordinate its work with the designated corrosion technician to allow for site support during project startup and initial anode installation. The corrosion technician shall provide contractor training and support for development of application procedures, verification of electrical continuity, and project documentation.
- B. Storage:
1. Deliver, store, and handle all materials in accordance with manufacturer's instructions. Anode units shall be stored in dry conditions in the original unopened containers in a manner to avoid exposure to extremes of temperature and humidity.

#### 1.04 SUBMITTALS

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

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Embedded Galvanic Anodes
1. Embedded galvanic anodes shall be Anode Type 2A Class P. The anodes shall be pre-manufactured with a nominal 60 grams of zinc in compliance with ASTM B418 Type II cast around a pair of uncoated, non-galvanized steel tie wires and encased in a highly alkaline cementitious shell with a pH of 14 or greater.
  2. The anode unit shall contain no added sulfate nor shall it contain added chloride, bromide or other constituents that are corrosive to reinforcing steel. Anode units shall be supplied with integral unspliced wires for directly tying to the reinforcing steel.
  3. Acceptable manufacturer:
    - a. Galvashield® XP available from Vector Corrosion Technologies ([www.vector-corrosion.com](http://www.vector-corrosion.com))
    - b. Sentinel Silver available from the Euclid Chemical Company ([www.euclidchemical.com](http://www.euclidchemical.com))
    - c. Approved equal.
      - 1) Application for galvanic anode approved equals shall include verification of the following information.
        - a) The zinc anode is alkali-activated with an alkaline cementitious shell with a pH of 14 or greater.



- b) Contain no added constituents corrosive to reinforcing steel or detrimental to concrete, e.g. chloride, bromide, sulfate, etc.
- c) Documented test results from field installations showing that the anodes have achieved a minimum of 10 years in service.
- d) A minimum of ten projects of similar size and application.
- e) Anode units shall be supplied with solid zinc core (ASTM B418) cast around uncoated, non-galvanized non-spliced steel tie wires for wrapping around the reinforcing steel and twisting to provide a durable steel to steel connection between the tie wire and the reinforcing steel.
- f) Third party product evaluation, such as from Concrete Innovations Appraisal Service, BBA, etc.

### **PART 3 EXECUTION**

#### **3.01 CLEANING AND REPAIR OF REINFORCING STEEL**

- A. Clean exposed reinforcing steel of rust, mortar, etc. to provide sufficient electrical connection and mechanical bond.
- B. If significant reduction in the cross section of the reinforcing steel has occurred, replace or install supplemental reinforcement as directed by the engineer of record.
- C. Secure loose reinforcing steel by tying tightly to other bars with steel tie wire.
- D. Verify electrical continuity of all reinforcing steel, including supplemental steel, as per Section 3.2.E.
- E. If the reinforcing steel is to receive a barrier coating, do not coat the reinforcing steel within 1 in. of the anode and do not apply coating to any surface of the anode or the steel tie wires.
- F. Contractor shall confirm and provide documentation verifying electrical continuity of reinforcement steel prior to placement of anode.

#### **3.02 GALVANIC ANODE INSTALLATION**

- A. Install anode units immediately following preparation and cleaning of the steel reinforcement.
- B. Galvanic anodes shall be installed at a maximum spacing of 24 inches on center.
- C. Allow the concrete to fully encase the anode with a minimum concrete cover over the anode of 1 in.
  - 1. Place the anode such that it is attached to a single bar or at the intersection between two bars and secure to each clean bar.
  - 2. If less than 1 in. of concrete cover is expected, place anode beneath the bar and secure to clean reinforcing steel.
- D. The tie wires shall be wrapped around the cleaned reinforcing steel at least one full turn in opposite directions and then twisted tight to create a secure electrical connection and allow no anode movement during concrete placement.
- E. Electrical Continuity
  - 1. Confirm electrical connection between anode tie wire and reinforcing steel by measuring DC resistance (ohm  $\Omega$ ) or DC potential (mV) with a multi-meter.
  - 2. Electrical connection is acceptable if the DC resistance measured with the multi-meter is 1  $\Omega$  or less or the DC potential is 1 mV or less.
  - 3. Confirm electrical continuity of the exposed reinforcing steel within the overhang area. If necessary, electrical continuity shall be established by tying discontinuous steel to continuous steel using steel tie wire.

4. Electrical continuity between test areas is acceptable if the DC resistance measured with multi-meter is  $1 \Omega$  or less or the potential is 1 mV or less.

### **3.03 CONCRETE REPLACEMENT**

- A. If the repair procedures require the concrete surface to be saturated with water, do not damage the anode nor allow the anode units to be soaked for greater than 20 minutes.
- B. Complete the repair, taking care not to damage, loosen or leave voids around the anode.

**END OF SECTION**

**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 repairs to be made include but are not limited to:
- B. Repair of surface spalls on horizontal, vertical and overhead surfaces. Cracks in existing concrete.
- C. Full depth platform overhang slab replacement.
- D. Repair of post-tensioned platform girder ends.
- E. Pier cap spall repair at bridge bearing
- F. Existing ceiling panel replacement
- G. Related work specified elsewhere:
  - 1. Concrete Formwork: Section 03100
  - 2. Cast-in-Place Structural Concrete: Section 03300
  - 3. Embedded Galvanic Anodes: Section 03700
  - 4. Fiber Reinforced Plastic Panel Fabrications: Section 06610

**1.02 REFERENCES:**

- A. ASTM International (ASTM)
- B. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- C. ASTM C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
- D. ASTM C267, Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes.
- E. ASTM C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
- F. ASTM C496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
- G. ASTM C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
- H. ASTM D1042, Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
- I. Army Corps of Engineers (USACE):
- J. 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.
- C. Contractors shall provide the Engineer with two job references where they have successfully repaired existing concrete with the specified product.
- D. 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.
- E. Services shall include detailed instructions to the Contractor's personnel on the use of the concrete repair material.
- 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.

#### **1.05 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 shall be performed by the Contractor and any cost incurred due to deviation from the quantity shall be negotiated at the supplemental unit price. Repair of concrete required due to demolition of adjacent concrete or embedments shall be included in the Contract Bid price and shall be performed at no additional cost to the Owner. The Contractor shall not perform any repair work without prior approval and acceptance of repair locations, extent, and repair type from the Authority's Representative.
- B. Reinforcement may be encountered within the repair region.

### **PART 2 PRODUCTS**

#### **2.01 CEMENTITIOUS POLYMER MORTARS:**

- A. Polymer Repair Mortar:
- B. Repair of Horizontal Top Surfaces (Type D Repair):
  - 1. Polymer-modified, cementitious, 2-component, free-flow self-leveling mortar such as SikaTop 111 Plus as manufactured by Sika Corporation or approved equal.
  - 2. Polymer-modified, cementitious, 2-component, trowel-grade patching mortar such as SikaTop 122 Plus as manufactured by Sika Corporation or approved equal.
  - 3. Shrinkage properties: ASTM C 157 at 28 days
    - a. 1" x 1" x 11-1/4" shrinkage less than 0.05%
    - b. 3" x 3" x 11-1/4" shrinkage less than 0.022%
  - 4. Compressive properties: ASTM C 109 at 28 days
    - a. Compressive strength: 7,000 psi minimum
  - 5. Tensile properties: ASTM C 496 at 28 days
    - a. Tensile strength: 500 psi minimum

6. Flexural properties: ASTM C 293 at 28 days
  - a. Flexural strength: 1,500 psi minimum
- C. Repair of Vertical and Overhead Surfaces (Type B, F, and H).
  1. Polymer-modified, cementitious, 2-component, fast-setting mortar such as SikaTop 123 Plus, Gel Mortar, as manufactured by Sika Corporation or approved equal.
  2. Shrinkage properties: ASTM C 157 at 28 days
    - a. 1" x 1" x 11-1/4" shrinkage less than 0.05%
    - b. 3" x 3" x 11-1/4" shrinkage less than 0.038%
  3. Compressive properties: ASTM C 109 at 28 days
    - a. Compressive strength: 6,000 psi minimum
  4. Tensile properties: ASTM C 496 at 28 days
    - a. Tensile properties: ASTM C 496 at 28 days
  5. Flexural properties: ASTM C 293 at 28 days
    - a. Flexural strength: 1,500 psi minimum
- D. Bonding Compound
  1. Provide Bonding Compound on excavated surfaces (All Types)
- E. Acceptable Manufacturer:
  1. Sika Corporation: Sikadur 32, Hi-Mod LPL
  2. Approved equal.

## **2.02 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 A through H repair procedures are defined in this section with additional guidelines given on the Contract Drawings.

### **3.02 TYPE B, D AND H REPAIRS – CONCRETE SPALL (SHALLOW AND DEEP):**

- A. Description: Work consists of the removal of unsound concrete and the repair of spalled and delaminated concrete surfaces one inch or less in depth with no visible reinforcing.
- 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 half-inch deep, or to the depth of the reinforcing steel, whichever is less, saw cut around the perimeter of the repair area to prevent a feather edge condition. Do not cut or damage existing reinforcing steel.
  3. Remove spalled, scaled, loose, and deteriorated concrete to sound concrete. Use maximum 15-pound size pneumatic hammer or other approved method to remove deteriorated concrete.

4. Thoroughly blast and vacuum the newly exposed area prior to installing repair mortar. Remove all debris from the site.
5. Render all surfaces of exposed concrete and reinforcing steel free of oil, solvent, grease, dirt dust, bitumen, rust, loose particles, and foreign matter.
6. Pre-soak the substrate to provide saturated surface (SSD) condition prior to application of repair material.
7. Follow Manufacturer's application instructions for substrate preparation, material placement, and material curing.

**3.03 TYPE A AND C REPAIRS – FULL DEPTH CONCRETE SLAB REPAIR (CAST-IN- PLACE CONCRETE):**

- A. Description: Work consists of the removal of unsound concrete and the repair of spalled and delaminated concrete surfaces in areas as noted on drawings, using cast-in-place concrete.
- B. Mixing:
  1. Follow manufacturers' recommendations.
  2. See Section 03300.
- 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 half-inch deep saw cut (or as noted on drawings) around the perimeter of the repair area. Remove spalled, scaled, loose, and deteriorated concrete to sound concrete for full depth of slab. 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. Use caution where reinforcing steel is uncovered so as not to damage the steel. Do not use pneumatic tools in direct contact with reinforcing steel. Use maximum 15-pound size pneumatic 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.

- c. Place new reinforcing bars per drawings. Drill and grout into existing concrete using epoxy adhesive.
6. Form excavated areas on vertical surfaces of concrete members in accordance with Section 03100: Design forms so that placement access will be at the top of each formwork assembly.
7. Prior to forming up vertical surfaces, install reinforcement as indicated on the Contract Drawings or as required and directed by the Engineer.
8. Provide Bonding compound on excavated surfaces.

### **3.04 TYPE E REPAIR – REPLACEMENT OF EXISTING CEILING PANELS AND ANCHOR BOLTS**

- A. Description: Work consists of the replacement of all existing ceiling panels as shown in the plans with new panels that are constructed with modular FRP panels. This also includes the replacement of all existing steel bolts and neoprene pads and gaskets with new stainless-steel bolts and neoprene pads.

### **3.05 TYPE F REPAIR – PIER CAP REPAIR AT BEAM BEARINGS**

- A. Description: Work consists of the removal of unsound concrete and the repair of spalled and delaminated concrete surfaces on existing pier cap corbels at track girder support using repair mortar as required by the manufacturer of the repair materials. Reinforcing steel may be visible or may be encountered during repair work. Contractor shall notify Authority's representative for approval of work plans prior to starting repair work.
- 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. Care shall be taken to protect existing track, structure, and utilities. Prior to repair work, remove and temporarily relocate utilities such as cables and conduits from repair area as required.
  2. Install hydraulic jack under existing end diaphragm and lift the track girder as required. Install temporary steel support to hold the girder in lifted condition. Remove hydraulic jack.
  3. Make a half-inch-deep, or to the depth of the reinforcing steel, whichever is less, saw cut around the perimeter of the repair area to prevent feather edge condition. Do not cut or damage existing reinforcing steel.
  4. Remove spalled, scaled, loose, and deteriorated concrete to sound concrete. Use maximum 15-pound size pneumatic hammer or other approved method to remove deteriorated concrete. Maximum depth of concrete removal shall be 3-inches.
  5. Thoroughly blast and vacuum the newly exposed area prior to installing repair mortar. Remove all debris from the site.
  6. Render all surfaces of exposed concrete and reinforcing steel free of oil, solvent, grease, dirt dust, bitumen, rust, loose particles, and foreign matter.
  7. Pre-soak the substrate to provide saturated surface (SSD) condition prior to application of repair material.
  8. Blast reinforcing steel in accordance with SSPC-SP-6, Commercial Blast Cleaning, to remove all contaminants, rust and rust scale and apply anti-corrosion coating material.
  9. Consult the Engineer if after cleaning of reinforcing steel, the bar has lost more than 20% of area for additional details that may be required.
  10. Securely attach epoxy coated welded wire reinforcing to existing reinforcing bars. If necessary, install 1/4" diameter powder actuated domed head stainless steel nails at 8-

- inches on-center with a minimum of two pins per repair to secure the epoxy coated welded wire mesh.
11. Clean concrete surface of dust, dirt, laitance, or other inhibiting materials and apply Bonding Compound agent to the clean excavated concrete surface.
  12. Follow Manufacturer's application instructions for additional substrate preparation, repair mortar placement, and material curing.
  13. All repaired areas shall be cured by utilizing plastic sheeting taped all around. Sheetting shall remain in place for a minimum of three (3) days.
  14. Reinstall hydraulic jack and follow the same procedure as described in step 2. Remove temporary steel support and reset track girder back to the original condition. Allow at a minimum seven (7) days between mortar placement and resetting the track girder back to the original condition.

### **3.06 GRAVITY REPAIR OF CONCRETE CRACK**

- 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.

### **3.07 CONCRETE CRACK REPAIR INJECTION AT UNDERSIDE**

- A. General: This work consists of underside crack repair of overhead cracks as indicated on the drawings.
1. Structural crack repairs shall not exceed more than ¼ inch in width.
  2. Clean out crack with hand tools or high pressure air blast. Vacuum clean the existing surface at crack location.
  3. Crack less than ¼ inch width shall be veed out to min. ¼ inch deep prior to filling. For cracks wider than ¼ inch, patch with epoxy repair mortar.
  4. Drill holes for ports to a width and depth sufficient to assure a snug fit of the port. Clean out debris with high pressure air blast and vacuum.
  5. Insert ports and seal surface of crack with epoxy surface sealant. Seal shall extend above concrete surface a minimum of 1/16 inch and extend a minimum of 1 inch on either side of the crack.
  6. Allow a minimum of 8 hours curing time before initiating injection process.
  7. Inject injection gel epoxy paste from underside. Allow curing of epoxy gel paste per manufacturer's recommendation.
  8. Remove epoxy surface sealant and sealer to the satisfaction of the Authority's representative.
  9. Cut off grout tube flush with concrete face. Apply patch over injection ports.
  10. Grind epoxy surface sealant smooth to about 1/32 inch over crack and feathered concrete edge.
  11. Follow manufacturer's recommendations for additional information.



**3.08 CLEANING:**

- A. Leave finished work area in clean condition without evidence of spill over onto adjacent areas.
- B. Remove all repair procedure debris from the site.

**END OF SECTION**

**SECTION 05121  
STAINLESS STEEL**

**PART 1 GENERAL**

**1.1 DESCRIPTION**

- A. Section Includes
  - 1. This Section covers the design, manufacture, and installation of structural metal framing and stainless-steel elements. Related Sections
- 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

## 1.2 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.

## 1.3 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.

#### 1.4 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

#### 2.1 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.

## 2.2 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**

#### **3.1 EXAMINATION:**

- A. Do not proceed with erection until unsatisfactory conditions have been corrected.

#### **3.2 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 used in the fabrication of stainless steel shall be approved by the Authority Representative.
- I. Clean Stainless Steel using standard Stainless-Steel Passivation techniques.

### **3.3 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. Types and locations of defects found in work. Record work required 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 inspection procedures listed below:
  - 4. Complete penetration welds: Ultrasonic Inspection; ASTM E164.
    - a. Fillet welds: Magnetic Particle Method; ASTM E709.
    - b. Perform ultrasonic testing of all other groove and full-penetration welds for the following:
      - c. 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.

### **3.4 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**

**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.
- D. Qualification Statement:
1. Submit qualification statement denoting the requirements of this specification are met by:
    - a. Hot-Dip Galvanizing Company

**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, A194, 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. Hot-Dip Galvanizing Plant Qualification:
  - 1. Company shall be a member of the American Galvanizers Association (AGA).
  - 2. Submit letter denoting plant location proposed for the defined work and number of years of experience performing galvanizing work similar to work denoted in this Contract.
- E. 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 Hot-Dip Galvanized.

- 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:
  - 1. 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. Galvanizing: Hot-dip galvanized steel members and fabrications specified to be galvanized in accordance with ASTM A123.
  - 1. Coating Weight: Conform with Paragraph 6.1 of ASTM A123.
  - 2. Repair areas damaged by welding, flame cutting or during handling, transport and erection by an approved method in accordance with ASTM A780.
- F. Bituminous Coating: Cold-applied asphalt mastic complying with SSPC Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187.

## 2.05 FASTENERS

- A. General: Provide Type 304 or 316 stainless-steel fasteners with lock nut 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.
- C. Stainless steel, ASTM A194, Alloy S30400.
- D. 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 A194, Grade 8, 8A. 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
  - 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. For structural steel specified to be galvanized, hot-dip galvanize the steel members and fabrications in accordance with ASTM A123 and to the thicknesses specified therein.
  2. Repair galvanized areas damaged by welding and flame cutting and during handling, transport, and erection by using an approved repair method in accordance with ASTM A780.
- C. Shop Paint:

1. Ferrous metal thoroughly cleaned as recommended by primer manufacturer and in accordance with SSPC SP11 and, except for items to be encased in concrete, given prime coat of paint.
  2. Zinc yellow iron-oxide primer or red-lead base primer applied so as to thoroughly cover surfaces without leaving runs or sags.
- D. Stainless Steel: Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- E. Aluminum: AA-M10 (Mechanical Finish: As fabricated, unspecified).
- F. Non-Slip Abrasive Surfaces: SLIP-NOT as manufactured by the W. S. Molnar Company or approved equal. Fabricate from steel plate or bar with abrasive material metallurgically bonded to steel by a proprietary process. Provide material with coefficient of friction of 0.6 or higher when tested according to ASTM C1028.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. Remove foreign substances from surfaces to receive metal items.
- B. Protect surrounding surfaces from damage while performing the work of this section.

### **3.02 INSTALLATION**

- 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.
- 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 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 06610  
FIBERGLASS REINFORCED PLASTIC (FRP) CEILING PANEL**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Furnish, fabricate (where necessary), and install all fiberglass reinforced plastic (FRP) items, with all appurtenances, accessories and incidentals necessary to produce a complete, operable and serviceable installation as shown on the Contract Drawings and as specified herein, and in accordance with the requirements of the Contract Documents.

**1.02 RELATED SECTIONS**

- A. Metal Fabrications: Section 05500
- B. Stainless Steel: 05121

**1.03 REFERENCES**

- A. The publications listed below (latest revision applicable) form a part of this specification to the extent referenced herein. The publications are referred to within the text by the designation only.
  - 1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) Test Methods:
    - a. ASTM D635 Rate of Burning and/or Extent and Time of Burning of Self Supporting Plastics in a Horizontal Position
    - b. ASTM E84 Surface Burning Characteristics of Building Materials
    - c. ASTM D638 Standard Test Method for Tensile Properties of Plastics
    - d. ASTM D695 Standard Test Method for Compressive Properties of Rigid Plastics
    - e. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
    - f. ASTM D3846 Standard Test Method for In-Plane Shear Strength of Reinforced Plastics
    - g. ASTM D953 Standard Test Method for Bearing Strength of Plastics
    - h. ASTM D256 Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

**1.04 SUBMITTALS**

- A. The General Contractor shall furnish shop drawings of all fabricated panels and accessories in accordance with the provisions of this Section. Submit signed and sealed shop drawings by a professional engineer licensed in the District of Columbia for review.
- B. The General Contractor shall furnish manufacturer's shop drawings clearly showing material sizes, types, styles, part or catalog numbers, complete details for the fabrication and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.
- C. The General Contractor shall submit the manufacturer's published literature including structural design data, structural properties data, panel load/deflection tables, corrosion resistance tables, certificates of compliance, test reports as applicable, concrete anchor systems and their allowable load tables, and design calculations for systems that will be used under this contract. Submit signed and sealed design calculations for panels, panel

attachments as per the design load and deflection requirements specified in the contract documents.

- D. The General Contractor shall submit sample pieces of each item specified herein for acceptance by the Authority as to quality and color. Sample pieces shall be manufactured by the method to be used in the Work.
- E. Product Data: Submit material manufacturer's published product descriptive data indicating the following items:
  - 1. Minimum physical properties data and applicable descriptive test data for each product.
  - 2. Include pertinent installation instructions for prefabricated products.
  - 3. Submit certification that products comply with specified test data and/or referenced standards.

### **1.05 QUALITY ASSURANCE**

- A. All items to be provided under this Section shall be furnished only by manufacturers having a minimum of ten (10) years of experience in the design and manufacture of similar products and systems. Additionally, a record of at least five (5) previous, separate, similar successful installations in the last five (5) years shall be provided.
- B. Manufacturer shall offer a 3-year limited warranty on all FRP products against defects in materials and workmanship
- C. Manufacturer shall be certified to the ISO 9001-2008 standard.
- D. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, and AARR).

### **1.06 PRODUCT DELIVERY AND STORAGE**

- A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.
- B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Adhesives, resins and their catalysts are to be stored in dry indoor storage facilities between 70 and 85 degrees Fahrenheit until they are installed.

## **PART 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Acceptable Manufacturers for FRP Panels:
  - 1. Strongwell; Composolite Fiberglass Building Panel System, Fire Retardant

### **2.02 GENERAL**

- A. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- B. Fiberglass reinforcement shall be unidirectional glass rovings along with multidirectional mat reinforcement in sufficient quantities as needed by the application and/or physical properties required.
- C. Resin shall be Vinyl Ester with chemical formulations as necessary to provide the corrosion and chemical resistance, strength and other physical properties as required.



- D. All finished surfaces of FRP items and fabrications shall be smooth, resin rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering. A U.V. resistant synthetic veil shall be applied to all exposed surfaces.
- E. All FRP panel products shall have a tested flame spread rating of 25 or less per ASTM E 84 Tunnel Test. Panel shall not burn past the 25-mm reference mark and will be classified HB per ASTM D635.
- F. All clips and fasteners shall be manufactured of Type 304 Stainless Steel.

### 2.03 MODULAR FRP PANEL

- A. Manufacture: FRP modular panel shall be of a one-piece molded construction manufactured by pultrusion process. Thickness of the panel as required by design load and deflection. The cellular panel shall have a nominal thickness not less than 3 inches. Percentage of glass (by weight) shall not exceed the limit to achieve maximum corrosion and chemical resistance, and as required to maintain the structural requirements of the Contract. After molding, no dry glass fibers shall be visible on any surface. All surfaces shall be smooth and uniform with no evidence of fiber orientation irregularities, interlaminar voids, porosity, resin rich or resin starved areas.
- B. Non-slip surfacing: Panel shall have a gritted surface on the top side, integrally molded into the panel during the manufacturing process. Panels which are secondarily gritted shall not be allowed.
- C. Fire rating: Panel shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with ASTM E 84. Certifications shall be dated within the past two years and test data performed only on the resin shall not be acceptable.
- D. Resin system: The resin system used in the manufacture of the panel shall be Fire Retardant Vinyl Ester Resin. Manufacturer will be required to submit corrosion resistance data from tests performed on actual panel products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of panel product corrosion resistance and shall not be accepted.
- E. Color: Slate Grey
- F. Depth: As required to meet the design load and deflection. Minimum thickness 3 inches (with a tolerance of plus or minus 0.005 inch).
- G. Load/Deflection: Panel load/deflection requirements at the required span shall be less than manufacturers published maximum recommended loads. Load/deflection not to exceed the following:
  - 1. Uniform distributed load over a 4 feet span: 100 pounds per square foot
  - 2. Concentrated Load: 400 pounds at a location that produces maximum effect.
  - 3. Maximum allowable deflection for a 4 feet span: L/180
- H. Mechanical Properties:
  - 1. Flexural Strength (along the span direction),  $f_{yu}$ : 24.5 ksi
  - 2. Flexural Strength (across the span direction),  $f_{xu}$ : 8.2 ksi
  - 3. Flexural Modulus (along the span direction): 885 ksi
  - 4. Flexural Modulus (across the span direction): 646 ksi
  - 5. Ultimate Tensile Strength (along the span direction): 31 ksi
  - 6. Ultimate Tensile Modulus (along the span direction): 2,486 ksi

- I. Substitutions: Other products of equal strength, stiffness, fire retardant, corrosion and chemical resistant and overall quality may be submitted with the proper supporting data to the Authority's Representative and Engineer of Record for approval.

## **2.04 PANEL FABRICATION**

- A. Measurements: Panel supplied shall meet the dimensional requirements and tolerances as shown or specified. General Contractor shall field verify the locations of existing wedge inserts and existing reinforcement in track deck slabs for work fabricated to fit field conditions as required by the contract documents to complete the work. Contractor shall determine correct size and locations of required holes or cutouts from field dimensions before panel fabrication.
- B. Layout: Each panel section shall be readily removable, except where indicated on drawings. Manufacturer to provide openings and holes as required to suit the existing field conditions. Panel openings shall be discontinuous at approximately the centerline of opening so each section of panel is readily removable. Additional supports at openings shall be provided by the Contractor.
- C. Sealing: All shop fabricated panel cuts shall be capped with end cap and sealed to provide maximum corrosion resistance. Field cutting of panels are not allowed unless otherwise authorized by Authority's Representative.
- D. Hardware: Type 304 stainless steel hold down clips shall be provided and spaced at a maximum of four feet apart with a minimum of two per piece of ceiling panel, or as designed by professional engineer appointed by General Contractor. All panels are to be bolted in place.

## **PART 3 EXECUTION**

### **3.01 INSPECTION**

- A. The panel shall be as free, as commercially possible, from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles and pits. The surface shall have a smooth finish (except for grit top surfaces).
- B. Inspect all items prior to placement. Repair or replace damaged items as directed by Authority's Representative and Engineer of Record.
- C. Inspect installed work of other trades and verify such work is complete to point where this work can properly commence.
- D. General contractor to coordinate sequence of installation with other trades.

### **3.02 INSTALLATION**

- A. Contractor shall install sheets in accordance with manufacturer's assembly drawings. Lock sheet panels securely in place with hold down fasteners as specified herein and the Contract Drawings. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

**END OF SECTION**

**SECTION 07900  
SEALS AND SEALANTS**

**PART 1 GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies providing any sealants not specified elsewhere.

**1.2 REFERENCE STANDARDS**

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

**1.3 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.
  3. 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
  4. Where a manufacturer's colors are insufficient for proper color- match, use acceptable colors from another acceptable manufacturer.
  5. 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, on an average minimum air temperature of zero degrees F and a 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.

#### 1.4 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.

#### 1.5 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.

## 1.6 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

### 2.1 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**

### **3.1 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.
  - 3. 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.
  - 4. 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.
  - 5. 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.
  - 6. Install size of backup rod that will provide approximately 30 percent compression.
  - 7. 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.
  - 8. 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.

9. 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.

### **3.2 INSTALLATION**

- A. Comply with ASTM C1193 and with manufacturer's recommendations, except where more stringent requirements are shown or specified.
- B. 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.
- C. Install back-up material, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application used.
- D. Install bond-breaker tape where shown and where recommended by manufacturer to ensure that sealants will perform as intended.
- E. 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.
  1. 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.
  2. 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.
  3. 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.
  4. 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.
- F. 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.
- G. 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.

### **3.3 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.

### **3.4 FIELD TESTING**

- A. Sealant: Field test cured sealant installations in the presence of and where directed by the Engineer. Test each type of joint sealant for adhesion to joint substrates by hand-pull method as follows:
1. Make knife cuts as follows: A transverse cut from one side of joint to the other, followed by parallel cuts approximately 2 inches long at each side of joint and meeting the transverse cut at the end of the 2-inch cuts. Place a mark 1 inch from the top of 2-inch piece.
  2. Use fingers to grasp the 2-inch piece of sealant just above the 1-inch mark; pull firmly away at a 90-degree angle while holding a ruler alongside of sealant; pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than the distance equaling the specified maximum movement capability in extension; hold this position for 10 seconds.
  3. Report whether or not the sealant in joint (connected to pulled-out portion) failed to adhere to joint substrates or failed cohesively or adhesively. Include data on pull distance used to test each type of sealant and joint substrate.
  4. Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered acceptable, subject to certification of design and performance criteria by the manufacturer.
  5. Make a minimum of 10 such tests unless otherwise directed by the Engineer. Submit report of testing to the Engineer.

### **3.5 CLEANING**

- A. Immediately clean off excess primers, drippings, sealants and sealant smears as work progresses, using methods and with cleaning materials approved by manufacturer of each joint primer and sealant and by manufacturers of materials where joints occur.
- B. Use only materials and methods acceptable to the Engineer.

**END OF SECTION**



**SECTION 07911  
EXPANSION JOINT SEAL REPLACEMENT**

**PART 1 GENERAL**

**1.1 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.

**1.2 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.

**1.3 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
- 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**

**2.1 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 1/8" wide by 1/8" deep grooves spaced between 1/4" to 1/2" apart, running the entire length of the side wall bonding surfaces.
3. 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) 1/2 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

4. 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 M
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.

D. Silicone Rubber Sealant

1. For deck joint locations with a cross slope  $\leq 6\%$  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 = 1/2" x 1/2" x 2", 10 cycles)	+100% / -50%	ASTM C793

2. 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

## 2.2 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.
- C. 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

### **2.3 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.
- F. Soiled or damaged joint material shall not be used without written consent and instructions from the manufacturer, and the AR.

## **PART 3 EXECUTION**

### **3.1 JOB CONDITIONS:**

- A. Comply with all applicable OSHA and WMATA safety regulations and procedures.

### **3.2 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. Re-pour 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.

### **3.3 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 40mils (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  $\leq 6\%$ .
- 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  $\leq 6\%$  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 09920  
FIELD PAINTING**

**PART 1 GENERAL**

**1.1 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 under coaters, 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.

**1.2 REFERENCE STANDARDS:**

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

**1.3 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.

#### **1.4 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.

#### **1.5 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.

#### **1.6 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**

- 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
  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.

## 2.2 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.

### 2.3 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.
    - b. When the finish coat is applied to a floor surface, add anti-slip aggregate.
    - c. Epolon Series.
    - d. Duron: Dura Clad Polyamide Epoxy.
    - e. Moore: IronClad Chemical and Water-Resistant Epoxy Enamel.
    - f. 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:
    - 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:
    - 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**

#### **3.1 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.

#### **3.2 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.

**3.3 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.

**3.4 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.

**3.5 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:

Line	Pipe Color	Black Stenciled Legend
Fire lines	Red	F (use White Stencil instead of black)

**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. UL 467, Grounding and Bonding Equipment.
  - 4. ITS: Directory of ITS Listed Products.
  - 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. 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.

**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.
- C. Grounding for Personnel Safety:
  1. Exothermically weld or gas torch braze grounding and bonding connection to exposed metallic structure, structural metal deck/plating, junction box. Repair damaged galvanized coating in accordance with Section 02820.

#### **3.02 BONDING FOR STRAY CURRENT AND CATHODIC PROTECTION:**

- A. 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**

**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. UL: 44, Rubber-Insulated Wires and Cables Thermoset-Insulated Wires and Cables;1581, Standard for Electrical Wires, Cables, and
  - 7. 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.
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. 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. 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.
- C. To facilitate pulling cable, use listed per UL or ITS directory lubricant recommended by cable manufacturer.
- D. In damp and dusty indoor locations, tunnel areas, manholes and outdoor locations, seal cable at conduit termination using duct-sealing compound.

- E. 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.

**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.

**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. 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
  - 5. 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.
- B. 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:  $1 \times 10^{14}$  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 21-96.
  - 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. On cable splices, taps and terminations in 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 and taps in 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.

**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 Chloride (PVC) Tubing and Conduit.
  - 4. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc Coated; and Z55.1, Gray Finishes for Industrial Apparatus and Equipment.
  - 5. UL: 6, Rigid Metal Conduit; 50, Enclosures for Electrical Equipment; 94, Test for Flammability of Plastic Materials for Parts in Devices and Appliances; 360, Liquid Tight Flexible Steel Conduit; 514A, Metallic Outlet Boxes; 514B, Fittings for Conduit and Outlet Boxes.
  - 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.
  10. NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems
- 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.
    - c. Ductile iron: ASTM A536-84(1999)e1.
    - d. Malleable iron: ASTM A47/A47M-99.
    - e. Bronze extrusion: ASTM B455-96, Alloy C38500.
    - f. Bronze casting: ASTM B584-00, Alloy C83600.
    - g. Rigid fiberglass reinforced epoxy: UL 1684.
    - h. 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. Conduit Expansion Fittings and Expansion and Deflection Fittings:
  1. Materials:
    - a. For galvanized-steel rigid conduit:
      - 1) Expansion fittings: Steel or malleable iron, hot-dip galvanized.
      - 2) Expansion/deflection fittings: Bronze or ductile iron end couplings, neoprene sleeve and stainless-steel clamping bands.
    2. Conduit expansion fitting: Weatherproof.
    3. Conduit expansion and deflection fitting: Watertight.
    4. Metallic fittings equipped with bonding jumper cable to provide electrical continuity.
  - D. Conduit Connector Fittings:
    1. UL 514B, material and finish similar to that of conduit with which they are to be used.
    2. For enclosure, cabinets, boxes and gutters with hub in outdoor, tunnel, underground, and wet indoor locations: Threaded watertight hub fitting with gasket.
  - E. 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. 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.
  - F. 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.
- G. 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.
      - 3) NEMA 3R type 316 stainless steel in outdoor and wet indoor locations.
    - c. For outdoor, underground, and wet indoor locations:
      - 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.
  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.
    - e. For aboveground indoor locations and electrical rooms: Punched or formed knockouts.
    - f. For outdoor, underground, and wet indoor locations:
      - 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 for dry indoor locations, and stainless steel 316 NEMA 3R or 4X, as shown.
  - 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:
    - 1) Galvanized sheet metal enclosures: 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.
    - 2) Stainless Steel enclosures: Brushed finish, with all hardware of same or better stainless-steel grade.
- H. Expansion Bolt Anchors: FS FF-S-325C Group II, stainless steel, Type 304, or approved equal.

## **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.
- 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. 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.
- 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.

**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.

**3.04 FIELD QUALITY CONTROL:**

- A. Arrange with the Engineer for inspection and approval of embedded conduit and boxes prior to concrete placement.
- B. Test metallic conduit and boxes for electrical continuity. Conduct tests in presence of Engineer.
- C. 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.

**END OF SECTION**

**SECTION 16525  
LIGHTING FIXTURES**

**PART 1 GENERAL**

**1.01 DESCRIPTION:**

- A. This section specifies providing lighting fixtures.
- B. Related Work Specified Elsewhere:
  - 1. Grounding and bonding: Section 16060.
  - 2. Wire and cable: 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:
  - 2. Include photometric curves.
  - 3. Samples: One of each type of fixture.

4. 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 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. LED: As specified.
  5. Fixture body and housing: Shape, size and material as shown.
  6. Fixture wire: Section 16120.
  7. 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.
  - e. Field painting: Not used.
8. Mark each fixture and its components in accordance with applicable reference standard.
  9. Conduit: Section 16130.
  10. Connectors: Section 16125.
  11. 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: Not used.
- 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.
  4. Clean lamps, diffusers, globes, reflectors and exposed-to-view surfaces of fixtures after aiming and adjusting has been approved.

**3.02 FIELD QUALITY CONTROL:**

- A. Testing:
1. Furnish necessary personnel and equipment and perform tests and adjustments in the presence of the Engineer. Schedule adjustment of exterior installations to occur during hours of darkness.
  2. Test lighting circuits for continuity and operation.
  3. Test fixtures for continuity of grounding system.
  4. Aim and adjust fixtures to provide distribution pattern approximately as shown and as approved.

**END OF SECTION**